리박트® 과립

"리박트®는
근감소증 증상을
호전시켜 줍니다.[1*]"





*Leucine.

References 1. Kim HK, et al. J Am Geriatr Soc. 2012;60:16-23.

[제품명] 리박트과립 **[성분]** 리박트과립 1포(4.15g) 중 L-이스로이신 925mg L-로이신 1904mg, L-발린 1144mg **[성상]** 백색의 제피를 한 과립제로 약간의 방향과 감미가 있다. **[효능·효과]** 식사섭취량이 충분함에도 불구하고 저알부민혈증을 나타내는 비대상성 간경변환자의 저알부민혈증의 개선 **[용법·용량]** 통상 성인에 1회 1포(4.15g)를 1일 3회 식후 경구투여한다. **[저장방법]** 차광한 기밀용기, 실온보관(1~30℃)
※ 자세한 내용은 제품 설명서를 참조하시기 바랍니다.

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2026년 3월 21일(토)~ 22일(일) I SETEC 컨벤션센터

주최 · 주관. 사단법인 대한스포츠의학회
평 점. 21일(토): 의협평점 5점, 인증전문의 50점
22일(일): 의협평점 6점, 인증전문의 60점



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✚ Evidence in focus

Publication summary

Smith+Nephew

A **randomised controlled** trial(RCT) of medium and large full-thickness rotator cuff repairs augmented with the **REGENETEN® Bioinductive Implant** demonstrated significantly **lower re-tear rates,** compared with repair alone



Ruiz Ibán MA, Navlet MG, Marco SM, et al. Augmentation of a transosseous equivalent repair in posterosuperior non-acute rotator cuff tears with a bioinductive collagen implant decreases the re-tear rate at one year. A randomised controlled trial. Arthroscopy. Published online December 27, 2023.

Key points

Compared with repair alone, repair augmented with the REGENETEN Implant at 12-months follow-up demonstrated:

- **3x** Lower risk of re-tear
- Significantly better tendon integrity (p=0.03)
- No additional complications

Overview

- Blinded, **multi-centre,** RCT comparing the healing rate of fullthickness rotator cuff tears repaired with and without the augmentation of the REGENETEN Implant
- **124* patients** with reparable † medium and large (1–4cm) full-thickness posterosuperior rotator cuff tears were randomised (1:1) after suture anchor repair to receive either:
  - arthroscopic transosseous equivalent double-row rotator cuff repair (control group; n=62)
  - arthroscopic transosseous equivalent double-row rotator cuff repair augmented with the REGENETEN Implant (REGENETEN Implant group; n=60)
- No differences in pre-operative patient characteristics
- Primary outcome re-tear rate assessed on **MRI at 12 months** using the Sugaya classification
  - re-tear defined as Sugaya grades 4–5
- Secondary outcomes were characteristics of the healed tear (healed tear defined as Sugaya grades 1–3) and clinical outcomes including Brief Pain Inventory, EQ-5D-5L questionnaire, Constant-Murley score, American Shoulder and Elbow Society score and time to return to work

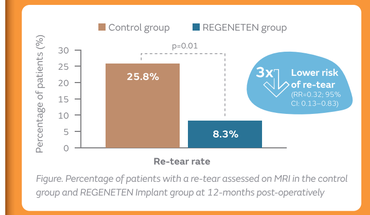


Figure. Percentage of patients with a re-tear assessed on MRI in the control group and REGENETEN Implant group at 12-months post-operatively

Results

At **12-months follow-up,** compared with repair alone, repair augmented with the REGENETEN Implant demonstrated:

- **Significantly lower re-tear rate (8.3 vs 25.8%; p=0.01; Figure)**
- **Significantly better tendon integrity (91.7 vs 74.2%; p=0.03)**
- **A three times lower risk of re-tear (RR=0.32; 95% CI: 0.13–0.83; Figure)**
- No differences in clinical outcome measures between groups
- No difference in the number of serious or minor complications

Conclusions

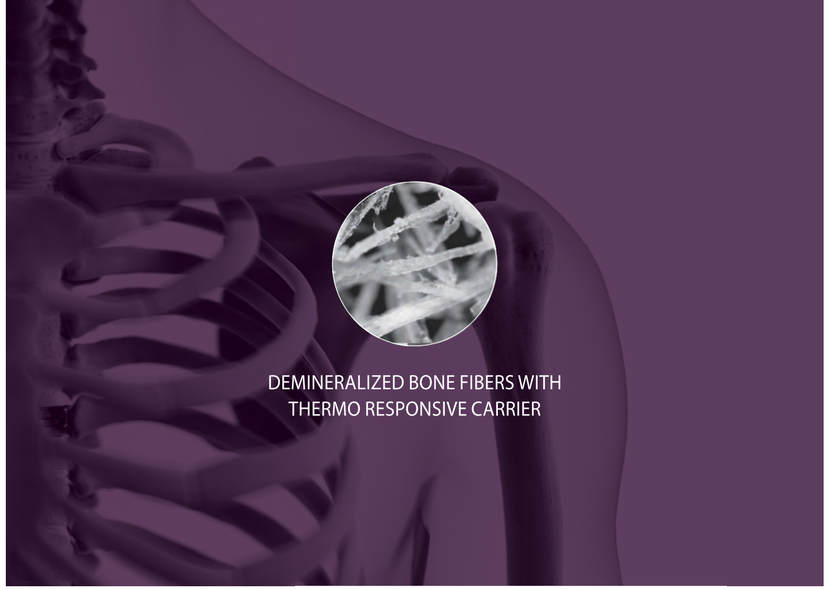
In a randomised controlled trial, results assessed on MRI at 12-months post-operatively demonstrated that repair of medium and large full-thickness tears augmented with the REGENETEN Bioinductive Implant led to better tendon integrity, reduced risk of re-tear and significantly lower re-tear rates compared with repair alone.

Abbreviations: CI = confidence interval; RR = relative risk.

*2 patients were lost at follow-up. †>80% footprint coverage without tension.

For detailed product information, including indications for use, contraindications, precautions and warnings, please consult the product's applicable Instructions for Use (IFU) prior to use.

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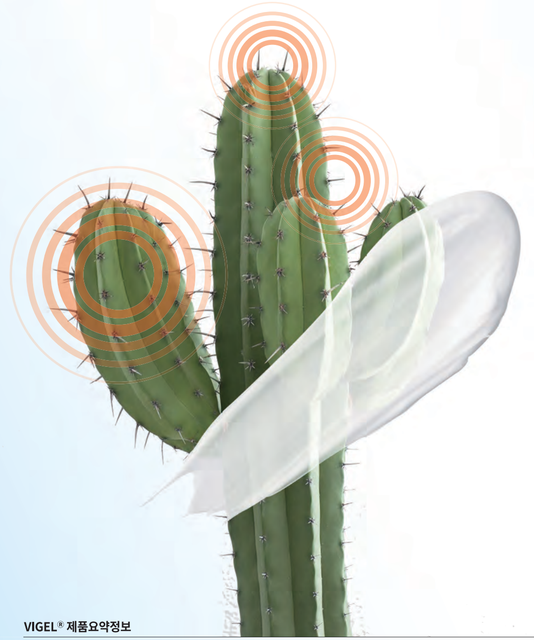
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[원료약품의 분량] 1g중 인도메타신(KP) 10.0mg **[첨가제]** 백납지방산에스테르, 정제수, 카프릴릭·카프릭트리글리세라이드, 티오황산나트륨수화물, 글리세린, 에데트산나트륨수화물, 파라옥시벤조산메틸, 파라옥시벤조산프로필, 카보머934, L-멘톨, 디이소프로필아디프산염, 디이소프로판올아민 **[성상]** 백색 ~ 연한 황색의 크림제 **[효능·효과]** 다음 질환 및 증상의 진통 · 소염 : 퇴행성관절염(골관절염), 어깨관절주위염, 건·건초염, 건주위염, 상완골상과염(테니스 엘보우 등), 근육통, 외상후의 종창 · 동통 **[용법·용량]** 통상에 따라 적당량을 1일 수회 환부에 바르고 잘 스며들도록 가볍게 문지른다. **[사용상의 주의사항]** 1.다음 환자에는 투여하지 말 것. 1) 이 약 또는 가르텐 인도메타신 제제에 과민증 및 그 밖에이 있는 환자 2)아스피린 천식(아스피린으로 소염진통제 등에 의한 천식 발작 유발)또는 그 병력이 있는 환자중증 천식발작을 일으킬 수 있다.3) 아스피린 또는 기타의 비스테로이드성 소염진통제에 기관지경련의 병력, 비염 및 맥관부종을 일으킨 환자 4).14세 미만의 소아 2. 다음 환자에는 신중히 투여할 것. 기관지 천식 환자(중증 천식발작을 일으킬 수 있다).3. 부작용 1) 매체로 가려움, 발적, 발진, 접촉피부염, 습진(투여 중지시 증상이 소실되기이 나타날 수 있으며 드물게 열감, 홍반, 홍조, 어니림박 시, 광과민증, 위장관불쾌감, 두통, 어지러움이 나타날 수 있다. 이러한 증상이 심한 경우에는 사용을 중지한다. 2) 건선 환자의 경우 증상이 악화될 수 있다.3. 피부반응, 기관지경련, 속에 이르는 혈압하강 등의 과민 반응이 나타날 수 있다. 특수한 경우 두통, 구역, 구토, 변, 탈력 뻣뻣함 또는 의식혼탁 등의 증상을 수반하는 무균성 뇌막염이 나타날 수 있다.(스프레이액제에 한함). **[저장방법]** 기밀용기 **[포장단위]** 자사 포장단위 ※제품에 대한 자세한 사항은 제품설명서를 참고하시기 바랍니다.

※**제품에 대한 자세한 사항은 제품설명서를 참고하시기 바랍니다.**

Ref. 1. 2023년 UBIST [M2A] 외용 류마티즘 치료제 및 진통제 기준 2. Osteoarthritis Cartilage. 2019 Nov;27(11):1578-1589.

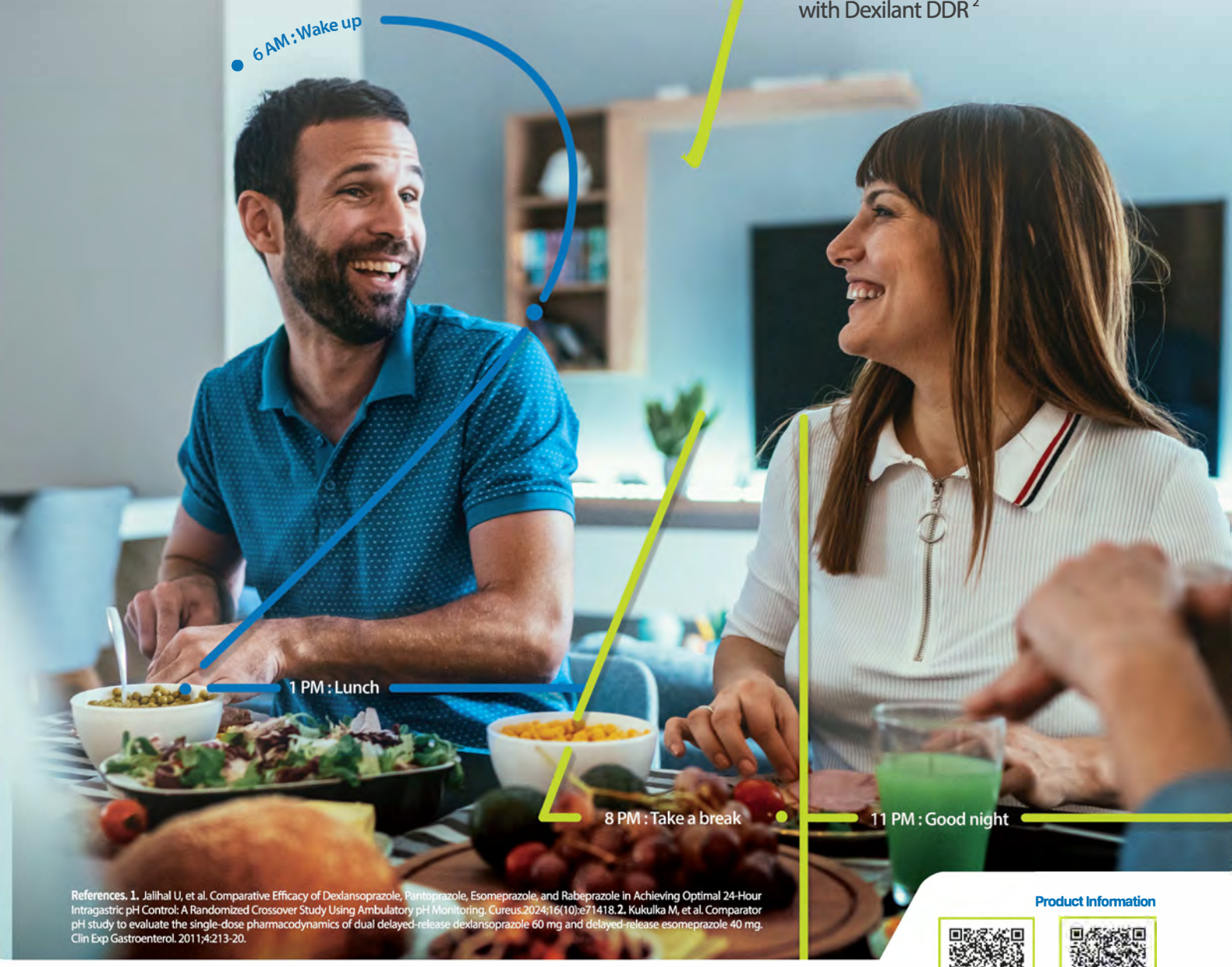
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References. 1. Jalihal U, et al. Comparative Efficacy of Dexlansoprazole, Pantoprazole, Esomeprazole, and Rabeprazole in Achieving Optimal 24-Hour Intragastric pH Control: A Randomized Crossover Study Using Ambulatory pH Monitoring. Cureus.2024;16(10):e71418. **2.** Kukulka M, et al. Comparator pH study to evaluate the single-dose pharmacodynamics of dual delayed-release dexlansoprazole 60 mg and delayed-release esomeprazole 40 mg. Clin Exp Gastroenterol. 2011;4:213-20.

Product Information

덱실란트디알캡슐
30밀리그램 (덱스란소프라졸)

덱실란트디알캡슐
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C-APROM/KR/DEXI/0209 Date of preparation:SEP/2025

수입원

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판매원

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- 글루코코르티코이드 유발성 골다공증의 치료[2)]
- 안드로겐 차단요법을 받고 있는 비전이성 전립선암 환자의 골 소실 치료[2)]
- 아로마타제 저해제 보조요법을 받고 있는 여성 유방암 환자의 골 소실 치료[2)]

Product Information[2)]

성분·함량	1mL 중 Denosumab 60mg	용법·용량	1시린지를 매 6개월마다 피하주사	포장 정보	1개 X 프리필드시린지(1mL)/박스
사용 기간	제조일로부터 36개월	저장 방법	밀봉용기, 동결을 피하여 차광, 냉장(2~8℃)		

Ref 1) Chung YS, et al. *Bone*. 2025 Mar;192:117371. **2)** 식품의약품안전처. 오보덴스프리필드시린지(데노수맙) 허가사항(2025년 4월 기준)
[성상] 무색 내지 약간 노란색이고, 투명하며 입자를 거의 포함하지 않는 액이 무색 투명한 프리필드시린지에 들어 있는 주사제 **[원료약품 및 그 분량]** 이 약 1 프리필드시린지(1 mL) 중, 주성분: 데노수맙(별규) 60 mg, 첨가제: 히스티딘, 히스티딘염산염, 폴리소르베이트20, 소르비톨, 주사침, 용제: 주사용수 **[효능·효과]** 1. 폐경 후 여성 골다공증 환자의 치료 2. 남성 골다공증 환자의 골밀도 증가를 위한 치료 3. 글루코코르티코이드 유발성 골다공증의 치료 4. 안드로겐 차단요법을 받고 있는 비전이성 전립선암 환자의 골 소실 치료 5. 아로마타제 저해제 보조요법을 받고 있는 여성 유방암 환자의 골 소실 치료 **[용법·용량]** 이 약은 보건의료 전문가에 의해 투여되어야 한다. 이 약 1 시린지(데노수맙 60 mg)를 매 6개월마다 상완, 허벅지 위쪽 또는 복부에 피하 주사한다. 모든 환자는 칼슘 1000 mg과 비타민D 400 IU 이상을 매일 복용해야 한다. 정기 투여일에 이 약을 투여하지 못했을 경우, 가능한 빨리 투여한다. 그 후, 마지막 투여일자로부터 매 6개월 마다 투여한다. **[사용상의 주의사항]** 이 약은 프롤리아프리필드시린지(데노수맙)을 대조약으로 한 동등생물의약품이다. **[포장단위]** 1개 x 프리필드시린지(1 mL)/박스 **[저장방법]** 밀봉용기, 동결을 피하여 차광, 냉장(2 ~ 8 °C) 보관 **[사용기한]** 외부포장을 참조하십시오. **[수입자]** 삼성바이오에피스(주), 대한민국, 인천광역시 연수구 송도교육로 76 **[제조의뢰자]** 삼성바이오에피스(주), 대한민국, 인천광역시 연수구 송도교육로 76 ※ 자세한 의약품정보는 식품의약품안전처 의약품통합정보시스템 (https://nedrug.mfds.go.kr →「의약품 등 정보」→「의약품 및 화장품 품목정보」→「의약품등 정보검색」) 을 참조하십시오.
※ 이 첨부문서 개정일자 이후 변경된 내용은 식품의약품안전처 의약품통합정보시스템(https://nedrug.mfds.go.kr)에서 확인할 수 있습니다.

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References

1. Wang-Smith L et al., Pharmacokinetics and relative bioavailability of a fixed-dose combination of enteric-coated naproxen and non-enteric-coated esomeprazole magnesium. *J Clin Pharmacol.* 2012;52(5):670-680.

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비모보정 500/20 밀리그램

• 주성분: 나프록센 500밀리그램, 에스오메프라졸마그네슘삼수화물 22.3밀리그램 **• 적응증(효능·효과)**: 비스테로이드성 소염진통제(나프록센 등)와 관련한 위궤양 및/또는 십이지장궤양의 발생 위험이 있으면서 저용량 나프록센 또는 다른 비스테로이드성 소염진통제에 의해 충분하지 않은 환자에서의 골관절염, 류마티스성 관절염, 강직성척추염의 증상 치료 **• 용법·용량**: 성인: 1일 2회, 1회 1정(나프록센 500mg/에스오메프라졸 20mg)씩 경구투여한다. 이 약은 쪼개거나 씹거나 부수지 말고 물과 함께 그대로 삼켜서 복용한다. 식전 최소 30분 전에 복용하는 것을 권장한다. **• 사용상 주요 주의사항**: 1. 경고 1) 매일 세잔 이상 정기적으로 술을 마시는 사람이 이 약이나 다른 해열진통제를 복용해야 할 경우 반드시 의사 또는 약사와 상의해야 한다. 이러한 사람이 이 약을 복용하면 위장출혈이 유발될 수 있다. 2) 심혈관계 위험: 이 약을 포함한 비스테로이드성 소염진통제는 중대한 심혈관계 혈전 반응, 심근경색증 및 뇌졸중의 위험을 증가시킬 수 있으며, 이는 치명적일 수 있다. 이러한 위험은 빠르면 치료 시작 첫 주에 발생할 수 있으며 투여 기간에 따라 증가될 수 있다. 심혈관계 혈전위험의 증가는 높은 복용량에서 일관되게 관찰되었다. 심혈관계 질환(예를 들면 비조절성 고혈압, 울혈성심부전, 허혈성 심질환, 말초동맥질환 및/또는 뇌혈관질환)이 있는 환자 및 심혈관계 질환의 위험 인자(예를 들면 고혈압, 고지혈증, 당뇨병 및 흡연)가 있는 환자에서는 더 위험할 수도 있으므로 신중하게 고려한 이후에 이 약으로 치료하여야 한다. 의사와 환자는 이러한 심혈관계 증상의 발현에 대하여 신중히 모니터링하여야 하며, 이는 심혈관계 질환의 병력이 없는 경우에도 마찬가지로 적용된다. 환자는 중대한 심혈관계 독성의 징후 및/또는 증상 및 이러한 증상이 발현되는 경우 취할 조치에 대하여 사전에 알고 있어야 한다. 3) 위장관계 위험: 이 약을 포함한 비스테로이드성 소염진통제는 위 또는 장관의 출혈, 궤양 및 천공을 포함한 중대한 위장관계 이상반응의 위험을 증가시킬 수 있으며, 이는 치명적일 수 있다. 나프록센 단독투여에 비하여 이 약이 위궤양 발생을 유의하게 감소시켰으나, 궤양 및 그와 관련된 합병증은 여전히 발생된다. 이러한 이상반응은 투여 기간 동안에 경고 증상 없이 발생할 수 있다. 고령자는 중대한 위장관계 이상반응의 위험이 더 클 수 있다. 투여 기간이 길어질수록 중대한 위장관계 이상반응의 발생 가능성이 증가될 수 있으나 단기 투여시 이러한 위험이 완전히 배제되는 것은 아니다. 이 약을 투여하는 동안 위장관계 궤양 또는 출혈의 증상 및 징후에 대하여 신중히 모니터링 하여야 하며, 중증의 위장관계 이상반응이 의심되는 경우 즉시 추가적인 평가 및 치료를 실시하여야 한다. 비스테로이드성 소염진통제를 중증의 위장관계 이상반응이 완전히 배제될때까지 투여 중단하는 것도 치료법이 될 수 있다. 고위험군의 환자에게는 비스테로이드성 소염진통제와 관련 없는 다른 대체 치료제를 고려하여야 한다. 2. 다음 환자에는 투여하지 말 것 1) 나프록센, 에스오메프라졸, 치환기인 벤즈이미다졸 및 이 약의 구성성분에 과민증이 있는 환자 2) 아스피린이나 기타 비스테로이드성 소염진통제(COX-2 저해제 포함)의 투여에 의하여 천식, 비염, 코의 용종, 두드러기, 알레르기 반응 또는 그 병력이 있는 환자 (이러한 환자에서 비스테로이드성 소염진통제 투여후 치명적인 중증의 아나필락시양 반응이 드물게 보고되었다.) 3) 활동성 소화성 궤양 환자 4) 위장관출혈, 뇌혈관출혈, 기타 출혈질환 환자, 심한 혈액이상 환자 5) 중증 간장애 환자(예, Childs-Pugh 등급 C) 6) 중증의 심부전 환자 7) 중증의 신장애 환자 (크레아티닌 클리어런스 30mL/min 미만) 8) 심한 고혈압환자 9) 관상동맥 우회로술(CABG) 전후에 발생하는 통증의 치료 10) 임신 말기 3개월 기간에 해당하는 임부 11) 아타자나비어, 넬피나비어 투여환자 12) 릴피비린 함유제제를 투여중인 환자 (「6. 상호작용」 참조) **• 설명서 개정년월일: 23년 5월 14일**

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References 1. SH Baek et al., Korean Pain Soc. 2004; 17(2):234-238 **2.** Alwine LK. Annual European Congress of Rheumatology 2000;59(1) :136
3. J.C Silverfield et al., Clinical Therapeutics 2002;24(2) : 282-297

* 보다 자세한 사항은 제품설명서를 참조하시거나 삼진제약 소비자 상담실 (080-082-1234)로 문의하십시오. www.samjinpharm.co.kr

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효과는 빠르고 강력하게[1]
적응증과 제형은 다양하게[2,3]
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[References] **1.** Han S, et al. Aliment Pharmacol Ther. 2019;50(7):751-759 **2.** K-CAB® tablet prescribing information(2023.11.30) **3.** K-CAB® orally disintegrating tablet prescribing information(2023.4.17)

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■ 효능효과 : 비스테로이드성 소염진통제와 관련한 위궤양 또는 십이지궤양의 발생 위험이 있으면서 저용량 나프록센 또는 다른 비스테로이드성 소염진통제로 충분하지 않은 환자에서의 골관절염, 류마티스성 관절염, 강직성척추염의 증상 치료

1) BMJ 2011;342:C7086 / N Engl j Med 2005;352:1071-80 2) Am J Gastroenterol, 2005;100(12):2650-7 / Aliment Pharmacol Ther 2010; 32:401-413

HM-Design2410_02

국내 최초의 Pregabalin 25mg, 50mg[1]



Drug Information[2]

성분 · 함량

Pregabalin 25mg, 50mg, 75mg, 150mg, 300mg

효능 • 효과

1. 성인에서 말초와 중추 신경병증성 통증의 치료
2. 간질 : 성인에서 이차적 전신증상을 동반하거나 동반하지 않은 부분 발작의 보조제
3. 섬유근육통의 치료

용법 • 용량

이 약은 프레가발린으로서 1일 총 투여용량을 1일 2회로 나누어 음식물과 상관없이 경구 투여한다. 이 약은 주로 신장으로 배설되므로, 신기능이 저하된 환자에 대해서는 용량이 조절되어야 한다. 1. 신경병증성 통증 1) 말초 신경병증성 통증(성인): 이 약은 시작용량으로 1일 150mg을 투여할 수 있다. 개개 환자에서의 반응과 내약성에 근거하여 3일 내지 7일 후에 1일 300mg까지 증량할 수 있다. 필요하다면, 이후 7일 간격으로 1일 최대 600 mg까지 증량할 수 있다. 2) 중추 신경병증성 통증(성인): 이 약은 시작용량으로 1일 150mg을 투여할 수 있다. 개개 환자에서의 반응과 내약성에 근거하여 1주일 후에 1일 300mg까지 증량할 수 있다. 추가로 1주일 후에 목표 1일 용량인 600mg까지 증량할 수 있다. 목표 1일 용량에서 내약성을 나타내지 않을 경우 용량 감소가 고려될 수 있다. 2. 간질 (성인): 이 약은 시작용량으로 1일 150mg을 투여할 수 있다. 개개 환자에서의 반응과 내약성에 근거하여 일주일 후에 1일 300mg까지 증량할 수 있다. 필요하다면, 이 후 7일 간격으로 1일 최대 600mg까지 증량할 수 있다. 3. 섬유근육통: 이 약의 권장 용량은 1일 300mg~450mg 이다. 이 약은 시작 용량으로 75mg씩 1일 2회(1일 150mg)를 투여하며, 유효성과 내약성에 근거하여 1주일 이내에 150mg씩 1일 2회(1일 300mg) 까지 증량할 수 있다. 1일 300mg의 용량에서 충분한 유익성을 경험하지 못한 환자의 경우에는 1주일 이내에 225mg씩 1일 2회 (1일 450mg) 까지 증량할 수 있다. 1일 600mg의 용량에서도 임상 연구가 실시되었으나, 이 용량에서의 부가적인 유익성이나 충분한 내약성에 대한 증거는 없다. 용량 의존적인 이상반응을 고려하면, 1일 450mg을 초과하는 용량 투여는 권장되지 않는다.

사용상의 주의사항

1. 경고 1) 자살충동과 자살행동 (1) 항간질약을 복용한 환자에서 자살충동 또는 자살행동을 보이는 위험성이 증가되므로 항간질약을 치료받은 환자는 자살충동 또는 자살행동, 우울증의 발현 또는 악화 및 기분과 행동의 비정상적 변화에 대하여 모니터링되어야 한다.(2) 항간질약을 처방받는 간질과 다른 많은 질병은 그 자체가 이환 및 사망, 치료기간 동안의 자살충동과 자살행동의 위험성증가와 관련된다. 따라서 처방자는 항간질약 처방시 환자의 치료기간 동안 자살충동 또는 자살행동과 치료될 질병간의 연관성 유무 및 이 약의유효성을 함께 고려한다. 2. 다음 환자에는 투여하지 말 것 1) 프레가발린 또는 이 약의 성분에 과민한 환자 2) 이 약은 유당을 함유하고 있으므로, 갈락토오스 불내성 (galactose intolerance), Lapp 유당분해효소 결핍증 (Lapp lactase deficiency) 또는 포도당-갈락토오스 흡수장애 (glucose-galactose malabsorption) 등의 유전적인 문제가 있는 환자에게는 투여하면 안 된다.

* 기타 자세한 사항은 제품설명서를 참고하십시오.

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Reference 1. 「약제 급여 목록 및 급여 상한금액표」보건복지부 고시 제 2017-133호 (2017년 8월 15일 시행) 2. 카발린캡슐 허가사항

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- ICRS Grade 3 또는 4인 환자의 90%에서 연골결손부위가 완전히 복구되었습니다.[2]



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전문의약품

[원료약품 및 분량] 이 약 1 프리필드시린지(3.0 mL) 중 • 주성분 : 바솔자가연골유래연골세포(별규) 2.0~5.0 × 10^7개 • 현탁용제 : 패놀렛 비함유 고농도 포도당의 둘베코즈 모디파이드 이글스 메디아 3.0 mL **[성상]** 무색투명한 주사기에 담긴 연황색 맑은 용액에 백색의 펠렛들이 침강하는 주사제 **[효능효과]** 무릎 연골결손 ICRS grade Ⅱ 또는 Ⅳ, 결손면적 2 내지 10 cm^2의 치료 **[용법용량]** 성인의 무릎 관절 연골 결손 부위에 깊이를 고려한 결손 용적 1 cm^3 당 1개 프리필드시린지(4D)에 펠렛을 이식한다. * 공여조직 채취: 1) 이 약은 자가세포치료제이므로 환자 자신의 늑연골에서 표준 수술지침에 따라 공여조직을 채취하여 제조한다. 2) 이 약은 자가세포치료제이므로 투여하기 전에 대상 환자가 맞는지 확인하도록 한다. * 이식: 1) 관절연골 결손부를 관절절개술로 노출시킨다. 2) 손상된 연골의 변연절제술을 실시하고 결손부에 존재하는 혈액을 최대한 제거한 후 이식부위가 기능한 수평이 되도록 다리를 고정한다. 3) 필요할 경우 프리필드시린지에 내경 1.8 mm 굵기 이상의 철근내튜브카테터나 케뉼라 등을 부착하여 깊은 부위에 주입이 용이하도록 할 수 있다. 4) 이 약을 투여하기 전에 프리필드시린지를 가볍게 좌우로 흔들거나 손가락으로 가볍게 쳐서 펠렛들이 부유되도록 한다. 5) 이 약의 펠렛들을 연골 결손부에 서서히 주입한다. 이때 주변 연골 높이 수준으로 펠렛들을 이식하여 튀어나오거나 혈액되지 않도록 한다. 6) 펠렛의 이탈을 방지하기 위해 피브린접착제를 이식부위 표면에 얇게 점적하고 굳을 때까지 10분 내지 15분 동안 방치한다. 7) 이 약의 투여 시에는 「사용상의 주의사항」 중 적용상의 주의를 참고한다. 이식 후 재혈: 이 약의 투여 후 의사가 추천하는 재활방법에 따라 신체활동을 실시하도록 한다. **[사용상의 주의사항]** 1. 경고: 1) 이 약은 관절강을 개방한 후 투여되므로 전체 과정에서 무균상태를 유지해야 한다. 2) 이 약은 자가세포치료제이므로 타인에게 사용될 경우 면역반응과 감염원이 전달될 수 있으므로 반드시 환자 본인에게만 사용해야 한다. 2. 투여금기: 1) 우루트백질에 과민한 환자 2) 겐타마이신에 과민한 환자 3) 류마티스 관절염 등 염증성 관절 질환 환자 4) 골관절염 Kellgren-Lawrence grade 4 인 환자 5) HCV, HIV-1/2 양성인 환자 6) 응혈증혈 및 심한 정맥출혈이 있는 환자 신중투여 1) 이 약의 투여를 위해서는 연골개방시술이 필요하며 수술 중 또는 수술 후 합병 증 및 부작용이 발생할 수 있으므로 이 약의 투여에 의한 유익성이 수술의 위험성 , 을 상회한다고 판단할 경우 사용해야 한다. 2) 벙용약인 피브린접착제의 첨부문서를 확인하고 신중히 투여 3. 이상반응: 이 약을 대상으로 시행한 임상시험(1상 1건, 2상 1건)에서 관찰된 모든 이상사례는 다음 증상 등을 포함한다(이 약과의 인과관계 없을 포함): 발생2수 비율 5% 이상은 비, 오심, 수술 후 통증, 두통이며 5% 미만은 치아낭, 구토, 관절통, 요통, 근골격 통증, 목통증, 화학적 안구손상, 시술 후 혈종, 수술 후 유착, 어지러움, 접촉성 피부염, 만성부비동염, 상기도감염이다. 4. 일반적주의: 1) 투여 전 이 약에 대한 정보와 시술방법을 충분히 숙지하도록 한다. 2) 무릎 관절의 불안정성 또는 부정 정렬이 있는 경우 이 의 투여 전 또는 투여 중에 교정되도록 한다. 3) 이 약의 주성분은 살아있는 자가연골유래연골세포로 유효기간제조일시로부터 96시간 내에 사용해야 한다. 4) 스테로이드제제, 기타 관절 주사제외의 병용투여에 대한 안전성 및 유효성은 확인되지 않았다. 5) 이 약은 살아있는 자가연골유래연골세포를 포함하므로 별도의 멸균 처리를 시행하지 않는다. **[저장방법]** 일반용기 냉장(2~6℃)보관 **[사용기간]** 제조일시로부터 96시간 **[제조원 및 판매원]** ㈜ 바이오솔루션 대한민국 ※ 보다 자세한 사항은 제품설명서를 참고하여 주시기 바랍니다.

References 1 Yoon et al, Am J Sports Med, 2020 Apr;48(5):1236-1245, doi: 10.1177/0363546520905665, Epub 2020 Mar 3, 2 Yoon et al, Cartilage, 2021 Dec;13(1_suppl):1092S-1104S, doi: 10.1177/1947603520921448, Epub 2020 Jun 1.

BS-CTL-A-2022-005

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The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회
제68차 춘계학술대회

2026년 3월 21일(토)~ 22일(일) | SETEC 컨벤션센터

주최 · 주관. 사단법인 대한스포츠의학회
평　　점. 21일(토): 의협평점 5점, 인증전문의 50점
　　22일(일): 의협평점 6점, 인증전문의 60점



사단법인 대한스포츠의학회
The Korean Society of Sports Medicine

Invitation



스포츠의학의 새로운 지평: 현장의 열정과 학문의 깊이를 잇는 소통의 장

안녕하십니까.

만물이 새로운 생명력을 얻는 이 화창한 봄날, 대한스포츠의학회 춘계학술대회에 함께해주신 회원 여러분과 내외 귀빈 여러분께 따뜻한 환영의 인사를 드립니다.

오늘날 스포츠 현장은 단순한 승부를 넘어 인간의 한계에 도전하고, 기술과 의학이 융합되는 거대한 변화의 흐름 속에 있습니다. 부상 치료라는 전통적 역할을 넘어 완전한 스포츠 복귀(RTS/RTP)와 경기력 최적화, 전 생애주기에 걸친 건강 증진, 그리고 공정한 경쟁 환경의 확립까지—우리 학회가 감당해야 할 시대적 책무는 그 어느 때보다 막중합니다.

이번 학술대회는 이러한 시대적 요구에 부응하고자 '임상과 현장, 과학과 정책의 유기적 연결'을 대주제로 삼았습니다.

우리 학회의 핵심 역량인 스포츠과학, 여성스포츠, 현장 의무 협력 분야는 물론, 교육·인증 체계를 더욱 체계화하여 스포츠 현장과 긴밀히 호흡하는 전문 인력 양성에도 힘을 기울이고 있습니다. 특히 기존 AT(Athletic Trainer) 관리 체계를 발전시켜 'Sports Athletic Trainer(SAT)' 인증 제도를 새롭게 정비하였으며, 지난해 1기 수료생을 배출하였고 현재 2기 교육과정 모집을 진행하고 있습니다. 이미 본 과정을 수료한 인재들이 엘리트 스포츠 현장에 진출하여 활동하고 있다는 점은 매우 고무적인 성과라 할 것입니다. 이는 단순한 자격 부여를 넘어, 스포츠 현장의 질적 수준을 제고하고 다학제 협력 체계를 공고히 하는 우리 학회의 장기적 비전의 일환입니다.

아울러 이번 학술대회에서는 대한육상연맹(KAF), DCC-KADA(도핑방지위원회), 한국운동생리학회(KSEP), 대한정형외과스포츠의학회(KOSSM) 등 유관 단체들과의 초청 세션을 통해 종목별 특수성, 도핑 방지 정책, 기초 생리학, 정형외과적 임상까지 폭넓은 통합적 통찰을 공유하고자 합니다. 이를 통해 스포츠의학이 학문적 깊이와 현장 적용성을 동시에 갖춘 실천적 학문으로 더욱 도약하는 계기가 되기를 기대합니다.

또한 지식의 전달을 넘어 실전 역량을 강화하기 위한 다양한 Hands-on 및 실기 프로그램과, 신진 연구자들의 열정을 조명하는 구연 발표 및 시상 프로그램을 마련하였습니다. 오늘 이 자리가 경험과 지혜가 교류되는 배움의 장이자, 미래 세대가 성장하는 토양이 되기를 바랍니다.

이 귀한 자리를 위해 혜안을 나누어 주시는 좌장 및 연자 선생님들, 그리고 보이지 않는 곳에서 헌신적으로 대회를 준비해 주신 학술위원회와 관계자 여러분께 깊은 경의를 표합니다.

이번 춘계학술대회가 여러분의 진료실과 훈련 현장에 실질적인 영감을 더하고, 스포츠의학의 미래를 함께 설계하는 뜻깊은 이정표가 되기를 소망합니다.

감사합니다.

2026년 3월

사단법인 대한스포츠의학회 회장 **하철원**

Program at a glance

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(인증SAT 관리위원회 1)</td><td>구연 1</td></tr>
<tr><td>09:00-10:00</td><td>심포지엄 2: 장애인의 기능적 회복에서 스포츠 수행 능력으로: 체계적 접근법의 전환</td><td>심포지엄 3: 밀라노·코르티나담페초 동계올림픽을 위한 맞춤형 스포츠과학지원
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<tr><td>10:30-11:30</td><td>심포지엄 4:
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병원 기반 치료에서 운동 환경으로</td><td>심포지엄 5:
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뉴로사이언스, 임상적 이해,
그리고 실제 적용
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<tr><td>11:30-12:30</td><td>심포지엄 6:
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<tr><td>12:30-13:30</td><td colspan="3">런천세미나, 기념촬영 및 점심식사</td></tr>
<tr><td>13:30-14:30</td><td>심포지엄 8: 견관절 가성마비:
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에너지 밸런스를 넘어서:
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<tr><td>15:30-16:00</td><td colspan="3">Coffee Break</td></tr>
<tr><td>16:00-17:00</td><td>심포지엄 11: 스포츠에서 발생하는 근건 손상의 도전:
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Program at a glance

22일(일요일)			
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07:50-08:00	인사말 및 개회		
08:00-09:00	심포지엄 13: 글로벌 브릿지 구축: 글로벌 네트워킹에 관한 관점 (인증SAT 관리위원회 2) ROOM A		심포지엄 14: 좋은 논문, 좋은 저널: KJSM과 함께 성장하기 (편집위원회)
09:00-09:40	해외연자 강의 1: AI application in tackling Sports injury: from prevention, to surgical treatment & rehabilitation Patrick Yung (Hong Kong)		
09:40-10:00	Coffee Break		
10:00-11:00	초청세션 2: 한국운동생리학회 혈관 기능 조절과 운동 생리학	우수구연 (ROOM B)	
11:00-12:00	초청세션 3: 대한육상연맹 육상 선수들의 경기력 극대화와 부상 관리 분야의 최신 지견 (ROOM A)		
12:00-12:10	제25대 제마스포츠의학상 발표 및 시상		
12:10-13:00	정기 총회(대의원), 기념촬영 및 점심식사, MOU (대한육상연맹, 한국운동생리학회)		
13:00-13:30	해외연자 강의 2: How JSCSM make relationship and leadership with Field Coaches and trainer group? Hideo Matsumoto (Japan)	초청세션 4: 대한정형외과스포츠의학회 흔한 달리기 부상: 수술 시기와 방법	Hands on: 심폐소생술 실습 1
13:30-14:00	심포지엄 15: 러닝 심포지엄: 달리기 성능의 과학 및 실전		
14:00-15:00		심포지엄 18: 부위별 스포츠 관련 발목 손상: 전방 및 외측 인대 손상, 후방-내측 병변	Hands on: 심폐소생술 실습 2
15:00-15:30	Coffee Break		
15:30-16:30	심포지엄 16: 스마트 러닝을 위한 생체역학: 보폭·보빈도 조절에서 관절 부하 관리까지 (스포츠과학위원회 3)	심포지엄 19: KBO 주치의협의회 야구선수에서 발생하는 회전근 힘줄 및 근육파열	Hands on: 테이핑 실습
16:30-17:30	심포지엄 17: 러너를 위한 훈련 설계의 과학 (스포츠과학위원회 4)	초청세션 5: 대한체력코치협회 무릎 스포츠 손상 후 현장 복귀를 위한 통합 전략: 기능적 통합 트레이닝	
17:30-17:45	시상식 및 폐회사		

Room A

3월 21일(토요일)

07:50-08:00	**인사말 및 개회**	
08:00-09:00	**심포지엄 1: 부상에서 필드까지: RTS와 RTP를 위한 통합적 접근** **From Injury to Field: An Integrated Approach for Return to Sports and Return to performance** **(인증SAT 관리위원회1) ROOM A**	**좌장: 명지병원 김용균, 순천향대학교 김철현**
08:00-08:20	스포츠 복귀를 위한 재활 Rehabilitation for Return to performance	진천선수촌 배중현
08:20-08:40	스포츠 복귀를 위한 기능적 통합 훈련 Functional Integrative Training for Return to performance	진천선수촌 천우호
08:40-09:00	토의 Discussion	
09:00-10:00	**심포지엄 2: 장애인의 기능적 회복에서 스포츠 수행 능력으로: 체계적 접근법의 전환** **From Functional Recovery to Sport Performance in Individuals with Disabilities:** **A Shift in Systematic Approaches**	**좌장: 부민병원 서경묵, 강동경희대병원 김동환**
09:00-09:15	신경가소성 회복을 위한 초기 재활의 패러다임 전환: 고강도 훈련(HIT)과 활동 기반 치료(ABT)의 임상적 적용 A Paradigm Shift in Early Rehabilitation for Neural Plasticity Recovery: Clinical Application of High-Intensity Training (HIT) and Activity-Based Therapy (ABT)	국립재활원 도기현
09:15-09:30	장애인 엘리트 스포츠 초기 단계에서의 기능 중심 평가: 구조화 가능성과 과제 Function-Focused Assessment in the Early Stages of Elite Sports for Persons with Disabilities: Feasibility and Challenges	대한장애인체육회 김윤기
09:30-09:45	장애인 엘리트 스포츠에서 측정과 트레이닝 체계의 시대적 변화와 과제: 휠체어 농구를 중심으로 The Evolution and Challenges of Measurement and Training Systems in Elite Sports for Persons with Disabilities: Focusing on Wheelchair Basketball	대한장애인농구협회 김현수
09:45-10:00	토의 Discussion	
10:00-10:30	Coffee Break	
10:30-11:30	**심포지엄 4: 노인에서의 근감소증 관리: 병원 기반 치료에서 운동 환경으로** **Management of Sarcopenia in Older Adults: From Hospital-Based Care to Exercise Settings**	**좌장: 건강보험심사평가원 노권재, SNU서울병원 이상훈**
10:30-10:45	종합병원에서의 근감소증 관리 Management of Sarcopenia in General Hospitals	검단탑병원 백민수
10:45-11:00	트레이닝 센터에서의 근감소증 관리 Management of Sarcopenia at the Training Center	R2B운동과학센터 김희중
11:00-11:15	필라테스 센터에서의 근감소증 관리 Managing Sarcopenia at the Pilates Center	리본필라테스 허진희
11:15-11:30	토의 Discussion	
11:30-12:30	**심포지엄 6: 경기 당일 급성 손상 관리: 경기장 옆에서 수술실까지** **Acute Injury Management on Match Day: From Sideline to Operating Room**	**좌장: 서울바른세상병원 임홍철, 한림대강남성심병원 김원희**
11:30-11:42	경기날 준비 물품 및 경기전 준비사항 Match Day Preparation Items and Pre-Match Preparations	세종스포츠정형외과 김진수

Room A	3월 21일(토요일)	
11:42-11:54	축구경기에서 발생한 뇌진탕 및 두경부 외상 Concussions and head and neck injuries sustained during soccer matches	스피크재활의학과 정태석
11:54-12:06	농구경기에서 발생한 무릎 및 근골격 손상 Knee and musculoskeletal injuries sustained during basketball games	계명대동산병원 김두한
12:06-12:18	대규모 종합국제대회의 경기 중 급성 손상 관리 Acute Injury Management During Competitions at Large- Scale Comprehensive International Events	진천선수촌 배중현
12:18-12:30	토의 Discussion	
12:30-13:30	런천세미나, 기념촬영 및 점심식사	
13:30-14:30	**심포지엄 8: 견관절 가성마비: 수술과 운동 치료의 통합적 접근** **Shoulder Pseudoparalysis: Integrating Surgery and Exercise Therapy**	**좌장: 서남병원 이석현, 이대목동병원 권지은**
13:30-13:45	견관절 가성마비의 병태생리와 진단 Pathophysiology and Diagnosis of Pseudoparalysis of the Shoulder Joint	고려대 안산병원 김현곤
13:45-14:00	수술적 치료 전략 - 회전근개 재건부터 역행성 견관절 치환술까지 Surgical Treatment Strategies - From Rotator Cuff Reconstruction to Reverse Shoulder Arthroplasty	고려대 구로병원 문준규
14:00-14:15	운동재활의 접근방법과 기능 회복 전략 Exercise Rehabilitation Approaches and Functional Recovery Strategies	고려대 구로병원 박세현
14:15-14:30	토의 Discussion	
14:30-15:30	**초청세션 1: DCC -KADA 클린 스포츠를 위한 과학과 규정의 동행** **DCC - KADA Bridging Scientific Innovation and Regulatory Evolution for Clean Sports**	**좌장: 일산백병원 양윤준, 한양대병원 박훈기**
14:30-14:42	내인성 스테로이드 반도핑 분석 기술 Endogenous Steroid Anti-Doping Analysis Technology	KIST/도핑콘트롤센터 이강미
14:42-14:54	바이오도핑의 최신 동향 및 유전자 도핑 기술 개발 Recent Trends in Bio-Doping and Development of Gene-Doping Technology	KIST/도핑콘트롤센터 성창민
14:54-15:06	2027 세계도핑방지규약(CODE) 및 주요 국제표준 개정사항 2027 World Anti-Doping Code and Key International Standard Amendments	KADA/과학연구부장 임철환
15:06-15:18	2027 치료목적사용면책 국제표준(ISTUE) 주요 개정사항 Key Amendments to the 2027 International Standard for Therapeutic Use Exemption	KADA/TUEC 위원장 이승림
15:18-15:30	토의 Discussion	
15:30-16:00	Coffee Break	

Room A		3월 21일(토요일)
16:00-17:00	**심포지엄 11: 스포츠에서 발생하는 근건 손상의 도전: 근육 손상에서 난치성 건병증까지** **Challenging Musculotendinous Injuries in Sports:** **From Muscle Injuries to Refractory Tendinopathy** 좌장: 아산재건정형외과 조우신, 서을적십자병원 이경태	
16:00-16:12	허벅지 뒤가 아프고 땡겨요 (슬괵근 손상) Hamstring muscle injury	한양대 구리병원 정규성
16:12-16:24	종아리 뒤가 아프고 땡겨요 (비복근 및 가자미근 손상) Gastrocnemius and soleus injury	서울의료원 김기천
16:24-16:36	골반부위가 아프고 땡겨요 (장요근 손상) Iliopsoas injury	전주새강병원 송하헌
16:36-16:48	발목 뒤가 아프고 땡겨요 (장무지굴건염) Flexor hallucis longus tendinitis	부천 본본정형외과 제갈혁
16:48-17:00	토의 Discussion	
17:00-	**임원만찬**	

Room B

3월 21일(토요일)

07:50-08:00	**인사말 및 개회 (컨벤션홀)**	
08:00-09:00	**심포지엄 1: 부상에서 필드까지: RTS와 RTP를 위한 통합적 접근 (컨벤션홀)**	
09:00-10:00	**심포지엄 3: 밀라노·코르티나담페초 동계올림픽을 위한 맞춤형 스포츠과학지원** **Customized Sports Science Support for the Cortina d'Ampezzo Winter Olympics** **(스포츠과학위원회1)**	**좌장: 동국대학교 정진욱, 대구대학교 이종삼**
09:00-09:15	쇼트트랙 선수를 위한 체력 & 컨디셔닝 지원 Physical Fitness & Conditioning Support for Short Track Athletes	한국스포츠과학원 임정준
09:15-09:30	롱트랙 스피드 스케이팅 선수를 위한 운동 역학적 지원 Biomechanical Support for Long Track Speed Skating Athletes	한국스포츠과학원 박상헌
09:30-09:45	컬링 선수를 위한 심리지원 Mental Health Support for Curling Athletes	한국스포츠과학원 장태석
09:45-10:00	토의 Discussion	
10:00-10:30	Coffee Break	
10:30-11:30	**심포지엄 5: 골프 관련 부상으로 인한 만성 근골격계 문제에 대한 운동 기반 접근법** **Exercise-Based Approaches to Chronic Musculoskeletal Problems Resulting from Sports-Related Injuries in Golf**	**좌장: 서울아산병원 진영수, 양산부산대병원 이창형**
10:30-10:45	골프에서 유발되는 요추 만성 통증의 운동 기반 관리 전략 Exercise-Based Management Strategies for Chronic Lumbar Pain Induced by Golf	삼성서울병원 서용곤
10:45-11:00	골프에서 유발되는 팔꿈치/손목 만성 통증의 운동 기반 관리 전략 Exercise-Based Management Strategies for Chronic Elbow/Wrist Pain Caused by Golf	반포스탠다 정형외과 임민우
11:00-11:15	골프에서 유발되는 무릎 만성 통증의 운동 기반 관리 전략 Exercise-Based Management Strategies for Chronic Knee Pain Caused by Golf	차의과학대학 문찬웅
11:15-11:30	토의 Discussion	
11:30-12:30	**심포지엄 7: 러닝의 부상 매커니즘 및 장비의 역학** **Injury Mechanisms in Running and Equipment Dynamics**	**좌장: 계명대학교 김기진, 명지병원 임길병**
11:30-11:45	러닝 부상은 어떻게 시작되는가? - 반복 충격과 생체역학 How Do Running Injuries Begin? - Repetitive Load and Biomechanics	R스포츠재활센터 남 용
11:45-12:00	러닝 장비는 부상을 줄였는가? - 신발과 기술의 양면성 Has Running Equipment Reduced Injuries? - The Double-Edged Sword of Technology	윈윈정형외과 박은수
12:00-12:15	러닝 붐 시대, 스포츠의학의 역할은 무엇인가? The Role of Sports Medicine in the Era of the Running Boom	진천선수촌 김찬혁
12:15-12:30	토의 Discussion	
12:30-13:30	**런천세미나, 기념촬영 및 점심식사 (컨벤션홀)**	

Room B

3월 21일(토요일)

13:30-14:30	**심포지엄 9: 에너지 밸런스를 넘어서: REDs에 관한 최첨단 통찰** **Beyond Energy Balance: The Cutting Edge Insights on REDs (여성스포츠위원회 1)** **좌장: 일산백병원 이언숙, 국립중앙의료원 전숙하**	
13:30-13:50	여성운동선수 건강 패러다임의 확장 : Female Athlete Triad 에서 IOC 합의문까지 The evolution of REDs: Advancing woman's health from the Female Athletes Triad to the IOC consensus	삼육서울병원 김리나
13:50-14:10	대한민국 여성 엘리트 선수의 에너지 가용성: 현황 진단과 체계적 관리 전략 Energy Availability in Korean Female Elite Sports: Current Status and Systematic Management Strategies	한국스포츠과학원 박수현
14:10-14:30	토의 Discussion	
14:30-15:30	**심포지엄 10: 여성 스포츠의 의학적 패러다임: FAIR 합의문에서 생활체육까지의 임상적 확장** **The Medical Paradigm in Women's Sports: Clinical Expansion from the FAIR Consensus Statement to Recreational Sports (여성스포츠위원회 2)** **좌장: 건국대병원 이선주, 상명대학교 김태경**	
14:30-14:50	여성 운동선수 손상예방: FAIR consensus의 임상적 의미 Injury Prevention in Female Athletes: Clinical Implications of the FAIR Consensus	세종스포츠정형외과 박지환
14:50-15:10	생활체육 여성 러너를 위한 부상 예방 전략 Injury Prevention Strategy for Female Recreational Runners	건국대학교병원 박병선
15:10-15:30	토의 Discussion	
15:30-16:00	Coffee Break	
16:00-17:00	**심포지엄 12: 팀주치의, 필드닥터 현장 경험** **Team Physician, Field Doctor: Sharing On-Site Experience (대외협력위원회)** **좌장: 서울대병원 최호천, 국가대표재활의학과 윤정중**	
16:00-16:15	KLPGA 의무지원 : 투어주치의 역할 및 향후 방향성 KLPGA Medical Support: Role of Tour Physicians and Future Direction	솔병원 최승호
16:15-16:30	두산베어스 팀주치의의 시즌 전 후, 시즌 중 역할 Doosan bears Professional Baseball team Physician's Roles Before and After the Season, and During the Season	청담리온정형외과 이제형
16:30-16:45	대한체육회 의사의 업무 : 선수촌 일상과 대회 출장 Duties of the Korean Sport & Olympic Committee Physician	대한체육회 배중현
16:45-17:00	토의 Discussion	
17:00-	**임원만찬**	

Room C

3월 21일(토요일)

07:50-08:00 **인사말 및 개회 (컨벤션홀)**

08:00-09:00 구연 1

좌장: 노원을지대병원 양기원, 분당서울대병원 이용석

08:00-08:08	전방머리자세 교정에서 중재 방식에 따른 훈련 효과 비교: 대면 훈련, 온라인 실시간 훈련, 멀티미디어 자가훈련 Training Effects of Forward Head Posture Correction Across Delivery Methods: Face-to-Face, Real-Time Online, and Multimedia Self-Training	국립부경대 임나단
08:08-08:16	24시간 움직임 행동 가이드라인 준수와 고혈압 유병률의 연관성 Association Between Adherence to 24-Hour Movement Guidelines and Hypertension Prevalence	서울시립대 김선정
08:16-08:24	한국 성인에서 사회경제적 지위에 따른 신체활동 패턴과 고혈압 유병률 간의 연관성 The association between physical activity patterns and hypertension by socioeconomic status in Korean adults	서울시립대 최태구
08:24-08:32	발목 및 중간볼기근 키네시오 테이핑이 발목염좌 대상자의 동적균형과 하지 운동역학에 미치는 영향 Effects of Ankle and Gluteus Medius Kinesio Taping on Dynamic Balance and Lower Extremity Biomechanics in Individuals with Ankle Sprain	국립부경대 정경열
08:32-08:40	엘리트 수영선수의 장기 방치된 슬개골 하극 골절로 인한 슬개고위에 대한 슬개건 단축 및 전경골건 동종이식 재건술: 증례 보고 Patellar Tendon Imbrication with Anterior Tibialis Allograft Augmentation	거인병원 김상효
08:40-08:48	만성 아킬레스건 파열 스포츠인에서 동종건을 이용한 최소침습 아킬레스건 재건술 후 스포츠 복귀: 2증례 보고 Return to Sport after Minimally Invasive Achilles Tendon Allograft Reconstruction	SNU서울병원 강태병
08:48-09:00	토의 Discussion	

09:00-10:00 구연 2

좌장: 구로성심병원 김병성, 아주대병원 정준영

09:00-09:10	급성 흡기근 운동이 고강도 근력 운동 후 동맥경직 반응을 완화할 수 있을까? Does Acute Inspiratory Muscle Exercise Attenuate Arterial Stiffening After High Intensity Resistance Exercise?	서울시립대 김선정
09:10-09:20	봉합 불가능한 회전근개 파열 환자에서 하부 승모근 건 이전술 후 임상 증상과 등속성 근력 평가 Clinical outcomes and isokinetic muscle performance after lower trapezius tendon transfer for irreparable rotator cuff tear	고려대 안암병원 정웅교
09:20-09:30	만성 발목 불안정증 환자에서 올인사이드(All-inside) 외측 발목 인대 복합체 봉합술과 개방형 브로스트롬 술식의 임상 결과 비교: 무작위 대조 연구 Clinical results of all-inside lateral ankle ligament complex repair were comparable to open Brostrom procedure in patients with chronic ankle instability: Randomized controlled study.	분당차병원 정심호
09:30-09:40	등척성 운동 유형이 고혈압 전단계 젊은 남성의 24시간 활동 혈압에 미치는 영향 비교: 무작위 교차 연구 Acute effects of different Isometric Exercise modalities on 24-hour Ambulatory Blood Pressure in Young Men with Prehypertension: A Randomized Crossover Trial	서울시립대 송현수

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09:40-09:50	만성 목 통증이 있는 사무직 근로자에서 견갑골 운동이상 검사와 측면 견갑골 슬라이드 검사 간의 관계: 단면 연구 Relationship between Scapular Dyskinesis Test and Lateral Scapular Slide Test in Office Workers with Chronic Neck Pain: A Cross-Sectional Study	목포과학대 문성은
09:50-10:00	토의 Discussion	
10:00-10:30	Coffee Break	
10:30-12:30	**체화된 소마틱 움직임 뉴로사이언스, 임상적 이해, 그리고 실제 적용 Embodied Somatic Movement Neuroscience, Clinical Understanding, and Practical Application (스포츠과학위원회 2 실기세션)**	**좌장: 연세대학교 송경택**
10:30-11:20	소마틱 움직임의 뉴로사이언스 기반 이해: 작용 메커니즘과 임상적 의미: 이론 강의 Neuroscience-Based Understanding of Somatic Movement: Mechanisms and Clinical Implications	Tokyo Alexander Centre, Japan Yoshi Inada
11:20-12:10	체화된 소마틱 실습: 알렉산더테크닉 기반 일상 자세 및 동작 실습: 실기 강의 Embodied Somatic Practice: Alexander Technique-Based Practice of Everyday Posture and Movement (Lying Down, Sitting, Standing, and Breathing)	Alexander Technique PnM, Korea 김수연
12:10-12:30	토의 Discussion	
12:30-13:30	**런천세미나, 기념촬영 및 점심식사 (컨벤션홀)**	
13:30-15:30	**Hands on: Sono 1 (Shoulder, Elbow, Hand)**	**좌장: 청담리온정형외과 이제형**
13:30-13:35	강의 (Shoulder)	청담리온정형외과 이제형
13:35-13:40	강의 (Elbow, Hand)	서울삼성의료원 심재우
13:40-15:30	실습	청담리온정형외과 이제형, 고려대 안산병원 김현곤, 부천성모병원 박종훈, 서울삼성의료원 심재우
15:30-16:00	Coffee Break	
16:00-17:00	**Hands on: Sono 2 (Knee, Foot & Ankle)**	**좌장: 세종스포츠정형외과 차민석**
16:00-16:05	강의 (Around knee including muscle)	세종스포츠정형외과 차민석
16:05-16:10	강의 (Foot and Ankle)	중앙보훈병원 여의동
16:10-17:00	실습	세종스포츠정형외과 차민석, 중앙보훈병원 여의동, 천안순천향병원 김우종, 계명대 동산병원 김두한
17:00-	**임원만찬**	

Room A	3월 22일(일요일)
07:50-08:00	**인사말 및 개회**
08:00-09:00	**심포지엄 13: 글로벌 브릿지 구축: 글로벌 네트워킹에 관한 관점** **Building Global Bridges: Perspectives on Global Networking (인증 SAT 관리위원회 2) (ROOM A)** **좌장: 명지병원 김용균, 연세대학교 서상훈**
08:00-08:25	한국스포츠과학원 소개와 중국스포츠과학원, 일본스포츠과학원과 교류 Introduction to Korea Institute of Sport Science(KISS) and Mutual Exchange with China Institute of Sport Science(CISS) and Japan Institute of Sport Science(JISS) 한국스포츠과학원 임정준
08:25-08:50	일본임상스포츠의학회 펠로우십 프로그램 Travelling Fellowship Program with JSCSM 부경대학교 김대희
08:50-09:00	토의 Discussion
09:00-09:40	**해외연자 초청 강연 1** **좌장: 삼성서울병원 유재철, 한양대병원 이진규**
09:00-09:30	AI application in tackling Sports injury: from prevention, to surgical treatment & rehabilitation Hong Kong Patrick Yung
09:30-09:40	토의 Discussion
09:40-10:00	Coffee Break
10:00-11:00	**초청세션 2: 한국운동생리학회 - 혈관 기능 조절과 운동 생리학** **Regulation of Vascular Function and Exercise Physiology** **좌장: 솔병원 나영무, 서울아산병원 최경효**
10:00-10:20	고혈압 환자에서 유산소 운동이 혈관기능에 미치는 영향 Effects of Aerobic exercise on vascular function in hypertensive patient 한국방송통신대학교 윤은선
10:20-10:40	골격근에서의 저산소증 반응과 혈관세포 간의 관계 규명 Unraveling the Intricate Relationship Between Hypoxia Responses in Skeletal Muscle and Vascular Cells 경북대학교 신준철
10:40-11:00	토의 Discussion
11:00-12:00	**초청세션 3: 대한육상연맹 - 육상 선수들의 경기력 극대화와 부상 관리 분야의 최신 지견** **Cutting-edge insights in maximizing athletic performance and injury management for track and field athletes (ROOM A)** **좌장: 분당척병원 성상철, 닥터핏 박원하**
11:00-11:15	육상 선수의 경기력 향상과 부상 방지 전략 Strategies for improving track and field athletes' performance and preventing injuries 육상연맹 의무위원회 최승호
11:15-11:30	육상 종목별 흔한 손상과 수술/비수술 치료 접근법 Common Injuries by Track and Field Event: Surgical and Non-surgical Approaches 진천선수촌 김찬혁
11:30-11:45	부상 예방과 기술 향상을 위한 운동역학적 현장 적용 Biomechanical Approaches to Injury Prevention and Performance Enhancement 한국스포츠개발원 김주년
11:45-12:00	토의 Discussion
11:15-11:30	육상 종목별 흔한 손상과 수술/비수술 치료 접근법 Common Injuries by Track and Field Event: Surgical and Non-surgical Approaches 진천선수촌 김찬혁

Room A	3월 22일(일요일)	
11:30-11:45	부상 예방과 기술 향상을 위한 운동역학적 현장 적용 Biomechanical Approaches to Injury Prevention and Performance Enhancement	한국스포츠개발원 김주년
11:45-12:00	토의 Discussion	
12:00-12:10	**제25대 제마스포츠의학상 발표 및 시상**	**좌장: 제마의학상 위원장 이경태**
12:10-13:00	**정기 총회(대의원), 기념촬영 및 점심식사, MOU (육상협회, 한국운동생리학회)**	
13:00-13:30	**해외연자 초청 강연 2**	**좌장:서울적십자병원 이경태, 하병원 하철원**
13:00-13:25	How JSCSM make relationship and leadership with field Coaches and trainer group?	Japan Hideo Matsumoto
13:25-13:30	토의 Discussion	
13:30-15:00	**심포지엄 15: 러닝 심포지엄: 달리기 성능의 과학 및 실전** **Running Symposium: Science & Practice of Running Performance**	**좌장: 용인세브란스병원 이태임, 가톨릭대성빈센트병원 김준성**
13:30-13:50	달리기의 생체역학 Biomechanics of Running	연세진 재활의학과 김동진
13:50-14:10	신발 및 러닝 성능 Footwear & Running Performance	상계백병원 안재기
14:10-14:30	달리기 기술 및 부상 예방 Running Technique & Injury Prevention	보라매병원 정세희
14:30-14:50	달리기 훈련 방법 및 퍼포먼스 최적화 Running Training Methods & Performance Optimization	썬코치 러닝클래스 이선춘
14:50-15:00	토의 Discussion	
15:00-15:30	Coffee Break	
15:30-16:30	**심포지엄 16: 스마트 러닝을 위한 생체역학: 보폭·보빈도 조절에서 관절 부하 관리까지** **Biomechanics for Smart Learning: From Stride and Cadence Adjustment to Joint Load Management (스포츠과학위원회 3)**	**좌장: 한양대병원 김미정, 동아대학교 박현태**
15:30-15:45	더 스마트하고 안전하게 달리기 위한 방법, 발착지 운동역학 및 달리기 경제성 개선을 위한 보폭 조절 기법 How to Run Smarter and Safer? Step Rate Manipulation as a Tool to Modify Foot Strike Kinematics and Running Economy	순천향대학교 김영욱
15:45-16:00	달리기 부하와 하지 골관절염: 생체역학적 힘의 역할 Running Loads and Lower Limb Osteoarthritis: The Role of Biomechanical Forces	동국대학교 전형규
16:00-16:15	발목 내·외측 분리 모델 기반 러닝 중 발목 관절 부하 분석 Analysis of Ankle Joint Loading During Running Based on an Ankle Medial and Lateral Separation Model	순천향대학교 김 훈
16:15-16:30	토의 Discussion	

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16:30-17:30	**심포지엄 17: 러너를 위한 훈련 설계의 과학** **The Science of Training Programs for Runners (스포츠과학위원회 4)**	**좌장: 서울대학교 김연수, 계명대학교 안나영**
16:30-16:45	에너지대사에 기반한 맞춤형 러닝 훈련 강도 설정 Customized running training intensity setting based on energy metabolism	차의과학대학교 스포츠의학대학원 양우휘
16:45-17:00	러너를 위한 근력 운동프로그램 Strength Training Program for Runners	가톨릭관동대학교 이승엽
17:00-17:15	러너를 위한 보충제 섭취 전략 Supplement Intake Strategy for Runners	엔루틴연구소 김희재
17:15-17:30	토의 Discussion	
17:30-17:45	**시상식 및 폐회사**	

Room B

3월 22일(일요일)

07:50-08:00	**인사말 및 개회 (컨벤션홀)**
08:00-09:00	**심포지엄 13: Building Global Bridges: Perspectives on Global Networking (컨벤션홀)**
09:00-09:40	**해외연자 강의 1** **AI application in tackling Sports injury: from prevention, to surgical treatment & rehabilitation (컨벤션홀)**
09:40-10:00	Coffee Break
10:00-11:00	**우수구연** — **좌장: 동아대학교 이종화, 동아병원 심상돈**
10:00-10:08	초기 급성 외측 발목 염좌 후 보존적 치료 실패의 위험 인자: 전향적 코호트 연구 Risk Factors for Failed Conservative Treatment After First-Time Acute Lateral Ankle Sprain: A Prospective Cohort Study — 분당차병원 이성현
10:08-10:16	외측주를 침범한 소두 박리성 골연골염에서 보존적 치료 후 조기 투구 복귀 전략의 임상적 결과 Clinical Outcomes of an Early Return-to-Throwing Strategy Following Conservative Treatment for Capitellar Osteochondritis Dissecans Involving the Lateral Column — 좋은삼선병원 조형래
10:16-10:24	만성 발목 불안정증 환자에서 보존적 치료 및 modified Broström operation 후 성공적인 스포츠 복귀 예측 위하여 Side hop test는 중요하다: Ankle-GO 점수 기반 연구 Side hop test is a predictor of successful return to sports after conservative treatment or modified Broström operation in patients with chronic ankle instability: Based on Ankle-GO score — 고려대 안암병원 이진혁
10:24-10:32	6주간의 Weighted Ball 훈련이 청소년 엘리트 야구 선수의 구속 및 운동학적 변인에 미치는 영향 Effects of a 6-Week Weighted Ball Training Program on Pitch Velocity and Kinematic Variables in Youth Elite Baseball Players — 진천국가대표선수촌 메디컬센터 문성환
10:32-10:40	한국 청소년의 신체활동 및 수면시간과 심리적 웰빙의 공동 연관성: 2021년 NYPI 횡단면 연구 Joint associations of physical activity and sleep duration with psychological well-being in Korean adolescents: 2021 NYPI cross-sectional study — 서울대학교 홍지원
10:40-11:00	토의 Discussion
11:00-12:00	**초청세션 3: 대한육상연맹 (ROOM A) (컨벤션홀)**
12:00-13:00	**제마의학상 시상, 정기 총회(대의원), 기념촬영 및 점심식사, MOU(대한육상연맹, 한국운동생리학회) (컨벤션홀)**
13:00-14:00	**초청세션 4: 대한정형외과스포츠의학회 KOSSM (ROOM B)** **흔한 달리기 부상: 수술 시기와 방법** **Common Running Injuries: When and How to Operate** **좌장: 경희대병원 정비오, 천안국가대표정형외과의원 유중진**
13:00-13:15	아킬레스건을 포함한 족부족관절 손상 Foot and Ankle Injuries including Achilles tendon — 영남의대 박철현
13:15-13:30	골 손상 (스트레스 골절 등) Bone Injuries (stress fx. Etc) — 세종스포츠정형외과 김진수
13:30-13:45	무릎관절 주위 손상 Around Knee Injuries — 조선의대 김동휘

Room B

3월 22일(일요일)

13:45-14:00	토의 Discussion
14:00-15:00	**심포지엄 18: 부위별 스포츠 관련 발목 손상: 전방 및 외측 인대 손상, 후방-내측 병변** **Sports-Related Ankle Injuries by Region: Anterior and Lateral Ligament Injuries, and Posterior-Medial Conditions** **좌장: 서울의료원 김기천, 고려의대 강 석**
14:00-14:15	스포츠 상황에서의 내측 발목 병변: 삼각 인대 손상의 진단 및 치료 Medial Ankle Injuries in Sports: Diagnosis and Treatment of Deltoid Ligament Injuries 중앙보훈병원 여의동
14:15-14:30	스포츠 상황에서의 전후방 발목 손상: 경비인대결합 손상 및 전방 불안정성 후방 FHL 병변의 정형진단과 치료 전략 Anterior and posterior Ankle Injuries in Sports: Syndesmosis Injuries, Posterior (FHL) Lesions 천안순천향병원 김우종
14:30-14:45	스포츠 상황에서의 외측 발목 인대 손상: 급성 염좌부터 만성 외측 불안정성까지 Lateral Ankle Ligament Injuries in Sports: From Acute Sprains to Chronic Lateral Instability 분당차병원 이성현
14:45-15:00	토의 Discussion
15:00-15:30	Coffee Break
15:30-16:30	**심포지엄 19: 야구선수에서 발생하는 회전근 힘줄 및 근육파열** **Rotator cuff tendon and muscle tears occurring in baseball players (KBO 주치의 협의회)** **좌장: 네온정형외과 박진영, 문영래정형외과병원 문영래**
15:30-15:45	야구선수에서 발생하는 견갑하건 근육 파열 Subscapularis muscle tear occurring in baseball players 청담리온정형외과 이제형
15:45-16:00	야구선수에서 발생하는 극상근 근육 파열 Supraspinatus muscle tear occurring in baseball players 세종스포츠정형외과 금정섭
16:00-16:15	야구선수에서 발생하는 회전근 힘줄 파열 Rotator cuff tendon tears in baseball players 좋은삼선병원 조형래
16:15-16:30	토의 Discussion
16:30-17:30	**초청세션 5: 대한체력코치협회 (ROOM B)** **무릎 스포츠 손상 후 현장 복귀를 위한 통합 전략: 기능적 통합 트레이닝** **An Integrated Approach to Return to Play (RTP) After Knee Sports Injuries: Functional Integrated Training (FIT)** **좌장: SRC병원 김은국, 순천향대학교 김철현**
16:30-16:40	스포츠 손상 후 현장 복귀를 위한 기능적 통합 트레이닝 전략 F.I.T Strategies for RTP 국립부경대학교 김태규
16:40-17:00	스포츠 손상 후 현장 복귀를 위한 기능적 안정성 트레이닝 Functional Stability Training for RTP 양산부산대병원 김수용
17:00-17:20	스포츠 손상 후 현장 복귀를 위한 고강도 기능적 트레이닝 High-Load Functional Training for RTP 진천선수촌 천우호
17:20-17:30	토의 Discussion
17:30-17:45	**시상식 및 폐회사**

Room C	3월 22일(일요일)
07:50-08:00	**인사말 및 개회**
08:00-09:00	**심포지엄 14: 좋은 논문, 좋은 저널: KJSM와 함께 성장하기** **Better Papers, Better Journal: Growing with KJSM (편집위원회)** **좌장: 서울시립대 제세영, 순천향대부천병원 이영구**
08:00-08:15	AI 시대 의학논문출판 실전 Practical Guide to Publishing Medical Papers in the AI Era — 중앙의대 강 현
08:15-08:30	의학논문 작성 시 쉽게 활용하는 통계 꿀팁 Statistical Tips for Easily Writing Medical Papers — 서울성심병원 김지형
08:30-08:45	의학 논문 쉽게 쓰기; 스텝 바이 스텝 Writing Medical Papers Made Easy; Step by Step — 한양의대 정규성
08:45-09:00	토의 Discussion
09:00-09:40	**해외연자 강의 (컨벤션홀)**
09:40-10:00	Coffee Break
10:00-11:00	**우수구연 (세미나실1)**
11:00-12:00	**초청세션 3: 대한육상연맹 (ROOM A) (컨벤션홀)**
12:00-13:00	**제마스포츠의학상 발표 및 시상, 정기 총회(대의원), 기념촬영 및 점심식사,** **MOU (대한육상연맹, 한국운동생리학회)**
13:00-14:00	**Hands on: CPR1** — **좌장: 순천향대 부천병원 김호중**
	실습
14:00-15:00	**Hands on: CPR2** — **좌장: 순천향대 부천병원 김호중**
	실습
15:00-15:30	Coffee Break
15:30-17:30	**Hands on: Taping** — **좌장: 경북전문대 남형천**
	실습
17:30-17:45	**시상식 및 폐회사**

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

3월 21일(토요일)

Room A



The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

심포지엄 1: 부상에서 필드까지: RTS와 RTP를 위한 통합적 접근
From Injury to Field: An Integrated Approach for Return to Sports and Return to performance
(인증SAT 관리위원회1)

좌장: 명지명원 김용균, 순천향대학교 김철현



배중현

학력

중앙대학교 의과대학 학사
중앙대학교 의과대학 재활의학 석사
가톨릭대학교 의과대학 예방의학 박사

주요 경력

2024 파리올림픽 주치의
2026 밀라노코르티나 올림픽 주치의
전 솔병원 진료원장

현재 소속 및 직위

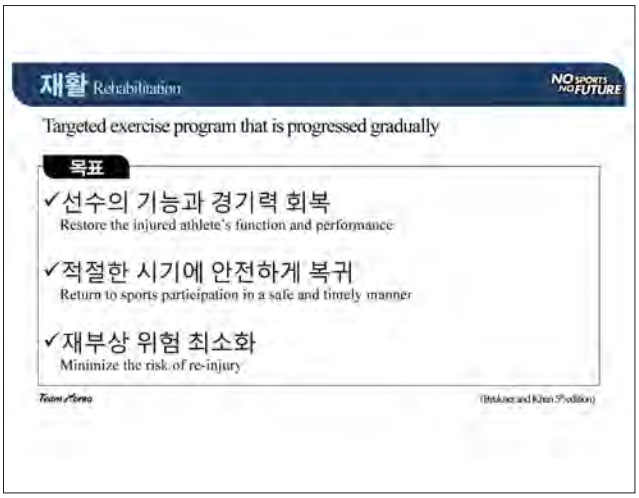
대한체육회 진천국가대표선수촌 메디컬센터 재활의학과

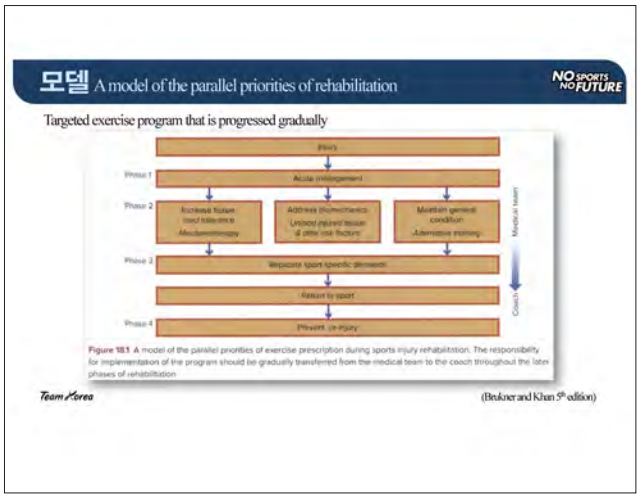
대표논문

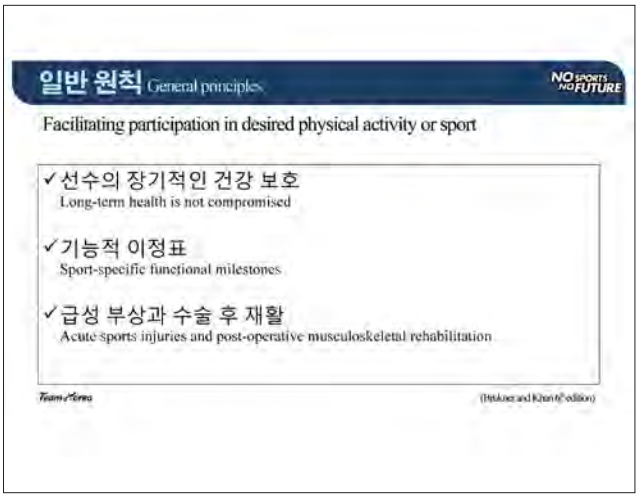
Bae, J., et al. (2025). “Team Korea injury and illness surveillance at the 2024 Paris Olympic Games.” Injury Epidemiology 12(1): 55.

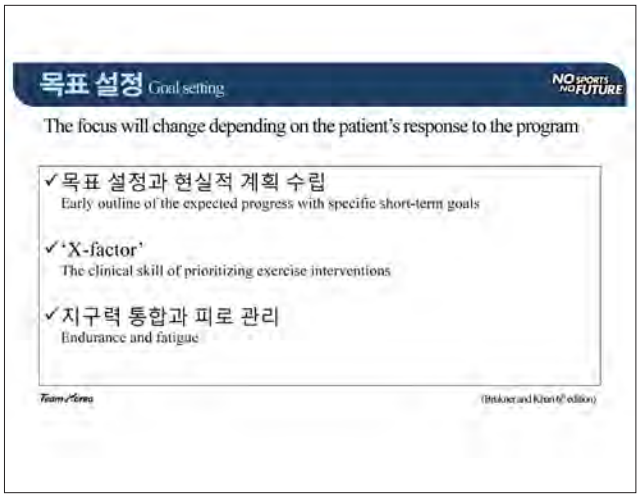
스포츠 복귀를 위한 재활
Rehabilitation for Return to performance

진천선수촌
배중현









재활의 단계 Phase of rehabilitation

NO SPORTS NO FUTURE

5 phases

RETURN TO PARTICIPATION | RETURN TO SPORT | RETURN TO PERFORMANCE

- ✓급성기 Acute phase
- ✓초기 Early phase: restore activities of daily living
- ✓스포츠 특화 단계 Sport specific phase
- ✓훈련 복귀 단계 Return to training phase
- ✓스포츠 복귀 단계 Return to sport phase

Team Korea

(Brukner and Khan 6th edition) / Arden, C. L. et al. IJSM 2016

예시 Example

NO SPORTS NO FUTURE

Throwing athlete, ankle inversion injury

Hx: reconstruction 10 YA, no CAI

- ✓Accurate diagnosis
- ✓Socioecological context
  - ✓ Elite, competition 4 wks, pitcher, full-time



Team Korea

(https://www.boneschool.com)

예시 Example

NO SPORTS NO FUTURE

Throwing athlete, ankle inversion injury

Hx: reconstruction 10 YA, no CAI

- ✓Key impairment & limitation
  - ✓ Swelling, full PF
  - ✓ Single-leg stance, raise & hop
- ✓Short-term & long-term goal



Team Korea

급성기 Acute phase 1

NO SPORTS NO FUTURE

Swelling, full ankle PF

Calf muscle activation

- ✓수상 당일
  - ✓ PRICE (intensive cryo and compression)
  - ✓ Aircast with crutch
  - ✓ Hyaluronidase 1500IU

P PROTECTION
E ELEVATION
A NON-ANTIINFLAMMATORIES
C COMPRESSION
E EDUCATION
&
L LOAD
O OPTIMISM
V VASCULARISATION
E EXERCISE

Team Korea

급성기 Acute phase 1

NO SPORTS NO FUTURE

Swelling, full ankle PF

Calf muscle activation

- ✓수상 2일째
  - ✓ PT (whirlpool) 2 session + exercise session
  - ✓ Calf muscle activation
  - ✓ Upper extremity training
- ✓수상 3일째
  - ✓ Isometric + active strengthening
  - ✓ Pool walking



Team Korea

초기 Early phase 2

NO SPORTS NO FUTURE

Return to daily activity

Basic sport-specific technical movement

- ✓수상 5일째
  - ✓ Lunge, step-up (number, velocity and frequency)
  - ✓ No-stride pitch
- ✓수상 9일째
  - ✓ Single leg hop
  - ✓ Anti-gravity treadmill (jogging)

Team Korea

진행 Rehabilitation progression

NO SPORTS NO FUTURE

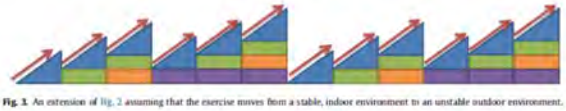


Fig. 3. An extension of Fig. 2 assuming that the exercise moves from a stable, indoor environment to an unstable outdoor environment.

Team Korea

스포츠 특화 단계 Sport-specific phase 3

NO SPORTS NO FUTURE

Gradually incorporate activites that related more closely to the sport

✓수상 14일째

- ✓ Performance characteristics (repeated short burst, prolonged activity..)
- ✓ Physiologic characteristics (anaerobic, aerobic)
- ✓ Physical characteristics (predominant muscle, ROM, strength)
- ✓ Single leg hop progression

Team Korea

훈련 복귀 단계 Return to training phase 4

NO SPORTS NO FUTURE

Returning to participation in their sport

More traditional strength and conditioning training can be incorporated

✓수상 21일째

- ✓ Higher rate of force development and on-field session
- ✓ Load management (check available pitch count)
- ✓ Greater than 90% of the contralateral side



Team Korea

스포츠 복귀 단계 Return to sport phase 5

NO SPORTS NO FUTURE

Return to sport decision

✓수상 28일째

- ✓ StARRT framework
- ✓ Control-chaos continuum



Team Korea

Rehabilitation is training in the presence of injury

감사합니다

스포츠 없는 미래는 없다 NO SPORTS, NO FUTURE

대안체육회

스포츠 복귀를 위한 기능적 통합 훈련
Functional Integrative Training for Return to performance

진천선수촌
천우호

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

심포지엄 2: 장애인의 기능적 회복에서 스포츠 수행 능력으로: 체계적 접근법의 전환

From Functional Recovery to Sport Performance in Individuals with Disabilities: A Shift in Systematic Approaches

좌장: 부민병원 서경묵, 강동경희대병원 김동환



도기현

학력

건국대학교 생활체육학과 학사

고려대학교 융합과학대학원 스포츠의학과 석사 과정

주요 경력

국립재활원 운동재활과

강남 제이에스 병원

인천대학교 스포츠센터

현재 소속 및 직위

국립재활원 운동재활과 재활체육지도사

신경가소성 회복을 위한 초기 재활의 패러다임 전환: 고강도 훈련(HIT)과 활동 기반 치료(ABT)의 임상적 적용

A Paradigm Shift in Early Rehabilitation for Neural Plasticity Recovery: Clinical Application of High-Intensity Training (HIT) and Activity-Based Therapy (ABT)

국립재활원

도기현









고강도 훈련을 가능케 하는 원동력: 현장 지도자의 전문성 진화

과거 단순 루틴 및 보조
- 매뉴얼화된 기본 운동 반복
- 보수적인 단순 운동 횟수 카운팅 위주
- 안전 최우선의 수동적 개입

▽

현재 데이터 및 근거 기반
- 운동지도자의 스포츠의학, 운동생리학 등 깊은 학술적 기반
- 양측 하지 근력(차이/합) 등 정밀한 임상 평가
- 환자 한계치 분석 후 '통제된 고강도' 적용

고강도 훈련을 가능케 하는 원동력: 현장 지도자의 전문성 진화

- 타겟 1: 보행 속도 향상 ➡ 마비측/비마비측 근력 '차이' 감소 (예: 횡단보도 건너기)
- 타겟 2: 보행 지구력 향상 ➡ 양측 하지 근력 '합' 증가 (예: 장시간 보행)



고강도 훈련(HIT)의 임상적 적용: 입원환자 대상 크로스핏 프로그램

1



2

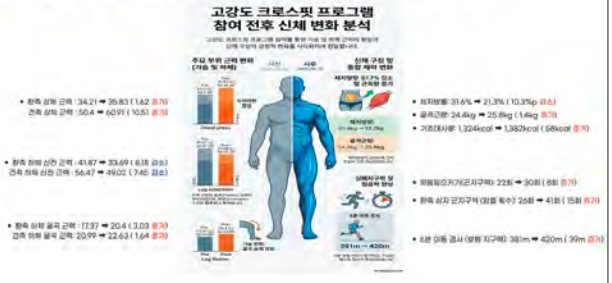


환자 중증도별 맞춤형 크로스핏(HIT) 적용 사례

(EMOM & AMRAP 활용)

구분(중증도)	세부 훈련 내용	비고 및 특이사항
경증 환자	무른 5kg 원통 트러스터(Thruster)를 지정된 시간 내에 20회 수행	최대의 무리를 놓아 심폐지구력 및 근지구력 극대화
중증 환자	무른 2kg 원통 혹은 맨몸추천하나니그림 제한 시 모래주머니 대체 무릎을 탈탈하여 트러스터를 지정된 시간 내 12회 수행	환자의 기능적 제한(근력 등)을 보완하여 상대적 고강도 유지
최중증 환자	맨몸 스쿼트(중량 없이)를 지정된 시간 내 10회 수행	매층 지지 및 기본 움직임 위주로 집중. 환자 개인의 최대 한계치 도달 유도

환자 중증도별 맞춤형 크로스핏(HIT) 적용 사례

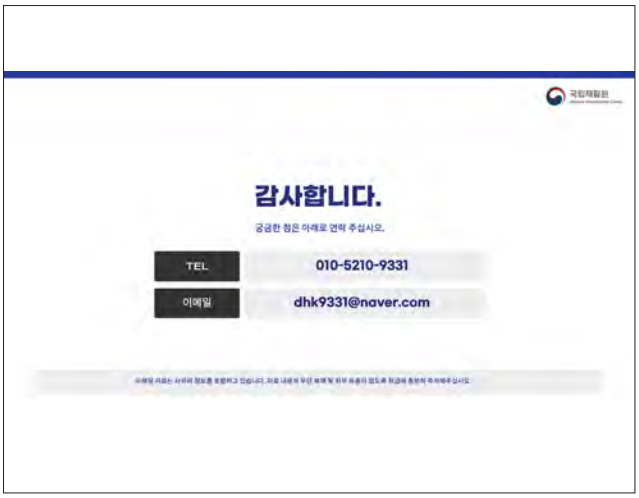


환자의 기능 수준은 달라도, 경험하는 강도는 같습니다!

환자의 기능 수준(중증도)은 달라도 '모두가 각자의 위치에서 동일한 고강도(Relative High-Intensity)'를 경험하도록 훈련을 설계한다!


현장의 딜레마:
안전(Safety)과 기능(Function)의 경계
Large Load
Medium Load
Small Load
Relative Intensity


진료실과 현장의 시너지
성공적인 재활을 위한 유기적 연결
6. 결론: 의학과 현장의 시너지 - 성공적인 재활을 위한 유기적 연결
진료실 (Medical Clinic)
체육관/현장
(Rehabilitation Gym)


감사합니다.
궁금한 점은 아래로 연락 주십시오.
TEL
010-5210-9331
이메일
dhk9331@naver.com

김윤기

학력

백석대학교 특수체육교육과 학사

고려대학교 융합과학대학원 스포츠의학과 석사 과정

주요 경력

대한장애인체육회 훈련지원부 지도자

천안시장애인종합체육관 장애인 엘리트 농구팀 지도자

에바다 특수학교 생활체육 역도 코치

고릴라짐 PT(personal trainer)

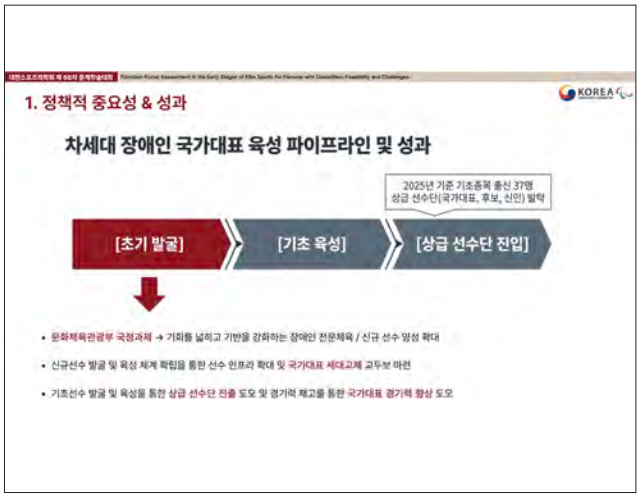
현재 소속 및 직위

대한장애인체육회 훈련운영실 훈련지원부 지도자

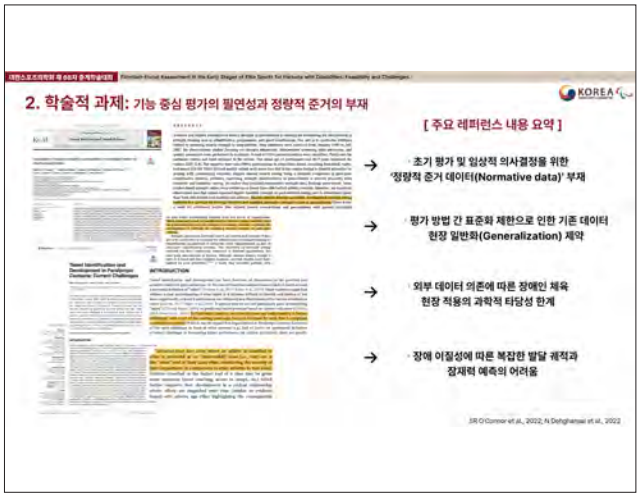
장애인 엘리트 스포츠 초기 단계에서의 기능 중심 평가: 구조화 가능성과 과제
Function-Focused Assessment in the Early Stages of Elite Sports for Persons with Disabilities: Feasibility and Challenges

대한장애인체육회
김윤기

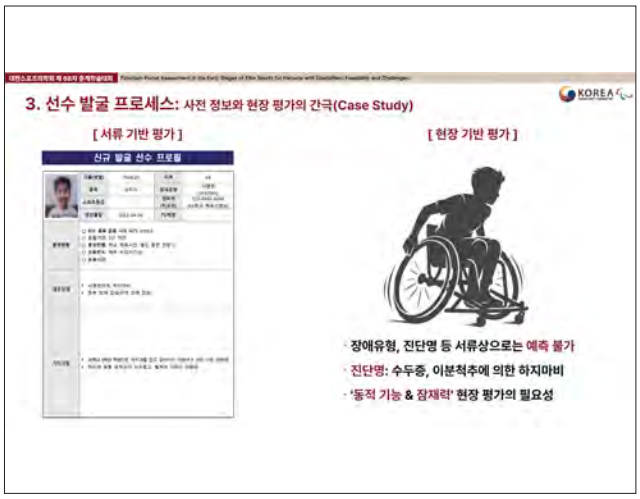




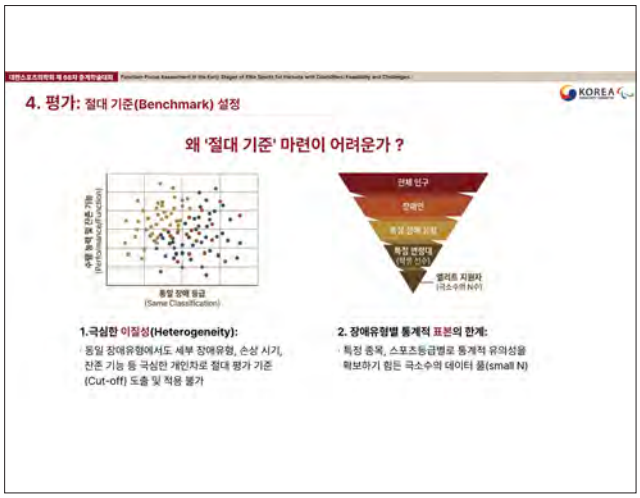


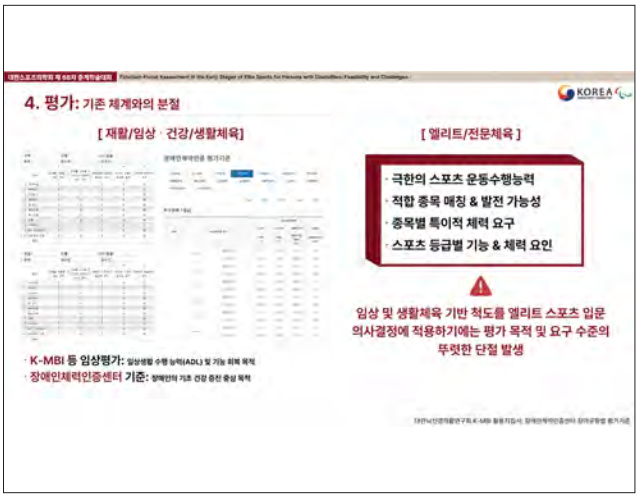


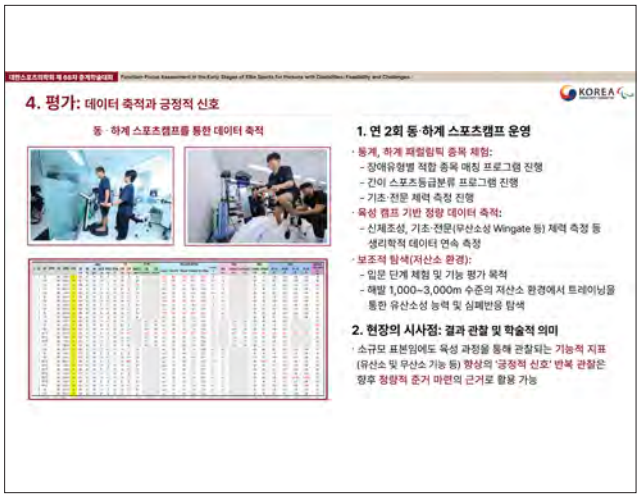

3. 선수 발굴 프로세스
KOREA
Step 1: 지역 및 기관 추천
(서류 기반의 초기 대상자 선별)
Step 2: 현장 방문 및 및 기능 확인
(발굴단의 대면 면담 및 동적기능/잔존능력 정성 평가)
Step 3: 위원회 심의
(관찰 데이터 기반의 잠재력 종합 평가)
Step 4: 기초선수 육성 및 종목 매칭
(전담 지도자 배치, 캠프 초청 및 종목탐색)


3. 선수 발굴 프로세스: 사전 정보와 현장 평가의 간극(Case Study)
KOREA
[서류 기반 평가]
신규 발굴 선수 프로필
[현장 기반 평가]
· 장애유형, 진단명 등 서류상으로는 예측 불가
· 진단명: 수두증, 이분척추에 의한 하지마비
· '동적 기능 & 잠재력' 현장 평가의 필요성


3. 선수 발굴 프로세스: 현장에서의 정성평가
KOREA
현장 관찰
의사결정
결과 매칭
실제 세부 장애유형 및 정도 확인
'수행 능력 & 발전 가능성' 현장 평가
기초선수 선발 및 캠프 제첨
적합 종목 매칭(할체어 육상),
전담지도자 배치,
운전장소&용품 지원


4. 평가: 절대 기준(Benchmark) 설정
KOREA
왜 '절대 기준' 마련이 어려운가 ?
1. 극심한 이질성(Heterogeneity):
· 동일 장애유형에서도 세부 장애유형, 손상 시기, 잔존 기능 등 극심한 개인차로 절대 평가 기준 (Cut-off) 도출 및 적용 불가
2. 장애유형별 통계적 표본의 한계:
· 특정 종목, 스포츠등급별로 통계적 유의성을 확보하기 힘든 극소수의 데이터 풀(small N)


4. 평가: 기존 체계와의 분절
KOREA
[재활/임상 · 건강/생활체육]
[엘리트/전문체육]
· 극한의 스포츠 운동수행능력
· 적합 종목 매칭 & 발전 가능성
· 종목별 특이적 체력 요구
· 스포츠 등급별 기능 & 체력 요인
· K-MBI 등 임상평가:
· 장애인체력인증센터 기준:
임상 및 생활체육 기반 척도를 엘리트 스포츠 입문 의사결정에 적용하기에는 평가 목적 및 요구 수준의 뚜렷한 단절 발생


4. 평가: 데이터 축적과 긍정적 신호
KOREA
동 · 하계 스포츠캠프를 통한 데이터 축적
1. 연 2회 동·하계 스포츠캠프 운영
· 통계, 하계 패럴림픽 종목 체첨:
- 장애유형별 적합 종목 매칭 프로그램 진행
- 간이 스포츠등급분류 프로그램 진행
- 기초·전문 체력 측정 진행
· 육성 캠프 기반 정량 데이터 축적:
- 신체조성, 기초·전문(무산소성 Wingate 등) 체력 측정 등 생리학적 데이터 연속 측정
· 보조적 탐색(저산소 환경):
- 입문 단계 체첨 및 기능 평가 목적
- 해발 1,000~3,000m 수준의 저산소 환경에서 트레이닝을 통한 유산소성 능력 및 심폐반응 탐색
2. 현장의 시사점: 결과 관찰 및 학술적 의미
· 소규모 표본임에도 육성 과정을 통해 관찰되는 기능적 지표 (유산소 및 무산소 기능 등) 향상의 '긍정적 신호' 반복 관찰은 향후 정량적 준거 마련의 근거로 활용 가능

4. 평가: 결론

The Missing Link: 최소 기능 평가 지표 모색



- 당장 완벽한 '절대 기준'은 불가하나, 현장 의사결정을 도울 **'최소 기능 평가 지표'** 합의 시급
- 현장의 **정성적 판단(경험)**을 **정량적 준거**로 발전시키는 구조화 작업 필요
- 병원(초기 재활)의 데이터가 엘리트 체육(초기 입문) 현장으로 단절 없이 이어지는 **연속성 추적**

Take home message

[평가 지표]

입문 대상자의 기능 및 체력적 장점을 객관적으로 파악할 '표준화된 평가 지표' 개발 시,
필수적으로 고려되어야 할 요인은 무엇인가?

[훈련 설계]

사전 평가 결과와 장애 특성을 반영하여 '초기 맞춤형 훈련 프로토콜 및 부하(Load) 관리'를 설계할 때,
어떠한 의학적 · 생리학적 요인들이 고려되어야 하는가?

감사합니다.

freeky1230@korpanpc.kr

김현수

학력

가천대학교 운동재활학과 학사

고려대학교 융합과학대학원 스포츠의학과 석사과정

주요 경력

휠체어 농구 국가대표팀 트레이너

중,고등부 농구연맹 대회 의무 트레이너

중,고등부 럭비 대회 의무 트레이너

현재 소속 및 직위

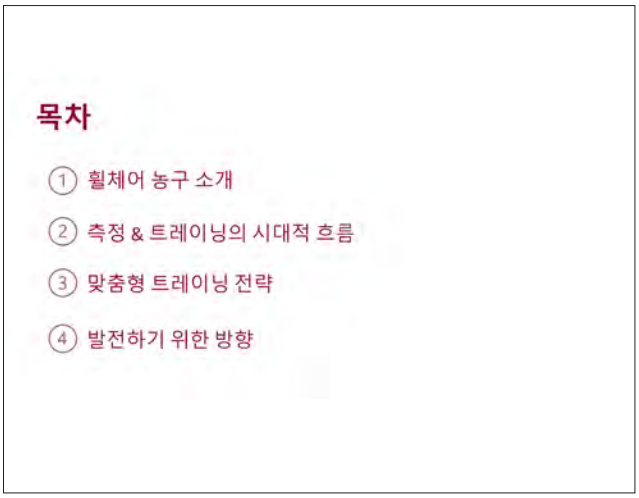
대한장애인농구협회 소속 대표팀 트레이너

장애인 엘리트 스포츠에서 측정과 트레이닝 체계의 시대적 변화와 과제: 휠체어 농구를 중심으로

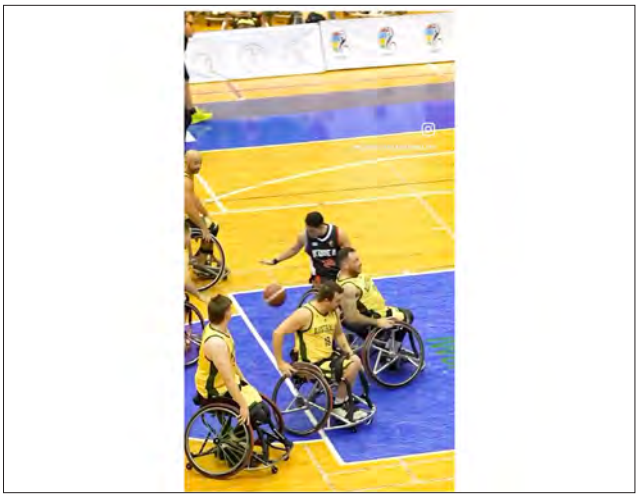
The Evolution and Challenges of Measurement and Training Systems in Elite Sports for Persons with Disabilities: Focusing on Wheelchair Basketball

대한장애인농구협회

김현수









휠체어 농구의 역사와 대한민국의 궤적

1945년 구트만(Guttmann)의 재활 체육에서 고도로 전문화된 엘리트 스포츠로의 진화



종목의 DNA: 휠체어 농구의 생리학적 요구사항

- 고강도 인터벌 형태의 경기 운영
- 반복적인 전력질주와 급격한 방향 전환
- 빈번한 신체 접촉과 충돌 상황
- 상지 중심의 추진 운동
- 무산소성 에너지 기여도 증가



핵심 규칙이자 훈련의 기준: 등급 분류 (Classification)

1.0 ~ 4.5 등급 시스템

분류 기준: 체간 움직임과 안정성
(Trunk movement and stability)

정의: 균형을 잃지 않고 최대로 체간을 조절하며 도달할 수 있는 범위

개인의 잔존 기능 차이가 전술적 구조와 훈련의 출발점이 되며, 체간 안정성은 경기력에 직접적인 영향을 미칩니다.





측정&트레이닝의 시대적 흐름

과거의 한계: 잘못된 열정과 모방 (1980s~Early 2000s)

- 장애 특성 이해 부재
  - 비장애인 지도자의 경험적 지도에 의존
- 맹목적 모방의 결과
  - 비장애인 측정 프로토콜의 도입으로 임상적 유의성 결여
  - 측정 결과를 실제 훈련 강도 설정에 활용 불가
  - 근력 불균형 초래 및 '휠체어 선수는 웨이트가 불필요하다'는 잘못된 인식 팽배



시스템의 현대화: 모방에서 전문화로 (Late 2000s~Present)

더 이상 축소판이 아닌, 독자적이고 정밀한 과학적 시스템으로의 진입

근거 기반 트레이닝	종목 특이적 지표 도입	등급별 데이터 정밀화
해외 선진 사례 도입 및 데이터 기반 개별 피드백 구축	가속, 감속, 회전 등 실제 휠체어 조작 기술 반영	선수의 개인 특성과 장애 등급을 고려한 맞춤형 트레이닝 체계 구축

측정의 진화 I: 종목 특이적 지표의 식별

- 과거: 전통적 체력 요인 측정에 편중
- 현재: 실제 휠체어 농구 경기에서 요구되는 '복합 기능' 평가

1,254편의 문헌 중 엄격한 기준을 통과한 최종 14편의 핵심 연구 체계적 분석 결과





가속 (Acceleration)



제동 (Break)



회전 (Slalom)

드리블 등 16개의 종목 특이적 움직임 테스트 식별

측정의 진화 II: 과학적 타당성 검증

현장 활용 가이드라인: 감에 의존하는 훈련 탈피, 정밀한 훈련 강도 설정 및 부상 복귀 시점 결정

FIELD TEST VALIDATION FOR WHEELCHAIR BASKETBALL PLAYERS' AEROBIC CAPACITY ASSESSMENT

28m 셔틀런 테스트 프로토콜 검증 (Field Test Validation)

- 실험실 표준 데이터(VO2peak 등)와 현장 셔틀런 테스트 결과 간의 높은 상관관계 입증

In conclusion, the findings of this study confirm the **specificity of the shuttle run type test** for WBP as it **faithfully reproduces the demands of the sport, provides reliable** data on HR, test duration and distance covered and is **a valid predict or of** VO2peak as an indicator of **aerobic performance in elite players.**

정밀 타겟팅의 과학적 근거: 등급과 무산소 출력의 상관관계

- **체간 조절 능력**(Trunk Control)의 차이가 **무산소 출력의 유의미한 격차**를 결정한다.
- **핵심 발견: 저기능군**의 **무산소 수행능력**은 **고기능군**보다 **유의미하게 낮음.**
- **시사점:** 현재의 등급 분류는 선수의 **신체적 능력**을 **정확히 반영**하며, 이는 곧 **등급별 맞춤 트레이닝**이 **필수적인 생리학적 근거**가 됨.

Relationship Between Functional Classification Levels and Anaerobic Performance of Wheelchair Basketball Athletes

Table 2. Indexes of anaerobic performance across the eight wheelchair basketball functional classification levels

Level[a]	*n*	MP (W)		PP (W)		FI (W/s)	
		M	*SD*	*M*	*SD*	*M*	*SD*
1.0	16	223	56	306	75	6.8	2.0
1.5	7	268	28	399	40	6.5	1.3
2.0	12	287	53	460	101	8.1	3.2
2.5	6	290	29	371	44	7.6	1.0
3.0	15	344	51	472	77	10.8	3.1
3.5	9	398	70	532	104	11.5	2.9
4.0	17	389	77	539	123	12.6	3.9
4.5	15	382	80	542	115	13.7	3.8

Note. MP = mean power; PP = peak power; FI = fatigue index; *M* = mean; *SD* = standard deviation.
[a]International Wheelchair Basketball Federation classification levels.



맞춤형 트레이닝 전략

맞춤형 트레이닝 전략: 저기능군 (Class 1.0~2.5)

Focus: Stability & Endurance (안정성과 지구력)

1. 체간 안정화: 상지 가동 시 발생하는 불필요한 보상 작용 최소화

2. 관절 보호: 휠체어 추진으로 인해 과부하가 걸리는 견관절 복합체의 균형 잡힌 강화

3. 훈련 부하 모델: 고반복-저부하(High Repetition - Low Load) 전략을 통한 부상 예방적 근지구력 확보







맞춤형 트레이닝 전략: 고기능군 (Class 3.0~4.5)

Focus: Dynamic Power & Core (동적 파워와 코어)

- **1. 폭발적 파워:** 플라이오메트릭(Plyometric) 훈련 적극 적용
- **2. 코어 전이 (Core Transfer):** 잔존 기능을 최대한 활용하여 하체와 체간에서 상지로 이어지는 힘의 전달력 극대화
- **3. 훈련 부하 모델:** 고부하-저반복 (High Load - Low Repetition)을 통한 실전 대응력 및 고강도 파워 훈련



Kinetic Chain / Core Transfer



발전하기 위한 방향

전통적 부상 관리의 한계 (Limits of Rudimentary Care)

1980년대~2000년대 초반의 1차원적 처치 방식

- 단순 증상 완화와 일시적 통증 관리에만 초점
- 부상 이후 체계적인 단계적 복귀(RTP) 프로토콜의 부재
- 필연적으로 발생하는 훈련과 재활 사이의 거대한 '재활 공백'



현대 스포츠 의학의 역할: 완벽한 실전 복귀 (RTP 모델)

통증 소실이 목표가 아닌, '엘리트 선수로서의 완벽한 기능적 복귀'가 핵심 (이상적 모델 지향)

1. 역학적 과부하 이해 (현실적 한계)

많은 병원에서 휠체어 추진/제동/회전 시 발생하는 관절 내 기계적 스트레스와 상해 종류에 대한 인식 부족와 (발전 중이나 여전히 미흡)

2. 재발 방지 및 근력 회복

역학적 불균형을 해소하는 주동근-길항근 강화

3. Re-loading (점진적 부하)

손상 부위에 단계적 부하를 적용하며 실전과 유사한 환경에서 훈련 재개

현실적 과제 (Current Challenge)

- 이상적인 RTP 모델 구축을 위한 노력 지속 중
- 역학적 과부하 및 상해 특성에 대한 의료 현장의 이해도 향상 필요 (지속적인 교육 및 인식 개선 시급)

다학제적 협업 생태계 구축 (Multidisciplinary Ecosystem)

현실적인 제약(MOU 등)을 넘어, 지속적인 관심과 공동의 노력으로 이상적인 협업 모델을 함께 만들어가야 합니다.



의료진, 트레이너, 코치진 모두가 공감하고 참여하는
'원팀(One Team)' 문화 조성

결론: 증명된 진화, 그리고 새로운 목표

과거의 맹목적 열정에서 벗어나, 근거 기반의 정밀 트레이닝과 다학제적 스포츠 의학 시스템으로 눈부신 진화를 이뤄냈습니다.

지금 이 순간에도 현장에서는 엘리트 스포츠의 한계를 넘어서기 위한 시스템 고도화가 계속되고 있습니다.

Next Milestone

Asian Para Games Aichi-Nagoya 2026
AINAGOC
5th Asian Para Games Aichi-Nagoya2026 Dates October 18TH (SUN) - 24TH (SAT) .2026

대한스포츠의학회

Thank you

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The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

심포지엄 4:
노인에서의 근감소증 관리: 병원 기반 치료에서 운동 환경으로
Management of Sarcopenia in Older Adults: From Hospital-Based Care to Exercise Settings

좌장: 건강보험심사평가원 노권재, SNU서울병원 이상훈



백민수

학력

고려대학교 융합과학대학원 스포츠의학과 석사 수료

대구보건대학교 물리치료학 학사

주요 경력

울산과학대학교 스포츠재활학부 특강강사

코레일 인재개발원 사외강사

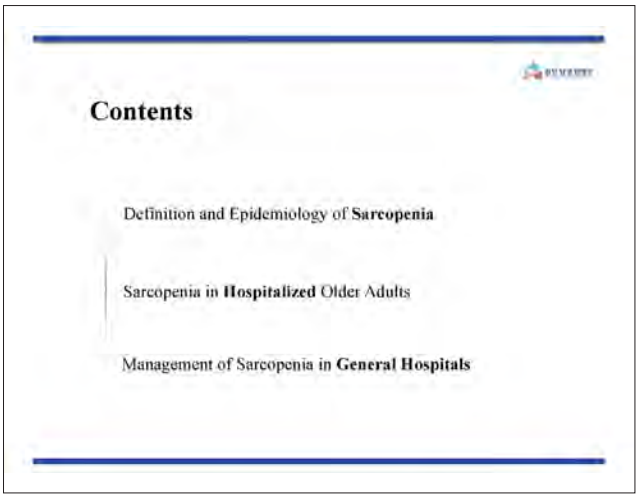
강 의료재단 강병원 운동치료실 물리치료사

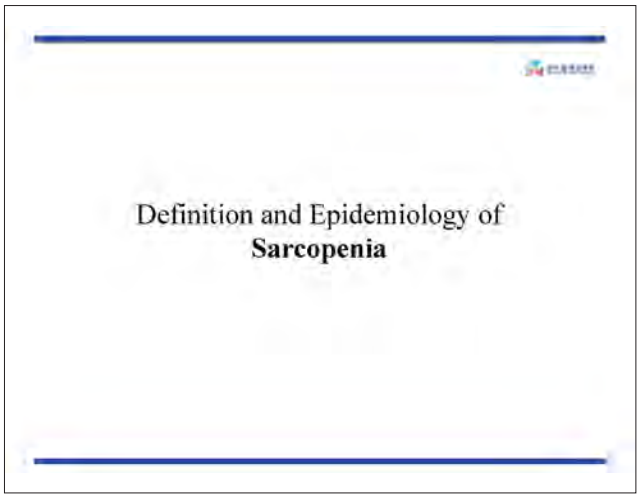
현재 소속 및 직위

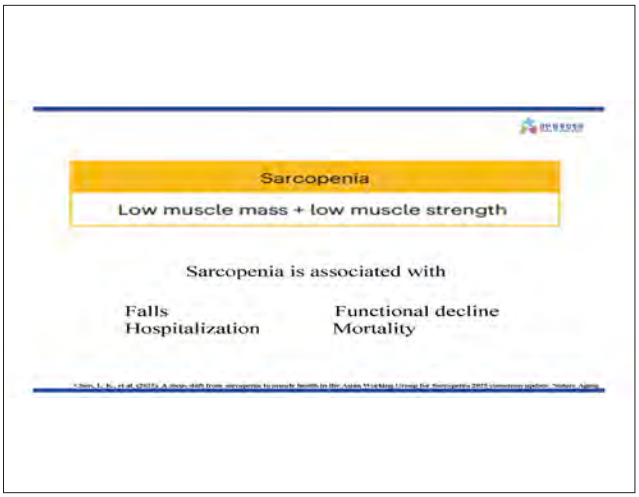
검단탑종합병원 물리치료실 실장

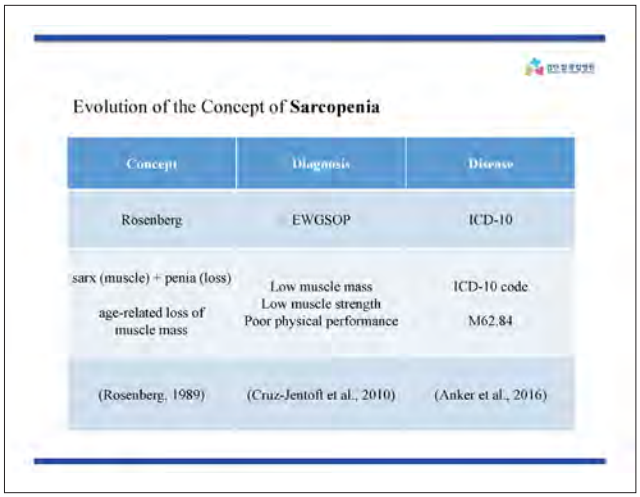
종합병원에서의 근감소증 관리
Management of Sarcopenia in General Hospitals

검단탑병원
백민수









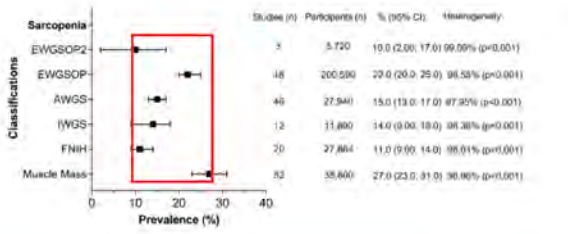
nature aging

Perspective

A focus shift from sarcopenia to muscle health in the Asian Working Group for Sarcopenia 2025 Consensus Update

Table 1 | The AWGS Consensus: evolution of criteria through 2019 and 2025 updates to the 2014 criteria

	AWGS 2014	AWGS 2019	AWGS 2025
Definition of sarcopenia	Age-related loss of skeletal muscle mass PLUS low muscle strength AND/OR low physical performance	No change from original 2014 definition	Age-related loss of skeletal muscle mass PLUS low muscle strength
Age cutoff	60 or 65 years (country-dependent)	60 or 65 years (country-dependent)	60 or 65 years for sarcopenia diagnosis, but introduces specific criteria for middle-aged adults (50–64 years)
Diagnostic algorithm	Linear algorithm: assess muscle mass and muscle function (grip strength, physical performance)	• Two separate algorithms: 1) Community settings 2) Hospital or research settings • Introduced 'possible sarcopenia' for primary care	• Enhanced two-track algorithm: 1) Community settings 2) Hospital or research settings • Emphasizes early identification and intervention
Case-finding	Not specifically addressed	1. Calf circumference: M <34 cm, F <33 cm 2. SARC-F: ≥4 3. SARC-CalF: ≥11	Add Yubi-wakka (finger-ring) test



Global prevalence of sarcopenia (≥60-65 years)

Prevalence of Sarcopenia in **Korea**

Table 2. Basic characteristics of study participants

Characteristics	Total elderly (n = 4,139)	65–74 (n = 2,639)	75+ (n = 1,508)	p-value
Presence of sarcopenia	442 (10.7)	160 (6.1)	282 (18.7)	0.013*

Age ↑
Sarcopenia prevalence ↑

Cho, J. M., & Bae, J. (2025). Nutritional, physical, and body composition profiles of the Korean sarcopenic population. Journal of Nutrition and Health, 58(3), 315–331

Sarcopenia in **Hospitalized** Older Adults

Prevalence and Factors Associated with Sarcopenia in Hospitalized Elderly Patients

Incident sarcopenia in hospitalized older people: A systematic review

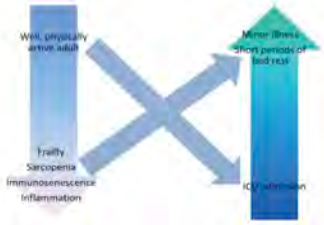
Systematic review: Prevalence of sarcopenia in ageing people using bioelectrical impedance analysis to assess muscle mass

Prevalence and Diagnosis of Sarcopenia in Residential Facilities: A Systematic Review

Sarcopenia prevalence by **care setting**

Setting	Prevalence	References
Community	~10%–27%	(Petermann-Rocha et al., 2022)
Hospitalize	~15–55%	(Beaudart et al., 2017)
Rehabilitation / post-acute	~35–50%	(Landi et al., 2012)
Nursing home	~25–70%	(Saka et al., 2015; Beaudart et al., 2017)

Acute sarcopenia during hospitalization



5 days bed rest → lean leg mass ↓

muscle strength ↓ → **acute sarcopenia**

Welch, C., et al. (2018). Acute sarcopenia secondary to hospitalisation Age and Ageing, 47(6), 764–772.

Acute sarcopenia during hospitalization



12–38.7% develop new sarcopenia

Welch, C., et al. (2018). Acute sarcopenia secondary to hospitalisation Age and Ageing, 47(6), 764–772.
Wan, S. X., et al. (2023). Incident sarcopenia in hospitalized older adults: prevalence and clinical implications. PLOS ONE.

Acute Sarcopenia, Chronic Sarcopenia

Category	Acute Sarcopenia	Chronic Sarcopenia
Time course	**Short-term progression (days to weeks)**	Long-term progression (years)
Main causes	**Acute illness, hospitalization, surgery, trauma**	Aging, physical inactivity, endocrine changes, chronic disease
Clinical consequences	**Functional decline, prolonged hospitalization, increased mortality**	Functional decline, falls, disability
Clinical implication	Early detection and hospital-based intervention	Prevention and long-term management

Management of Sarcopenia in **General Hospitals**

Screening for Sarcopenia in Hospital Settings

Korean Version SARC-F ≥4

Supplementary Table 1
Korean Version of SARC-F Questionnaire (Korean and English)

항목	질문	답변
근력	무거운 4.5 kg 가방을 얼마나 자주 들어 올리는 것이 힘듭니까?	전혀 어렵지 않다 = 0 좀 어렵다 = 1 상당 어렵다 = 2 전혀 할 수 없다 = 2
보행 보조	방 안 한 곳에서 다른 곳으로 걸어가는 것이 얼마나 어려운가요?	전혀 어렵지 않다 = 0 좀 어렵다 = 1 상당 어렵다 = 2 전혀 할 수 없다 = 2
의자에서 일어서기	의자 또는 침대에서 일어나는 것이 얼마나 어려운가요? 혼자 할 수 있는 것이 아니라면 보조기구나 다른 사람의 도움을 받는 것이 얼마나 어려운가요?	전혀 어렵지 않다 = 0 좀 어렵다 = 1 상당 어렵다 = 2 전혀 할 수 없다 = 2
계단 오르기	10개의 계단을 혼자 힘으로 오르는 것이 얼마나 어려운가요?	전혀 어렵지 않다 = 0 좀 어렵다 = 1 상당 어렵다 = 2 전혀 할 수 없다 = 2
낙상	지난 1년 동안 몇 번이나 넘어지셨나요?	전혀 없다 = 0 1~3번 = 1 4번 이상 = 2

Kim, S., Kim, M., & Won, C. W. (2018). Validation of the Korean version of the SARC-F questionnaire to assess sarcopenia: Korean Frailty and Aging Cohort Study. Journal of the American Medical Directors Association, 19(1), 40–45.

Screening for Sarcopenia in Hospital Settings

Handgrip strength (AWGS 2025)

Recommended Handgrip strength		
Measurement method	Age ≥65 years	Age 50–64 years
Hand dynamometry	M <28 kg, F <18 kg	M <34 kg, F <20 kg

Chen, L. K., et al. (2025). A focus shift from sarcopenia to muscle health in the Asian Working Group for Sarcopenia 2025 consensus update. Nature Aging.

Screening for Sarcopenia in Hospital Settings

DXA, BIA (AWGS 2025)

Diagnosis		
Appendicular skeletal muscle mass		
Measurement method	Age ≥ 65 years	Age 50–64 years
DXA	Height adjusted: M <7.0 kg m^{-2}, F <5.4 kg m^{-2} or BMI adjusted: M <0.79, F <0.52	Height adjusted: M <7.2 kg m^{-2}, F <5.5 kg m^{-2} or BMI adjusted: M <0.80, F <0.55
OR		
BIA	Height adjusted: M <7.0 kg m^{-2}, F <5.7 kg m^{-2} or BMI adjusted: M <0.83, F <0.57	Height adjusted: M <7.6 kg m^{-2}, F <5.7 kg m^{-2} or BMI adjusted: M <0.90, F <0.63

Chen, L. K., et al. (2025). A focus shift from sarcopenia to muscle health in the Asian Working Group for Sarcopenia 2025 consensus update. Nature Aging.

Management in Hospitals

Early Mobilization

Resistance Exercise

Nutritional Support

Welch, C., Hassan-Smith, Z., Greig, C., Lord, J., & Jackson, T. (2018). Acute sarcopenia secondary to hospitalisation. Age and Ageing, 47(5), 631–638.

Multicomponent exercise Program



Martínez-Velilla, N., Casas-Herrero, A., Zambom-Ferraresi, F., et al. (2019). Effect of exercise intervention on functional decline in very elderly patients during acute hospitalization. JAMA Internal Medicine, 179(1), 28–36.

Multicomponent exercise Program



Martínez-Velilla, N., Casas-Herrero, A., Zambom-Ferraresi, F., et al. (2019). Effect of exercise intervention on functional decline in very elderly patients during acute hospitalization. JAMA Internal Medicine, 179(1), 28–36.

Take home messege

1. Sarcopenia is a clinically relevant disease in older adults
2. Hospitalization is a critical window to detect and intervene sarcopenia
3. Exercise-based interventions are the cornerstone of treatment
4. Continuity of care after discharge is critical

사단법인 대한스포츠의학회
The Korean Society of Sports Medicine

검단탑종합병원

Thank you for your attention

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김희중

학력

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고려대학교 융합과학대학원 스포츠의학과 석사 수료

주요 경력

R2B운동과학센터 /트레이너

노원삼성정형외과 AI 퍼포먼스센터 / 운동사

대찬병원 스포츠메디컬센터 / 운동사

가천대학교 운동재활학과 / 운동손상 및 평가 특강

현재 소속 및 직위

R2B운동과학센터 /트레이너

트레이닝 센터에서의 근감소증 관리
Management of Sarcopenia at the Training Center

R2B운동과학센터
김희중

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Exercise Program Design for Sarcopenia

Clinical application in the Training Center

Screening and Assessment Strategies
in the Training Center

Selp assessments

Table 1 | The AWGS Consensus: evolution of criteria through 2019 and 2025 updates to the 2014 criteria

	AWGS 2014	AWGS 2019	AWGS 2025
Case-finding	Not specifically addressed	1. Calf circumference: M <34cm, F <33cm 2. SARC-F, ≥4 3. SARC-CalF, ≥11	Add Yubi-wakka (finger-ring) test



Figure 1 "Yubi-wakka" (finger-ring) test.

Tanaka et al., Geriatr Gerontol Int, 2018, 18(2)
Chen et al., Nature Aging, 2025, 5(11)

Muscle strength

Table 2 | Measurements of muscle strength, muscle mass and physical performance in the AWGS 2025 consensus

Measurement	Adjustment	Cutoff values: Age 50–64 years, Men	Age 50–64 years, Women	Age ≥65 years, Men	Age ≥65 years, Women
Muscle strength					
Handgrip (kg)		<34.0	<20.0	<28.0	<18.0

'Possible Sarcopenia'



Mechanical spring dynamometer(Smedley)



Hydraulic type(Jamar)

Chen et al., Nature Aging, 2025, 5(11)

Muscle mass measurement



BIA (Bioelectrical Impedance Analysis)

ASM (Appendicular Skeletal Muscle Mass) : Arm muscle mass + Leg muscle mass

SMM(Skeletal Muscle Mass) : Total Skeletal Muscle Mass – Estimate the risk of sarcopenia

Muscle mass measurement

Table 2 | Measurements of muscle strength, muscle mass and physical performance in the AWGS 2025 consensus

Measurement		Cutoff values			
		Age 50–64 years		Age ≥65 years	
	Adjustment	Men	Women	Men	Women
Muscle mass					
DXA	ASM/height^2	<7.2	<5.5	<7.0	<5.4
BIA	ASM/height^2	<7.6	<5.7	<7.0	<5.7
DXA	ASM/BMI	<0.80	<0.55	<0.73	<0.52
BIA	ASM/BMI	<0.90	<0.63	<0.83	<0.57

ASM, appendicular skeletal muscle.

Chen et al., Nature Aging, 2025, 5(11)

Muscle mass measurement

Table 4. Comparative data for threshold levels of low skeletal muscle mass for class I and class II sarcopenia in different populations.

	Men	Women
Present study		
Class I	39.8	35.5
Class II	36.7	32.3
Janssen et al. [3] from US		
Class I	37.0	28.0
Class II	31.0	22.0
Bahat et al. [40] from Turkey		
Class I	40.4	37.2
Class II	37.4	33.6

Data are presented as the skeletal muscle mass index (percentage).

Class I sarcopenia: Moderate sarcopenia

Class II sarcopenia: Severe sarcopenia

SMI(Skeletal Muscle Mass index) = SMM/Weight*100

Park et al., Medicina, 2022; 58(10):1361

Exercise Program Design

for Sarcopenia

Exercise program for sarcopenia

Resistance exercise: primary strategy for the treatment of sarcopenia.

Composed of a combined exercise program


Resistance Exercise


Balance Training


Aerobic Training

Hurst et al., Age and Ageing, 2022, 51(3)

Principles of exercise training

Specificity : Responses to exercise training are specific to the stimulus induced by the exercise dose.

Overload : A greater than habitual stress or load on the body is needed to induce adaptation.

Progression : A gradual and systematic increase in stress placed on the body is necessary to induce continual training adaptation over time.

Thornton et al., Age and Ageing, 2022, 51(1)

Exercise training variables

- Training frequency
- Exercise selection
- Exercise intensity
- Volume
- Rest periods

Hunter et al., Age and Ageing, 2022, 51(1)

Training frequency

The standard prescription for sarcopenia: two per week.

Very low baseline strength or Severe sarcopenia: once per week

Quality over Quantity

Table 3. Pretest and posttest for the 10RM tests (mean ± *SD*) in control (CG, n = 10) and experimental groups (EG1, n = 10; EG2, n = 11; EG3, n = 10).

	Bench press (kg)			Dumbbell curl (kg)		
Group	Pre	Post	Δ%	Pre	Post	Δ%
CG	9.2 ± 1.8	9.6 ± 1.5	4.4 ± 0.6	8.8 ± 1.6	9.0 ± 0.7	2.3 ± 0.7
EG1	9.2 ± 1.8	13.0 ± 2.0*†	56.5 ± 6.0†	7.6 ± 1.5	12.2 ± 2.3*†	56.4 ± 6.1†‡§
EG2	9.6 ± 2.2	14.4 ± 5.2*†	50.0 ± 4.5†	8.4 ± 1.7	13.6 ± 2.6*†	61.9 ± 5.6†‡§
EG3	10.4 ± 0.9	15.6 ± 1.7*†	52.0 ± 4.9†	9.2 ± 1.8	15.6 ± 0.9*†	69.6 ± 5.4†‡§

	Knee extension (kg)			Sitted calf raise (kg)		
Group	Pre	Post	Δ%	Pre	Post	Δ%
CG	19.4 ± 2.3	19.8 ± 2.5	2.1 ± 0.3	11.4 ± 1.1	11.6 ± 0.9	1.8 ± 0.2
EG1	18.0 ± 3.7	25.6 ± 3.2*†	42.2 ± 5.0†‡§	12.0 ± 2.0	16.8 ± 1.9*†	40.0 ± 3.9†
EG2	19.2 ± 4.6	29.6 ± 7.4*†	54.2 ± 6.4†‡§	12.2 ± 3.0	17.0 ± 3.7*†	39.3 ± 4.5†
EG3	19.8 ± 4.9	32.0 ± 6.8*†	61.6 ± 4.9†‡§	11.8 ± 0.5	16.8 ± 1.5*	42.4 ± 4.0†

Δ% = mean percent difference between pre and posttests.
Superscript alphabetic letter to statistical difference ($p < 0.05$) compared to a given experimental group (e.g., "a" indicates a significant difference from EG2).
*Statistical difference from pretest ($p < 0.01$).
†Statistical difference from CG ($p < 0.01$).

Farinatti et al., J Strength Cond Res, 2013, 27(6)

Exercise selection

Whole-body resistance exercise: Lower body training is essential

Upper body Exercise	Lower body Exercise
Instrumental activities of daily living	Activities of daily living
Exercises involving gripping movements	Walking
Forearm strength & Grip strength	Standing up from a chair
	Climbing stairs

Table 2. A proposed resistance exercise prescription for older adults with sarcopenia

Training frequency	Two sessions per week	
Exercise selection	*Lower body*	*Upper body*
	Squat/leg press	Chest press
	Knee extension	Seated row
	Leg curl	Pull-down
	Calf raise	

Hunter et al., Age and Ageing, 2022, 51(1)

Exercise intensity

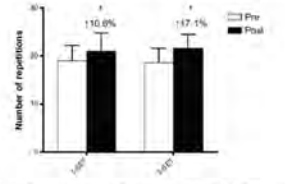
- Initial stage: low exercise intensity, emphasis on learning correct technique
- Severe sarcopenia or Very low physical function
  Low-intensity resistance exercise (30–60% 1RM) or bodyweight exercise
- Higher baseline strength and Functional capacity
  Higher exercise intensity (50–70% 1RM)

- Movement velocity
  Power training is an effective strategy for improving muscle power and functional performance in older adults

Hunter et al., Age and Ageing, 2022, 51(1)

Exercise volume

Short-term resistance training programs



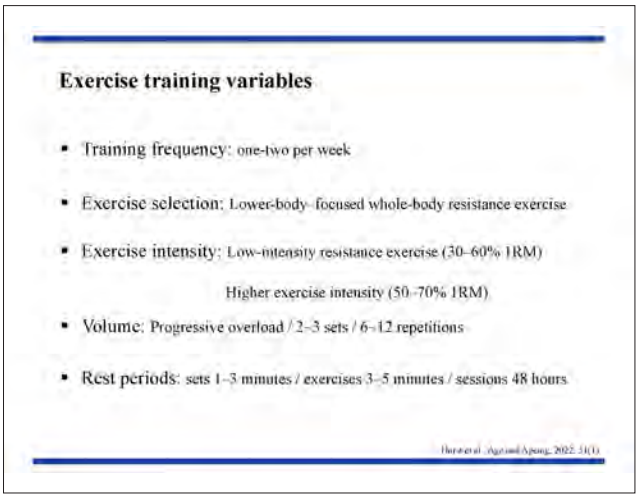
- Progressive overload
- 2–3 sets
- 6–12 repetitions

Hunter et al., Age and Ageing, 2022, 51(1)

Rest periods

- Between sets 1–3 minutes
- Between exercises 3–5 minutes
- Between sessions 48 hours
- It has not yet been clearly determined

Hunter et al., Age and Ageing, 2022, 51(1)


Exercise training variables
Training frequency: one-two per week
Exercise selection: Lower-body–focused whole-body resistance exercise
Exercise intensity: Low-intensity resistance exercise (30–60% 1RM)
Higher exercise intensity (50–70% 1RM)
Volume: Progressive overload / 2–3 sets / 6–12 repetitions
Rest periods: sets 1–3 minutes / exercises 3–5 minutes / sessions 48 hours


Clinical application
in the Training Center


사단법인 대한스포츠의학회
The Korean Society of Sports Medicine
R2BESC
Thank you for your attention
Instagram
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허진희

학력

경북전문대학교 물리치료학과 전문학사

고려대학교 융합과학대학원 스포츠의학과 석사

주요 경력

물리치료사 4년

필라테스강사 10년차

필라테스교육강사

현재 소속 및 직위

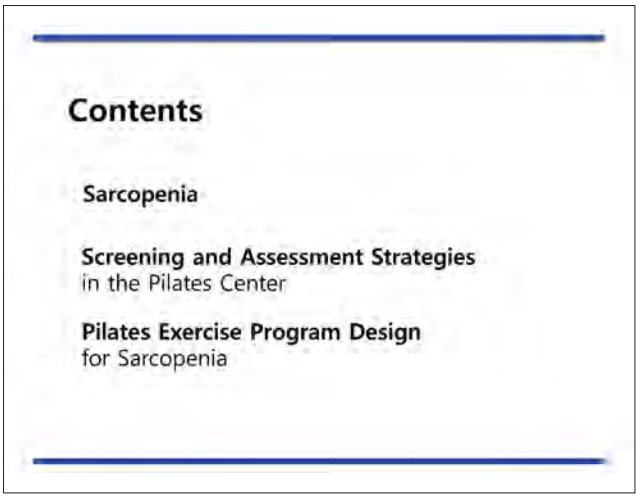
리본필라테스 전무이사 & 교육강사

대표논문

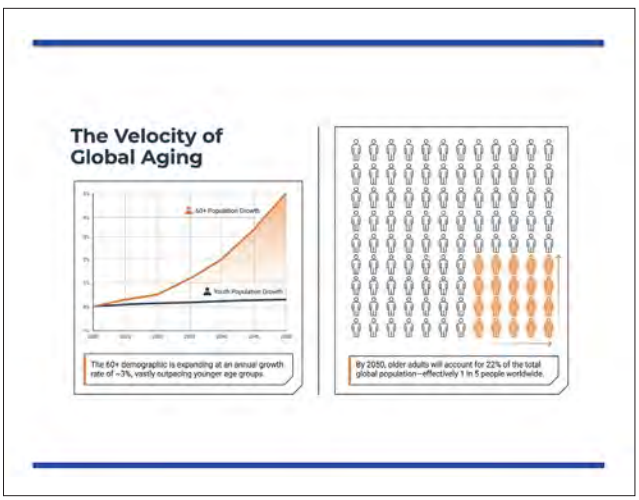
아쿠아백 도구 운동이 만성 요통을 가진 중년 여성의 통증, 기능장애, 균형 능력, 심리사회적 요인에 미치는 영향 (The Effects of Aquabag-Based Dynamic Stabilization Exercise on Pain, Disability, Balance, and Psychosocial Factors in Middle-Aged Women with Chronic Low Back Pain)

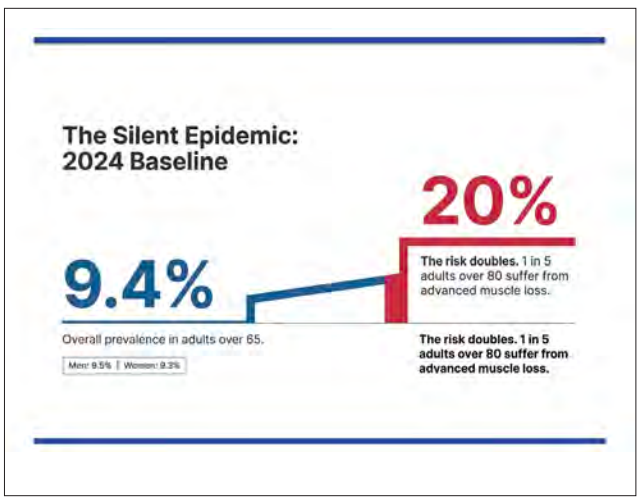
필라테스 센터에서의 근감소증 관리
Managing Sarcopenia at the Pilates Center

리본필라테스
허진희









Sarcopenia

Fall incidence rate by old adult

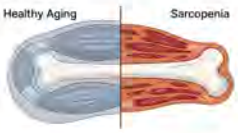
65 years of age or older



80 years of age or older



Sarcopenia



Meta-analysis	1.52배 증가 **1.52x**	Approximately **52% higher** risk of falls than healthy older adults
Systematic Review	1.60 ~ 1.89배 증가	Sarcopenia increases risk of falls and fractures
A Study On the Elderly Women	2.5 ~ 3.3배 증가	Significantly increased risk of falls in elderly women with sarcopenia

Sarcopenia

Fall incidence rate by old adult

1. Sarcopenia
The weakening of the structural foundation.

2. Falls
30% of adults 65+ fall annually. This leaps to 50% for adults 80+.

3. Hospitalization

The 2025 AWGS Guideline Update

	The Legacy Approach	AWGS 2025 Paradigm
Target Demographic	Age 65+ (Geriatric Focus)	**Age 50–64 (The Life-Course Approach)**
Primary Metric	Pure Muscle Mass	**Functional Sarcopenia (Muscle Strength & Performance)**
Intervention Timing	Reactive Treatment	**Proactive Early Intervention**

Screening and Assessment Strategies in the Pilates Center

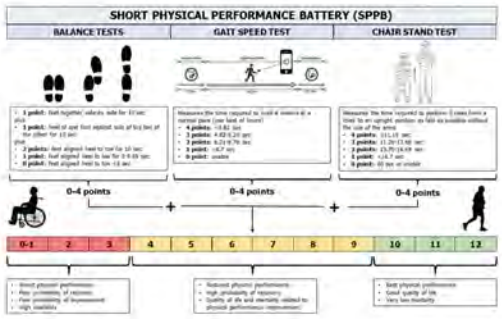
The Gold Standard Tracker: SPPB

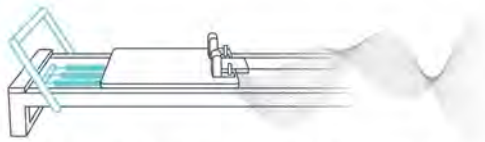
Short Physical Performance Battery

Balance
Static Balance. Side-by-side, semi-tandem, and full tandem stances for 10 seconds.

Gait Speed
Locomotion. Time required to walk 4 meters at a normal, habitual pace.

Chair Stand
Lower Body Power. Time required to complete 5 consecutive chair stands without arm assistance.





Evidence-Based Pilates for the Aging Body

Clinical impacts on physical performance, fall risk, and SPPB metrics in older adults.

More than movement. A precision clinical intervention.

Pilates directly alters the biomechanical trajectory of aging. By targeting specific neuromuscular pathways, it dramatically **reduces fall risk** while significantly elevating **functional performance** and independence in older populations.

Targeted Pilates Intervention

Enhanced SPPB Metrics

+

Reversed Fall Risk Trajectory

The Data: Proven Across Populations

THE MACRO: Systemic Fall Risk Reduction

0.90

Large effect size for fall risk reduction. Verified improvements in balance, strength, strength, and overall SPPB.

THE MICRO: Targeted SPPB Enhancement

p=0.013

Statistically significant increase in Total SPPB Score, driven primarily by gains in Gait Speed and Chair Stand metrics.

Balance & The Unstable Carriage

Apparatus focus: Pilates Reformer.

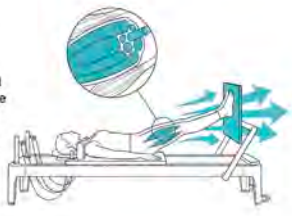
Clinical Mechanism: The inherent instability of the moving carriage continuously challenges the patient's base of support. This stimulates deep joint proprioception and proprioception and forces continuous micro-adjustments from the central nervous system, directly translating to **elevated static and dynamic balance scores.**



Gait Speed & Plyometric Power

Apparatus focus: Jumping Board (Reformer).

Clinical Mechanism: Horizontal plyometric training safely activates and strengthens Type II (fast-twitch) muscle fibers in the lower extremities without vertical joint loading. This specific neuromuscular adaptation is the exact physiological prerequisite for increasing baseline upright walking speed.



Chair Stand & Lower Body Coordination

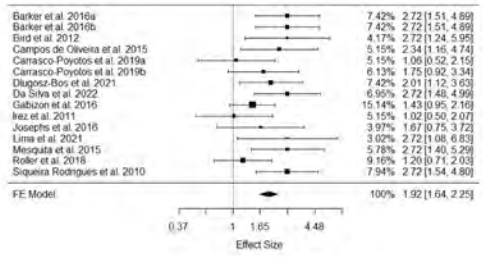
Apparatus focus: Pilates Chair (Step-ups / Footwork).

Clinical Mechanism: Pushing against the heavily sprung split-pedal builds extreme coordination between the quadriceps and glutes. This targeted lower-limb endurance training drastically reduces the physical time required to complete the SPPB Chair Stand test.



Pilates Exercise Program Design for Sarcopenia

Pilates



Park et al., Medicina, 2022; 58(10):1361

Decades of Validated Clinical Research

Evaluating over 20 independent clinical studies on Pilates interventions reveals a clear, overwhelmingly positive consensus across two critical domains of physical stability.



Static Balance Improvements
Significant reductions in Center of Pressure (COP) velocity, decreased sway amplitude, and enhanced single-leg/tandem stance stability.

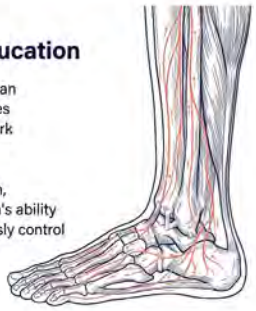


Dynamic Balance Improvements
Drastic reductions in Timed Up and Go (TUG) completion times and consistently elevated Berg Balance Scale scores.

Neuromuscular Re-education

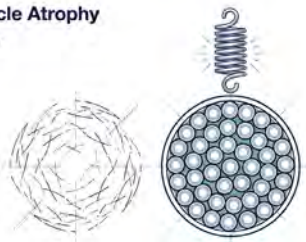
True fall prevention relies on more than simple muscle hypertrophy; it requires rebuilding the communication network between the body and the brain.

By focusing heavily on proprioception, Pilates enhances the nervous system's ability ability to intuitively and instantaneously control balance, replacing reliance on brute strength with refined motor control.



Combating Type II Muscle Atrophy

Age-related sarcopenia disproportionately targets Type II (fast-twitch) muscle fibers, stripping away the explosive power required to rapidly correct a stumble.



Atrophied Type II Fibers

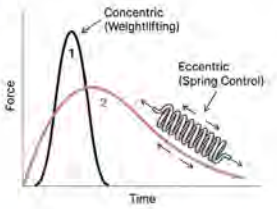
Preserved via Spring Tension

The unique, variable resistance profile of Pilates springs forces the **specific engagement that preserves these critical Type II fibers**, maintaining neuromuscular responsiveness.

Mastering the Deceleration Phase

Traditional resistance training heavily prioritizes the concentric phase (lifting a weight). In contrast, Pilates spring tension demands continuous, active control while the muscle is lengthening.

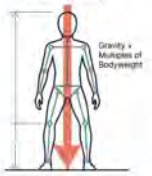
This eccentric control is the precise biomechanical mechanism the human body requires to safely descend stairs, absorb impact, or abruptly halt a fall.



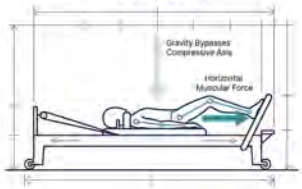
Eliminating Compressive Force

By shifting plyometric impact to a supine, horizontal plane, vertical joint compression is effectively neutralized. This makes explosive plyometric training entirely accessible and physically safe, even for elderly patients suffering from severe osteopenia or osteoporosis.

Ground Jump



Reformer Jump



Pilates Exercise Program

사단법인 대한스포츠의학회
The Korean Society of Sports Medicine

REBORN PILATES

Thank you for your attention

The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

심포지엄 6: 경기 당일 급성 손상 관리: 경기장 옆에서 수술실까지
Acute Injury Management on Match Day: From Sideline to Operating Room

좌장: 서울바른세상병원 임홍철, 한림대강남성심병원 김원희



김진수

학력

경상대학교 의학과 학사, 석사, 박사

주요경력

대한민국농구협회 의무위원장

대한축구협회 의무위원

서울이랜드FC, SK Nights 농구단 주치의

현재 소속 및 직위

세종스포츠정형외과 원장

대표논문

1. Jin Su Kim, Ki Won Young, Hun Ki Cho, Seung Min Lim
   Arthroscopic anterior talofbular ligament repair for chronic ankle instability with concomitant lesions of the ankle, Arthrosc Orthop Sports Med 2020;7(1):1-7
2. Jin Su Kim, Sang Bum Kim, Min Seok Cha
   Unsatisfactory outcomes after conservative treatment for proximal migration of acute calcaneal-side calcaneofibular ligament rupture in athletes: a preliminary report Arthrosc Orthop Sports Med 2021;8(1):9-14 https://doi.org/10.14517/aosm21001
3. Jin Su Kim, MD, PhD1 and Hyuck Soo Shin, MD2
   Suture Anchor Augmentation for Acute Unstable Isolated Ankle Syndesmosis Disruption in Athletes, Foot & Ankle International, 2021. DOI: 10.1177/107110072110151882.

경기날 준비 물품 및 경기전 준비사항
Match Day Preparation Items and Pre-Match Preparations

세종스포츠정형외과
김진수

엘리트 스포츠 현장에서 팀닥터(team physician)는 선수의 부상 예방, 경기 중 손상 평가, 응급 상황 대응, 그리고 경기 후 의료 의사결정까지 다양한 역할을 수행한다. 특히 경기일(match day)은 의료적 의사결정이 가장 집중되는 시간으로, 경기 전 준비와 현장 의료 물품의 체계적인 구성은 선수 안전과 경기 운영에 직접적인 영향을 미친다. 국제 스포츠의학 단체인 International Olympic Committee, Fédération Internationale de Football Association, 그리고 American Medical Society for Sports Medicine에서는 팀닥터가 경기 전 선수 상태 확인, 응급 대응 체계 점검, 그리고 현장 의료 장비 준비에 대한 예시 및 필수요소를 안내하고 있다. 그러나 실제 스포츠 현장에서는 종목 특성, 경기 환경, 의료 인력 구성에 따라 팀닥터의 준비 방식과 의료 장비 구성에 차이가 존재한다.

경기일 준비는 단순히 의료 가방을 준비하는 수준을 넘어, 선수 상태 확인과 의료팀 협업을 포함하는 체계적인 과정이다. 일반적으로 팀닥터는 경기 시작전 선수들의 의학적 상태를 확인하고, 최근 발생한 손상이나 통증 여부, 경기 출전 가능성, 보호 장비 필요 여부 등을 팀트레이너로부터 보고 받고, 논의를 한다. 필요한 경우 테이핑, 보호 장비 착용, 약물 복용 혹은 경기 출전 제한 등의 결정이 이루어진다.

경기장에서 발생할 수 있는 응급 상황에 대비하여 응급 대응 계획(Emergency Action Plan)을 확인하는 것도 필수적인 과정이다. 구급차 위치, 의료진 역할 분담, 병원 이송 경로, AED 접근성 등은 경기 시작 전 반드시 확인되어야 한다. 특히 시즌이 시작되는 날에는 전체적인 응급 구조에 대한 리허설을 시행하는 것도 필요하다.

현장에서 사용되는 팀닥터 의료 가방(team physician medical bag)은 경기 중 발생할 수 있는 다양한 의료 상황에 대응하기 위한 필수 도구이다. 일반적으로 의료 가방 구성은 생명 유지 장비, 선수 평가 장비, 손상 처치 장비, 약물 및 기타 의료 도구 등으로 구분되고, 생명 유지 장비에는 자동제세동기(AED), 산소 공급 장치, bag-valve-mask, airway adjunct, 혈압계, pulse oximeter 등이 포함되며 이는 심정지나 호흡 곤란과 같은 생명 위협 상황에 대응하기 위한 장비이다. 그러나, 보통 축구 K리그 이상에서는 1급 앰뷸런스가 무조건 준비되어 있기 때문에 위에 이야기한 필수 장비는 갖추어져 있다. 손상 처치 장비로는 elastic bandage, cohesive bandage, rigid tape, splint, ice pack, wound dressing 등이 포함되며 발목 염좌, 근육 손상, 열상

등 스포츠 현장에서 흔히 발생하는 손상의 초기 처치에 사용된다. 이 또한 트레이너의 백에 갖추어져 있기 때문에 실제 팀 닥터의 백에는 선수 평가를 위한 장비로는 펜라이트, 청진기, 체온계, 간단한 신경학적 평가 도구 등을 준비하며, 최근에는 휴대용 초음파 장비를 활용하여 경기 하프타임 혹은 경기 종료후 근육이나 인대 손상을 평가하는 사례도 증가하고 있다. 또한 약물 준비 역시 중요한 부분으로 진통제, 항히스타민제, epinephrine, 필수 의약품 등 제한된 범위의 약물을 준비할 수 있다. 모든 약물 사용은 해당 리그 규정과 anti-doping 규정을 고려하여 이루어져야 한다. 일반의약품의 경우는 선수에게 미리 처방을 하고 사용할 수 있다.

종목 특성에 따라 경기일 의료 준비에는 일정한 차이가 존재한다. 축구는 넓은 필드에서 진행되는 경기로 선수 접근 시간이 상대적으로 길고 충돌 손상의 빈도가 높으며, 햄스트링 손상이나 무릎 인대 손상과 같은 고속 주행 관련 손상이 자주 발생한다. 축구에서는 경기장으로 들어 갈때는 간단한 백을 사용하고, 항상 물을 가지고 경기장으로 들어가게 된다. 또한, head injury 평가 및 충돌 손상 대응 체계가 중요한 요소가 된다. 선수를 직접 평가할 수 있는 시간이 하프 타임혹은 실제 부상 당한 경우 뿐임으로 경기 내내 집중력을 잃지 않도록 해야한다. 반면 농구는 상대적으로 작은 코트에서 진행되고 선수 교체가 자유롭기 때문에 부상이 생기면 교체를 한 다음 그 선수를 빠르게 평가하고 return-to-play 시행할 지 결정하면 된다. 중간에 잠시 락커룸에 들어가서 초음파를 볼 수도 있다. 경기일 의료 장비 구성과 현장 대응 방식에도 영향을 미친다.

결론적으로 팀닥터의 경기일 준비는 단순한 의료 장비 준비를 넘어 선수 상태 평가, 의료팀 협업, 그리고 응급 대응 체계 확인을 포함하는 종합적인 의료 준비 과정이다. 체계적으로 구성된 팀닥터 의료 가방과 경기 전 준비 과정은 스포츠 현장에서 발생할 수 있는 다양한 상황에 대한 대응 능력을 향상시키며 선수 안전을 보호하는 데 중요한 역할을 한다. 또한 종목 특성에 따른 손상 패턴과 경기 환경을 고려한 의료 준비 전략은 현장 스포츠의학에서 매우 중요한 요소라고 할 수 있다.

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정태석

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축구경기에서 발생한 뇌진탕 및 두경부 외상
Concussions and head and neck injuries sustained during soccer matches

스피크재활의학과
정태석





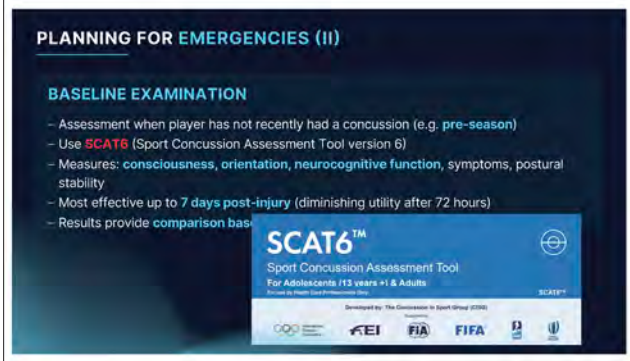




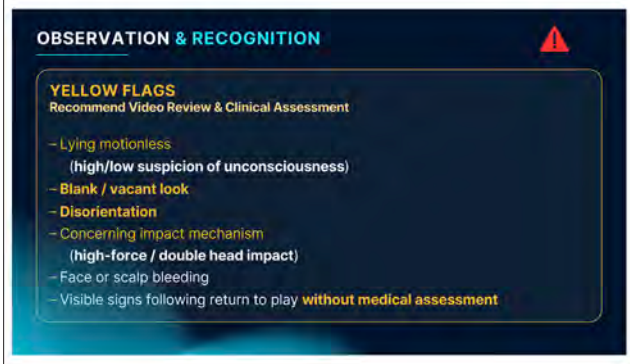

KNOW THE SYMPTOMS
HEADACHE OR PRESSURE
PROBLEMS WITH BALANCE, DIZZINESS OR BEING UNSTEADY
DISTORTED, BLURRY OR DOUBLE VISION
SENSITIVITY TO LIGHT AND/OR NOISE
NAUSEA OR VOMITING
MEMORY PROBLEMS
SLEEP PROBLEMS
FEELING DROWSY, CONFUSED OR UNABLE TO FOCUS


PLANNING FOR EMERGENCIES (I)
PRE-MATCH EMERGENCY ACTION PLAN
– Standardised protocol for medical teams managing emergencies
– Links key clinical assessments with predetermined roles
– Proactive team preparation model replacing reactive dynamics
– Minimises risks in time-critical emergencies on the field of play


FIFA


PLANNING FOR EMERGENCIES (II)
BASELINE EXAMINATION
– Assessment when player has not recently had a concussion (e.g. pre-season)
– Use SCAT6 (Sport Concussion Assessment Tool version 6)
– Measures: consciousness, orientation, neurocognitive function, symptoms, postural stability
– Most effective up to 7 days post-injury (diminishing utility after 72 hours)
– Results provide comparison bas
SCAT6™
Sport Concussion Assessment Tool
For Adolescents /13 years +1 & Adults
FIFA


OBSERVATION & RECOGNITION
RED FLAGS
Recommend Substitution
– Impact seizure / convulsion
– Tonic posturing
– No protective action / floppiness
– Motor incoordination
– Vomiting
– Visible signs after return to play with medical assessment


OBSERVATION & RECOGNITION
YELLOW FLAGS
Recommend Video Review & Clinical Assessment
– Lying motionless
(high/low suspicion of unconsciousness)
– Blank / vacant look
– Disorientation
– Concerning impact mechanism
(high-force / double head impact)
– Face or scalp bleeding
– Visible signs following return to play without medical assessment


EMERGENCY MANAGEMENT
CARDIOPULMONARY
Signs:
Unresponsiveness, not breathing normally
Actions:
Start CPR, rapid defibrillation with AED, spinal stabilisation
BRAIN
Signs:
GCS <13, LOC, severe headache, seizure, pupil asymmetry
Actions:
Neutralise cervical spine, protect airway, ventilate if needed
SKULL / FACE
Signs:
Blood/fluid from ears or nose, deformity, periocular haematoma
Actions:
Stabilise cervical spine; control bleeding, spinal board
CERVICAL SPINE
Signs:
Deformity, severe pain, swelling, paresis, impaired sensation
Actions:
Neutralise and stabilise cervical spine, spinal board extraction
All domains: Remove player from pitch, continue emergency management, consider immediate hospital transport


EXAMINATION & MANAGEMENT
Systematic Approach in the First 72 Hours
1
Observation
Observe match for mechanisms causing concussion
2
On-Pitch Exam
Initial inspection: acute signs, GCS, symptoms, orientation
3
Off-Pitch Exam
Detailed neurological assessment in quiet area
4
Post-Incident
Serial re-examination and follow-up for 72 hours
5
CT Scan
If GCS <13, skull fracture, vomiting, seizure, LOC
6
Return Program
Graduated Return-to-Football Programme
A player with a (suspected) concussion should NOT return to football on the same day.


GRADUATED RETURN-TO-FOOTBALL PROGRAMME
1
Symptom-limited activity
2
Light aerobic exercises
3
Football-specific exercises
4
Non-contact training drills
5
Controlled contact drills
6
Full-contact team training
7
Return to competitive play
KEY PRINCIPLES
– Each stage must include at least one training session and last a minimum of 24 hours
– If symptoms worsen or recur: rest until resolved (min. 24 hours), then return to previous stage
– Player cleared for match play only when all stages completed without symptoms
– More conservative approach required for younger players and those with repetitive concussion history
– Medical re-evaluation required before Stage 1 and before Stage 6


SUMMARY OF THE SESSION
REDUCE THE RISK OF COMPLICATIONS
BE AWARE
Concussion should always be taken seriously. No game – even at elite level – is worth the risk.
Know the common signs of concussion as well as when to seek urgent medical advice.
SUSPECT
Have you or a team-mate sustained a direct or indirect impact to the head, face, neck or body?
Symptoms may take up to 72 hours to present following an impact.
PROTECT
The Team Doctor will determine if you or your team-mate should leave the pitch, and if and when return to play is possible.
Any player who wishes to leave the field of play should be supported to do so. A second impact can have serious health consequences.


CONCLUSION OF THE SESSION
NO MATCH IS WORTH THE RISK
www.suspectandprotect.fifa.com
FIFA

김두한

학력

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농구경기에서 발생한 무릎 및 근골격 손상
Knee and musculoskeletal injuries sustained during basketball games

계명대동산병원
김두한

농구는 전 세계적으로 널리 시행되는 스포츠로, 빠른 속도의 경기 진행과 점프, 급격한 방향 전환, 그리고 선수 간 접촉이 반복되는 특징을 가지고 있다. 이러한 특성 때문에 농구에서는 다양한 근골격계 손상이 발생하며, 특히 하지 관절에 손상이 집중되는 경향을 보인다. 농구 경기 중에는 점프 후 착지, 방향 전환(cutting), 급격한 감속(deceleration), 그리고 신체 접촉이 빈번하게 발생하기 때문에 발목과 무릎 관절에 높은 생체역학적 부담이 가해진다. 이러한 이유로 농구는 하지 손상이 비교적 높은 비율로 발생하는 스포츠로 알려져 있으며, 스포츠 의학 분야에서도 지속적인 역학 연구가 이루어지고 있다.

최근 NCAA Injury Surveillance Program을 기반으로 한 연구에서는 2014년부터 2019년까지 대학 농구 선수에서 발생한 손상을 분석하였다. 해당 연구에서는 총 478,150 athlete exposures에서 3,481건의 손상이 보고되었으며, 전체 손상률은 1000 athlete exposures당 약 7.28건으로 나타났다. 또한 훈련 상황보다 실제 경기 상황에서 손상이 더 많이 발생하는 것으로 나타났으며, 경기 중 손상률은 훈련 중 손상률보다 약 두 배 높은 것으로 보고되었다. 이러한 결과는 경기 중 발생하는 신체 접촉과 높은 경기 강도가 손상 발생에 중요한 영향을 미친다는 점을 시사한다.

농구에서 발생하는 손상을 해부학적 부위별로 살펴보면 발목 손상이 가장 흔하며 전체 손상의 약 22%를 차지한다. 그 다음으로는 무릎 손상이 약 13%, 두부 및 안면 손상이 약 11%, 그리고 손목 및 손 손상이 약 10% 정도로 보고된다. 이러한 결과는 농구가 점프와 착지가 반복되는 스포츠라는 점을 반영하며, 하지 관절 특히 발목과 무릎 관절이 높은 손상 위험에 노출되어 있음을 보여준다. 손상의 형태를 보면 염좌(sprain)가 약 30%로 가장 흔하며, 그 다음으로 타박상(contusion)과 근육 손상(strain)이 각각 약 14% 정도를 차지하는 것으로 보고되었다.

농구 경기에서 발생하는 무릎 손상은 전체 손상의 약 13%를 차지하며, 발목 손상 다음으로 흔한 손상 부위이다. 농구에서 무릎 손상이 발생하는 주요 기전은 점프 후 착지, 급격한 방향 전환, 그리고 선수 간 접촉 상황에서 발생하는 비정상적인 관절 하중이다. 특히 점프 후 한쪽 다리로 착지하는 과정에서 무릎이 외반(valgus) 방향으로 붕괴되면서 동시에 회전력이 가해지는 경우 전방십자인대 손상이 발생할 수 있다. 이러한 손상 기전은 농구뿐 아니라 다양한 점프 스포츠에서 공통적으로 관찰되는 특징이다.

전방십자인대 손상은 농구 선수에서 비교적 흔하게 발생하는 무릎 손상 중 하나로 알려져 있다. ACL 손상은 주로 비접촉성 손상으로 발생하며, 점프 후 착지 과정에서 무릎이 과도한 외반 및 내회전을 보일 때 발생할 가능성이 높다. 또한 급격한 방향 전환이나 pivot 동작 중에도 ACL 손상이 발생할 수 있다. 이러한 손상은 선수의 경기 복귀까지 장기간의 재활이 필요하며, 경우에 따라 선수 경력에도 큰 영향을 미칠 수 있기 때문에 스포츠 의학에서 중요한 문제로 인식되고 있다.

농구에서는 반월상 연골판 손상 또한 흔하게 발생한다. 반월상 연골판 손상은 방향 전환이나 회전 동작 중에 무릎에 비틀림 힘이 가해질 때 발생하는 경우가 많으며, ACL 손상과 동반되는 경우도 흔하다. 특히 급성 외상성 손상뿐 아니라 반복적인 관절 부하에 의해 점진적으로 발생하는 퇴행성 변화도 관찰될 수 있다. 이러한 반월상 연골판 손상은 무릎 통증과 기계적 증상을 유발하며, 경우에 따라 관절 연골 손상으로 이어질 수 있다.

농구 선수에서는 슬개대퇴 관절 관련 질환도 흔하게 발생한다. 반복적인 점프와 착지 동작은 슬개대퇴 관절에 높은 압박력을 발생시키며, 이러한 반복적 부하는 슬개대퇴 통증 증후군(patellofemoral pain syndrome)이나 연골 손상으로 이어질 수 있다. 특히 착지 동작에서 하지 정렬이 좋지 않거나 고관절 및 코어 근육의 안정성이 부족한 경우 슬개대퇴 관절에 가해지는 스트레스가 증가할 수 있다.

농구 경기 중 손상이 발생하는 상황을 분석해 보면 일반적인 플레이 상황에서 가장 많은 손상이 발생하며 약 30%를 차지한다. 또한 수비 상황과 리바운드 상황에서도 각각 약 15% 정도의 손상이 발생하는 것으로 보고되었다. 특히 리바운드 상황에서는 점프와 착지가 반복되고 동시에 선수 간 접촉이 발생하기 때문에 하지 관절 손상 위험이 증가할 수 있다.

또한 시즌에 따른 손상 발생률을 살펴보면 프리시즌 기간에 손상이 가장 많이 발생하는 것으로 보고되었다. 연구에 따르면 프리시즌 손상률은 약 9.16/1000 athlete exposures로 정규 시즌이나 포스트 시즌보다 높은 것으로 나타났다. 이러한 현상은 offseason 이후 선수들의 신체 컨디션이 완전히 회복되지 않은 상태에서 갑작스럽게 훈련 강도가 증가하기 때문으로 설명될 수 있다. 따라서 프리시즌 기간 동안 적절한 훈련 부하 조절과 체력 준비가 손상 예방에 중요한 역할을 할 수 있다.

농구 손상을 예방하기 위해서는 다양한 전략이 제시되고 있다. 최근 연구에서는 neuromuscular training 프로그램이 하지 손상 예방에 효과적인 것으로 보고되고 있다. 이러한 프로그램에는 착지 동작 훈련, 균형 훈련, 고관절 및 코어 근력 강화, 그리고 proprioception 훈련 등이 포함된다. 특히 ACL 손상 예방 프로그램에서는 올바른 착지 자세와 하지 정렬을 유지하는 것이 중요한 요소로 강조되고 있다. 또한 최근 스포츠 과학 분야에서는 training load monitoring과 fatigue management를 통한 손상 예방 전략이 중요하게 강조되고 있다.

종합적으로 보면 농구는 하지 관절 특히 발목과 무릎 손상이 흔하게 발생하는 스포츠이며, 이러한 손상은 경기 상황에서 더욱 높은 빈도로 발생한다. 무릎 손상 중에서는 전방십자인대 손상, 반월상 연골판 손상, 그리고 슬개대퇴 관절 질환이 임상적으로 중요한 문제로 여겨진다. 따라서 농구 선수의 손상 예방을 위해서는 biomechanical risk factor에 대한 이해와 함께 neuromuscular training 및 적절한 훈련 관리 전략이 필요하다. 이러한 접근은 선수의 경기력 향상뿐 아니라 장기적인 관절 건강을 유지하는 데에도 중요한 역할을 할 것으로 생각된다.

배중현

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주요 경력

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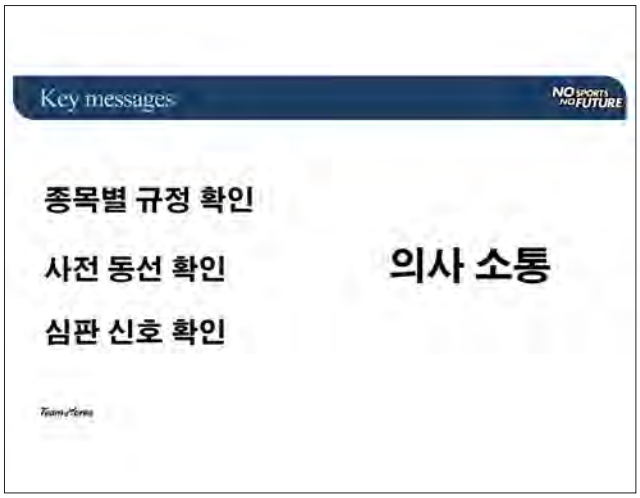
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대규모 종합국제대회의 경기 중 급성 손상 관리
Acute Injury Management During Competitions at Large- Scale Comprehensive International Events

진천선수촌
배중현







The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

심포지엄 8: 견관절 가성마비: 수술과 운동 치료의 통합적 접근
Shoulder Pseudoparalysis: Integrating Surgery and Exercise Therapy

좌장: 서남병원 이석현, 이대목동병원 권지은



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주요 경력

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견관절 가성마비의 병태생리와 진단
Pathophysiology and Diagnosis of Pseudoparalysis of the Shoulder Joint

고려대 안산병원
김현곤

서론

견관절 가성마비(pseudoparalysis)는 신경학적 마비 없이 능동적 견관절 거상(active elevation)이 소실되는 상태를 의미하며, 주로 massive rotator cuff tear (MRCT)와 관련되어 발생한다. 그러나 문헌에서는 pseudoparesis와 pseudoparalysis의 정의가 일관되지 않으며, 통증, 회전근개 파열, 관절 역학의 붕괴 등 다양한 요인이 기능 소실의 원인으로 작용할 수 있다. 특히 massive rotator cuff tear 환자에서 정상적인 glenohumeral force couple이 붕괴되면 상완골두의 상방 전위(superior migration)와 함께 견관절 운동학이 심각하게 손상되어 pseudoparalysis가 발생할 수 있다. 따라서 pseudoparalysis의 정확한 이해를 위해서는 단순한 임상적 정의를 넘어 견관절의 biomechanics와 병태생리, 그리고 체계적인 진단 과정을 이해하는 것이 중요하다.

본론

1. Pseudoparesis와 Pseudoparalysis의 정의

   견관절 기능 소실을 설명하는 용어로 pseudoparesis와 pseudoparalysis가 사용되지만 문헌마다 정의가 다르게 사용되고 있다. 일반적으로 능동적 전방거상(active forward elevation)이 90° 미만이지만 수동적 운동은 유지되는 경우를 pseudoparesis로 정의하며, 능동적 거상이 거의 불가능하고 단순한 shrug motion만 가능한 경우를 pseudoparalysis로 구분하는 것이 보다 엄밀한 개념으로 제시되고 있다. 이러한 구분은 치료 전략과 예후를 판단하는 데 중요한 의미를 가지며, 두 상태는 서로 다른 임상적 entity로 이해된다.

2. 병태생리: Force couple 붕괴와 견관절 운동학 변화

   정상적인 견관절 운동은 rotator cuff와 deltoid 사이의 force couple에 의해 유지된다. Supraspinatus, infraspinatus, subscapularis는 humeral head를 glenoid 중심에 안정화시키며 deltoid의 거상력을 효율적인 회전운동으로 변환시키는 역할을 한다.

Massive rotator cuff tear가 발생하면 이러한 force couple이 붕괴되며 다음과 같은 병태생리적 변화가 나타난다.

- Deltoid 작용 시 humeral head superior migration
- Glenohumeral fulcrum 상실
- Anterosuperior escape
- 견관절 거상 시 scapular compensation 증가

특히 subscapularis tendon과 rotator cable의 integrity는 active elevation 유지에 중요한 역할을 하며, 이러한 구조가 손상될 경우 pseudoparalysis가 발생할 가능성이 높다. 시간이 경과하면 rotator cuff muscle fatty degeneration, tendon retraction, rotator cuff arthropathy 등이 진행하면서 기능 소실이 더욱 고착화된다.

3. 통증에 의한 기능 제한과 pseudoparalysis의 구분

견관절 가성마비 환자에서 중요한 임상적 고려 사항은 통증에 의한 기능 제한과 실제 biomechanical failure에 의한 pseudoparalysis를 구분하는 것이다. 일부 환자에서는 통증 때문에 능동 거상이 제한되는 것처럼 보일 수 있다. 이러한 경우 subacromial 또는 intra-articular local anesthetic injection 후 active elevation의 변화를 평가하면 진단에 도움이 된다. 통증 조절 후에도 능동 거상이 회복되지 않는 경우에는 rotator cuff dysfunction에 의한 pseudoparalysis로 판단할 수 있다.

4. 임상적 평가

진단을 위해서는 체계적인 병력청취와 신체검사가 필수적이다. 주요 평가 요소는 다음과 같다.

Range of motion 평가

- Active forward elevation
- Passive elevation
- External rotation lag

Rotator cuff 검사

- Jobe test
- Drop arm test
- External rotation lag sign
- Hornblower test
- Belly press 또는 Lift-off test

Scapular function 평가

- Scapular dyskinesis
- Scapular assistance test

또한 axillary nerve injury, cervical radiculopathy, suprascapular nerve neuropathy 등 신경학적 원인을 반드시 감별해야 한다.

5. 영상학적 평가

영상검사는 pseudoparalysis의 원인을 파악하고 치료 전략을 결정하는 데 중요한 정보를 제공한다.

단순 방사선 검사

- Acromiohumeral distance 감소
- Humeral head superior migration
- Rotator cuff arthropathy 평가 (Hamada classification)

MRI

- Rotator cuff tear size 및 tendon retraction
- Muscle fatty degeneration (Goutallier classification)
- Subscapularis tendon 상태
- Rotator cable integrity

특히 Hamada grade가 높은 경우 rotator cuff arthropathy가 동반된 상태로 치료 전략에 중요한 영향을 미친다.

결론

견관절 pseudoparalysis는 단순한 운동 제한이 아니라 massive rotator cuff tear에 의해 발생하는 견관절 biomechanics 붕괴의 결과로 나타나는 복합적인 기능 장애이다. 정확한 진단을 위해서는 pseudoparesis와의 명확한 구분, 통증에 의한 기능 제한의 배제, rotator cuff integrity 및 관절 상태에 대한 영상학적 평가가 필수적이다. 이러한 체계적인 평가를 통해 pseudoparalysis의 병태생리를 정확히 이해하고 환자 특성에 맞는 적절한 치료 전략을 수립할 수 있다.

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수술적 치료 전략 – 회전근개 재건부터 역행성 견관절 치환술까지
Surgical Treatment Strategies – From Rotator Cuff Reconstruction to Reverse Shoulder Arthroplasty

고려대 구로병원
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1) 서론

Shoulder pseudoparalysis는 신경학적 손상 없이 능동적 거상(active elevation)이 불가능하거나 현저히 제한된 상태를 의미한다. 일반적으로 능동적 전방 거상(active forward elevation)이 90° 이하이면서 수동적 관절운동 범위(passive ROM)는 유지되는 경우를 지칭한다.

이 상태는 주로 massive rotator cuff tear와 관련되며, 특히 supraspinatus와 infraspinatus의 기능 상실, 그리고 경우에 따라 subscapularis 손상이 동반되면서 발생한다. 스포츠 의학 분야에서는 외상성 파열, 반복적 오버헤드 활동, 그리고 고에너지 스포츠 손상 이후 pseudoparalysis가 발생할 수 있다. 이러한 환자에서 적절한 수술적 치료 선택은 기능 회복과 스포츠 복귀에 중요한 역할을 한다.

2) Shoulder Pseudoparalysis의 병태생리와 수술적 치료의 원칙

정상적인 어깨 거상은 rotator cuff와 deltoid의 force couple에 의해 이루어진다. Rotator cuff가 상완골두를 중심으로 안정화시키고, deltoid는 상완골을 거상시키는 역할을 한다. Massive rotator cuff tear가 발생하면 다음과 같은 문제가 발생한다. 상완골두의 superior migration, glenohumeral joint의 force coupling 붕괴, deltoid 작용 시 비정상적 translation 발생한다. 결과적으로 환자는 능동적 거상을 수행할 수 없는 pseudoparalysis 상태에 이르게 된다. 따라서 수술적 치료의 목표는 rotator cuff 기능 회복, 상완골두의 중심화(restoration of humeral head centering), force couple의 재구성, deltoid 작용의 효율성 회복이다.

3) 수술적 치료 전략

Pseudoparalysis 환자에서 수술적 치료는 환자의 연령, 파열 양상, 관절염 여부, 조직 상태에 따라 선택된다.

1) 회전근 봉합술(Rotator Cuff Repair): acute traumatic tear 또는 repairable massive tear에서는 primary

rotator cuff repair가 가장 우선적인 치료이다. 특히 다음과 같은 경우에서 좋은 결과를 기대할 수 있다. 외상성 파열, 비교적 짧은 증상 기간, fatty degeneration이 심하지 않은 경우, tendon retraction이 제한적인 경우에 시행한다.

2) 부분 봉합술(Partial Repair): 완전한 cuff repair가 어려운 경우에도 partial repair는 기능적 개선을 가져올 수 있다. Partial repair의 핵심은 다음과 같다. anterior-posterior force couple 복원, humeral head depression 회복, deltoid의 biomechanical efficiency 개선, 특히 subscapularis와 infraspinatus repair가 가능할 경우 pseudoparalysis 회복 가능성이 높다.
3) 상부 관절낭 재건술(Superior Capsule Reconstruction, SCR): SCR은 irreparable rotator cuff tear 환자에서 상완골두의 superior migration을 방지하기 위해 개발된 술식이다. 이 술식은 superior capsule을 재건하여 humeral head의 상방 이동을 억제하고 deltoid의 작용을 정상화하는 것을 목표로 한다. 임상 연구에서는 SCR 이후 active elevation이 평균 60° 이상 향상되는 결과가 보고되었다.
4) 건이전술 (Tendon Transfer): 젊고 활동적인 환자에서 irreparable rotator cuff tear가 있을 경우 tendon transfer가 고려된다. 대표적인 술식은 Latissimus dorsi transfer, Lower trapezius transfer. 이 술식들은 젊은 환자에서 shoulder function을 회복시키는 중요한 옵션이 된다.
5) 역행성 인공관절 치환술 (Reverse Shoulder Arthroplasty,RSA): 고령 환자나 cuff tear arthropathy가 동반된 경우, 또는 다른 치료가 실패한 경우에는 reverse shoulder arthroplasty가 가장 예측 가능한 결과를 보인다. glenohumeral joint의 중심을 medialize하고 deltoid moment arm을 증가시켜 deltoid 단독으로 shoulder elevation을 가능하게 한다. 다수의 연구에서 RSA 이후 active forward elevation이 120° 이상 회복되는 결과가 보고되고 있다. 그러나 스포츠 활동이 많은 환자에서는 implant longevity와 complication을 고려해야 한다.

박세현

학력

건양대학교 운동처방학과 학사

고려대학교 의용과학대학원 스포츠의학과 석사

가천대학교 보건과학대학원 운동재활학과 박사

주요 경력

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전) SK 나이츠 프로야구 메디컬 체크 및 운동재활(MOU)

전) 건양대, 가천대 실습, 외래교수

현) 대한스포츠의학회, 대한비만학회 정회원

현재 소속 및 직위

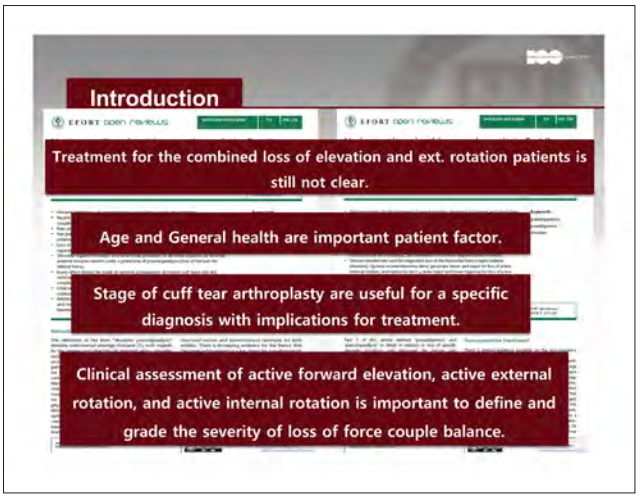
현) 고려대학교 구로병원 스포츠의학실, 팀장

대표논문

1. S.S Park, S.H Park, Y.J Choi, E.J Kim et al. Association of handgrip strength with readmission, mortality, and Exercise Capacity in Patients With Heart Failure, Journal of aging and physical activity(2025)
2. A.S Chang, S.J Hong, S.H Park, J.G Moon. Effectiveness of a mobile Application-Based Home Exercise Program for Postpartum Women with Abdominal Wall Dysfunction, The Korean Journal of Sports Medicine(2024)
3. B Battumur, S.Y Yoon, S.H Park, D.O Kang et al. Korean vs. Western Exercise Capacity Nomograms for Korean Patients with CVD. Journal of Korean medical science.(2023)

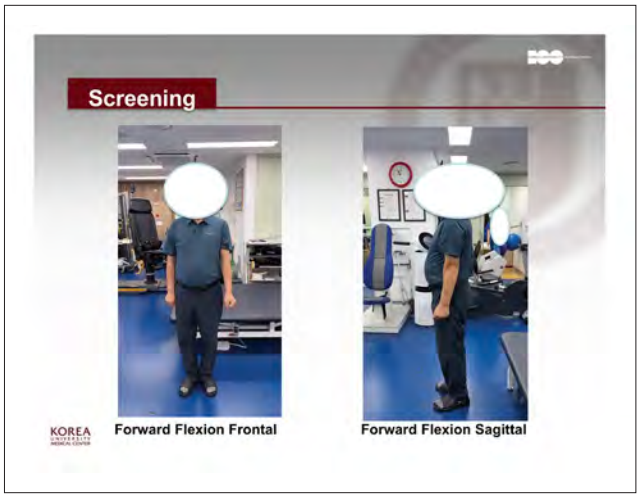
운동재활의 접근방법과 기능 회복 전략
Exercise Rehabilitation Approaches and Functional Recovery Strategies

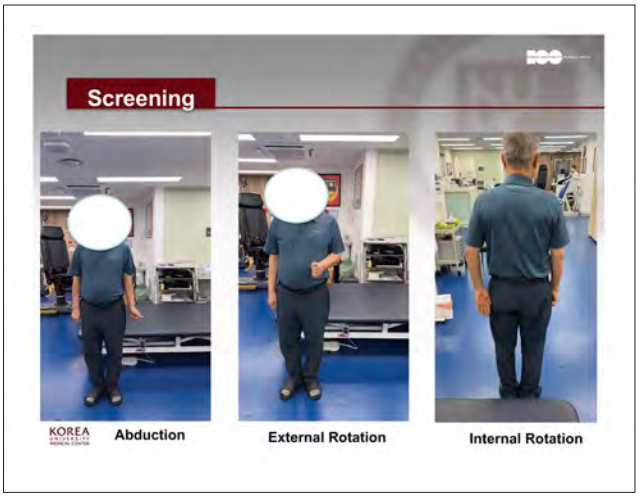
고려대 구로병원
박세현

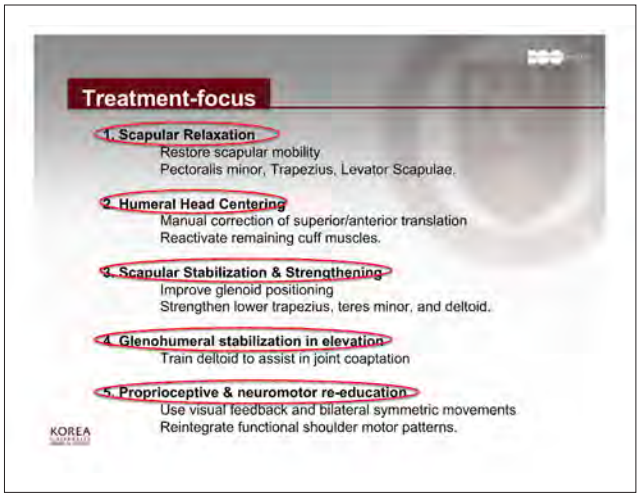


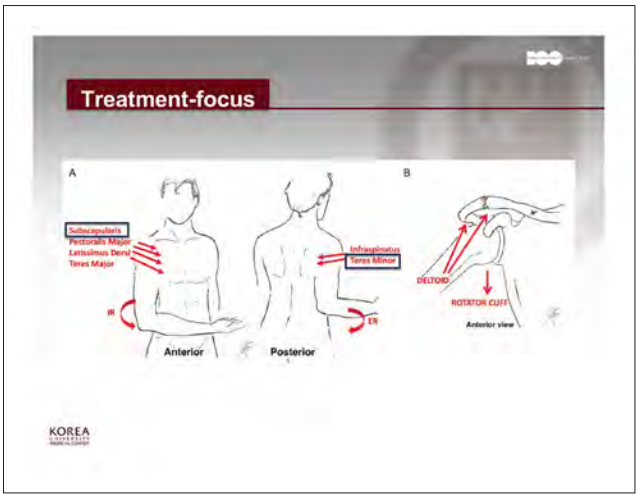


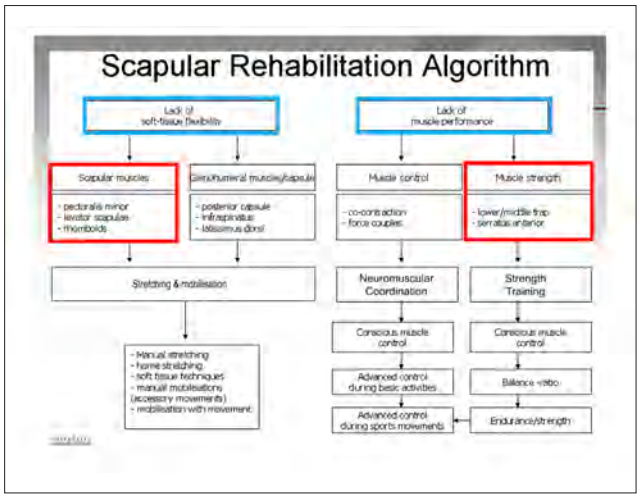


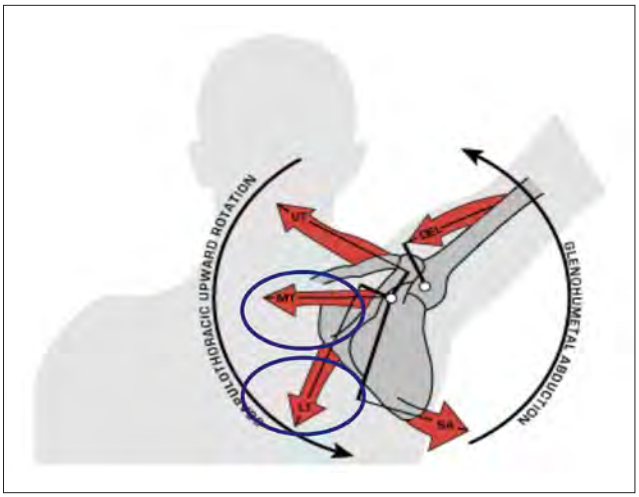


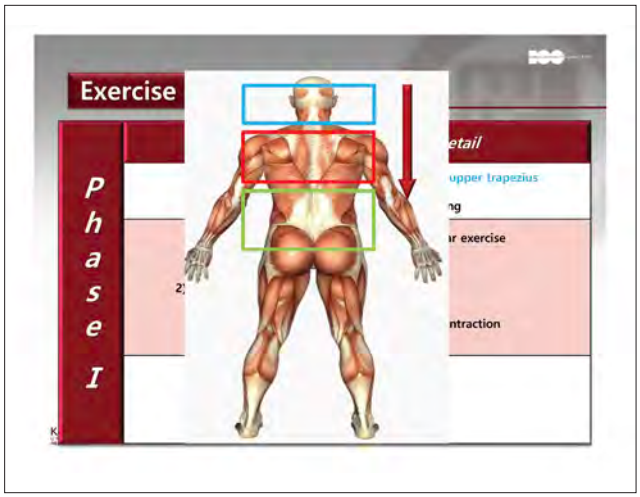

Screening
Abduction
External Rotation
Internal Rotation

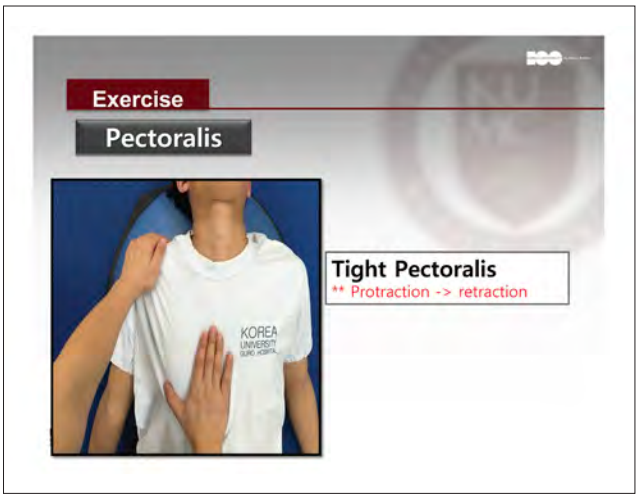

Treatment-focus
1. Scapular Relaxation
Restore scapular mobility
Pectoralis minor, Trapezius, Levator Scapulae.
2. Humeral Head Centering
Manual correction of superior/anterior translation
Reactivate remaining cuff muscles.
3. Scapular Stabilization & Strengthening
Improve glenoid positioning
Strengthen lower trapezius, teres minor, and deltoid.
4. Glenohumeral stabilization in elevation
Train deltoid to assist in joint coaptation
5. Proprioceptive & neuromotor re-education
Use visual feedback and bilateral symmetric movements
Reintegrate functional shoulder motor patterns.


Treatment-focus
Anterior
Posterior
DELTOID
ROTATOR CUFF

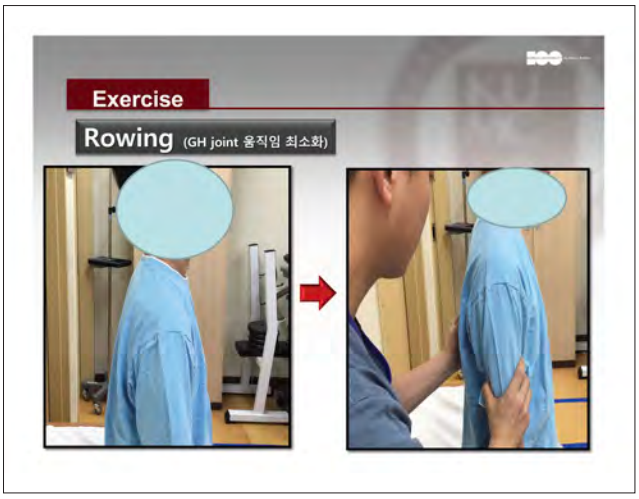

Scapular Rehabilitation Algorithm
Lack of soft-tissue flexibility
Lack of muscle performance
Scapular muscles
Muscle control
Muscle strength
Stretching & mobilisation
Neuromuscular Coordination
Strength Training
Conscious muscle control
Advanced control during basic activities
Advanced control during sports movements
Balance
Endurance/strength

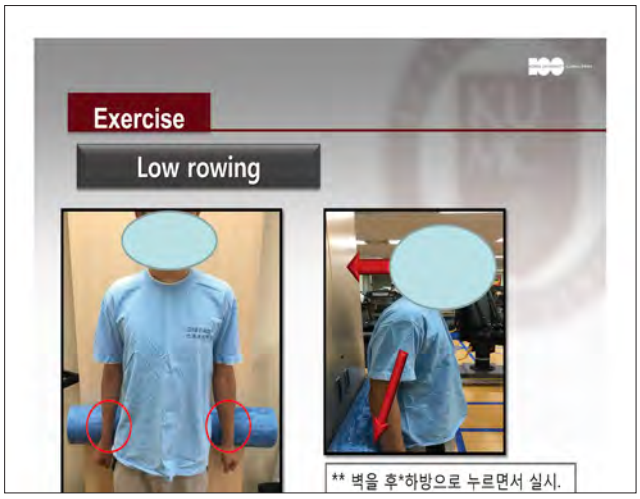

SCAPULOTHORACIC UPWARD ROTATION
GLENOHUMERAL ABDUCTION


Exercise
Phase I
upper trapezius
exercise


Exercise
Pectoralis
Tight Pectoralis
** Protraction -> retraction


Exercise
Scapular retraction
**등 뒤에 수건을 놓고 수건은 양쪽 Scapula로 누르는 연습 실시.
-> Rhomboid(isometic) -30초


Exercise
Rowing (GH joint 움직임 최소화)


Exercise
Low rowing
** 벽을 후*하방으로 누르면서 실시.


Exercise
Dips
** 바닥을 하방으로 누르면서 실시.
-> Low Trapezius / Rhomboid (isometic)


Exercise
Prone exercise
** GH joint 움직임 최소화
-> Low Trapezius
Rhomboid (isometic)

Exercise

Cat & camel co-contraction



**Retraction & neutral position
->co-contraction을 이용한 neuromuscular exercise

KOREA

Exercise





KOREA

Program

=Phase 1 (0–2(4)주)=
수동 ROM 회복 & 통증 조절

▶ 목표
-통증, 염증 감소
-GH joint의 superior migration 최소화
-Scapular setting-movement 회복
-Anterior deltoid 단독 강화 금지

▶ 운동
-Pendulum(Codman)
1–2분 / 2-3회
-Passive forward elevation (supine)
3×10–15 / 하루 2회
-Supine assisted ER with towel support
3×10–15
-Scapular retraction isometric
3×10초 × 2-3회
-Isometric ER (벽 밀기-isometric)
3×10초 × 2회

KOREA

Program

=Phase 2 (3(5)–6(8-10)주) =
Active-assist → Active ROM

▶ 목표
-Supine에서 능동 움직임 확보
-Anterior deltoid 단독 강화를 지양하며 Serratus anterior 중심의 Scapular-humeral rhythm회복을 우선함

▶ 운동
-Active-assisted elevation
(Humeral head control 될 때 supine → incline → sitting)
cane/pulley 3×10–15
-Scapular clock / wall slide
3×10
-Theraband row
3×10
-Side-lying ER
3×10
-Serratus punch (Trunk rotation 보상작용 주의)
3×10–15

▶ 다음 단계 기준
-능동 FF ≥ 80–90° -Scapular winging 감소

KOREA

Program

=Phase 3 (7(10)–12(14-16)주)=
upright functional movement

▶목표
-Upright에서 근력 강화
-Deltoid, teres minor 중심의 기능적 동작 회복

▶운동
-Scaption with band (30° 전방, 45° 이하 유지)
3×10
-Wall push-up plus
3×10
-Standing ER/IR with band
3×15

▶다음 단계 기준
-능동 FF ≥ 120
-일상 overhead 동작 가능(머리 빗기-옷입기)

=Phase 4 (12(16)주 이후)=
functional ADL

▶목표
-직업·일상 기능 복귀
-근지구력 향상
-동적 scapular control 확립
-Scapula winging 감소
-Active FF 120도 이상

▶운동
-functional reach progression
-scapula winging 감소 및
active FF 130도 이상일 때 실시

•CKC ex.
: full wall push-up → floor push-up

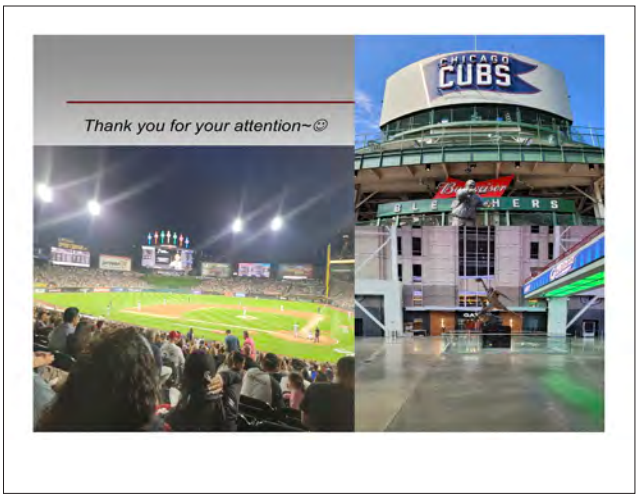
KOREA

Summary

- Scapular-humeral rhythm
- Periscapular muscle
- Upper-body strength
- Shoulder rotation

Multiple directional instability

Force couple balance


Thank you for your attention~☺
CHICAGO
CUBS

The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

초청세션 1: DCC -KADA 클린 스포츠를 위한 과학과 규정의 동행

DCC - KADA Bridging Scientific Innovation and Regulatory Evolution for Clean Sports

좌장: 일산백병원 양윤준, 한양대병원 박훈기



이강미

학력

연세대학교 생화학과 학사

서울대학교 약학대학원 생약학과 석사

서울대학교 약학대학원 생약학과 박사

주요 경력

2014 아시안 게임 도핑시료 분석

2018 평창 동계 올림픽 게임 도핑시료 분석

2022 베이징 동계 올림픽 게임 도핑시료 분석

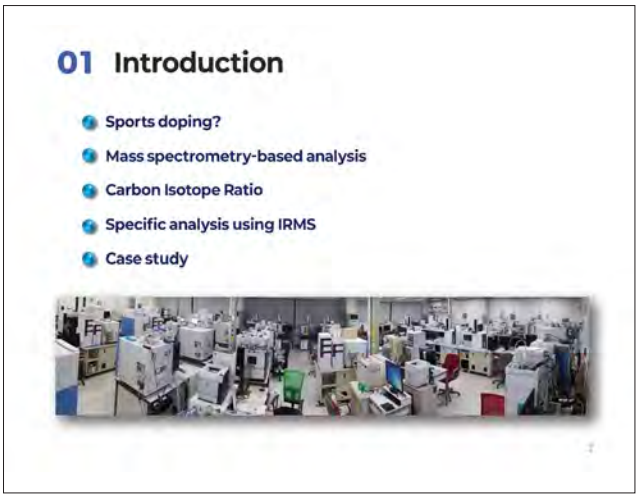
2023 항저우 아시안 게임 도핑시료 분석

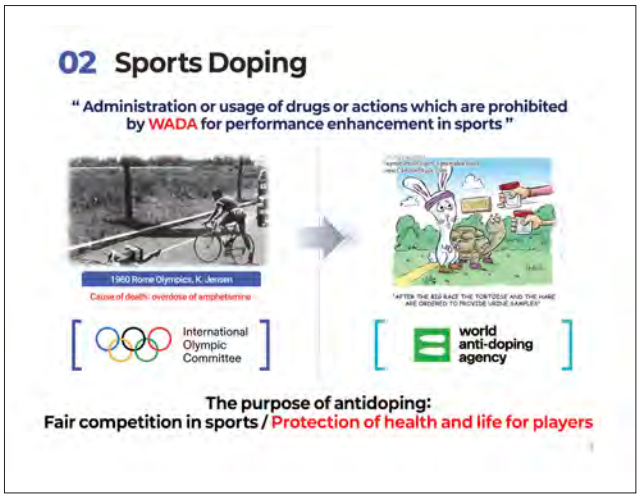
현재 소속 및 직위

한국과학기술연구원, 도핑콘트롤센터, 책임전문원

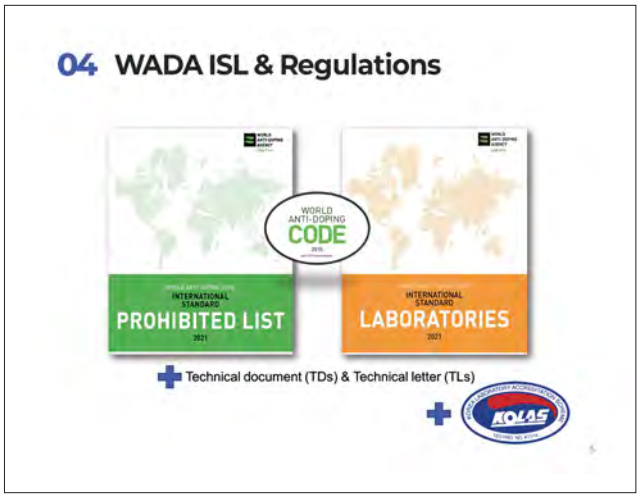
내인성 스테로이드 반도핑 분석 기술
Endogenous Steroid Anti-Doping Analysis Technology

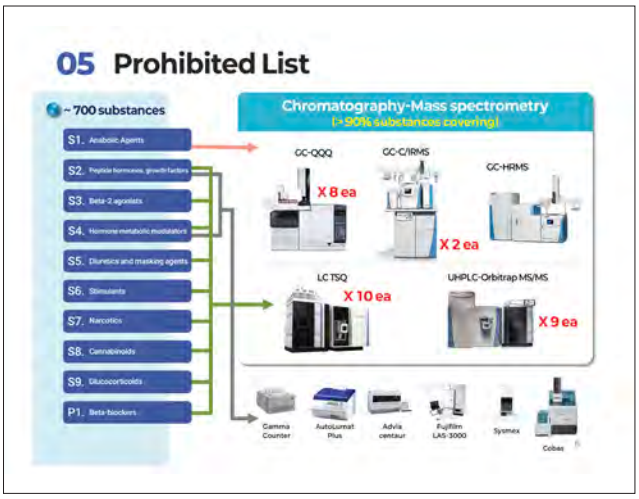
KIST/도핑콘트롤센터
이강미

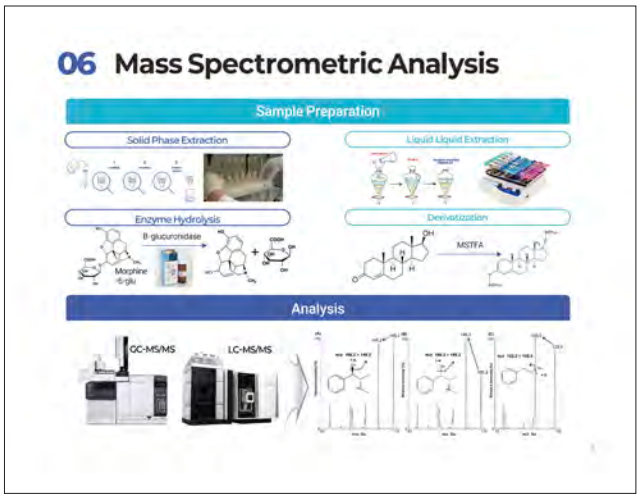


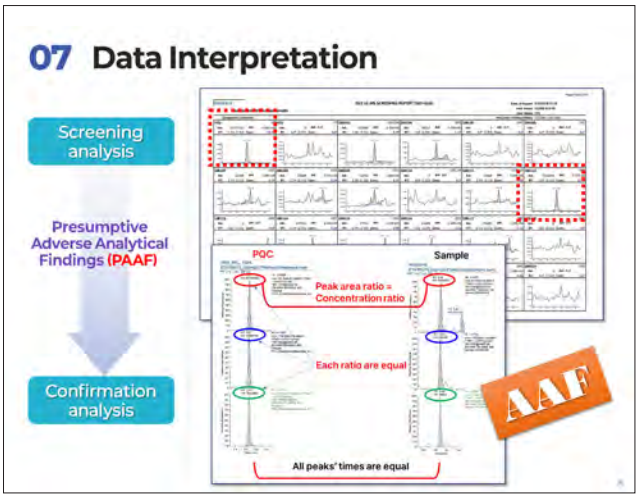


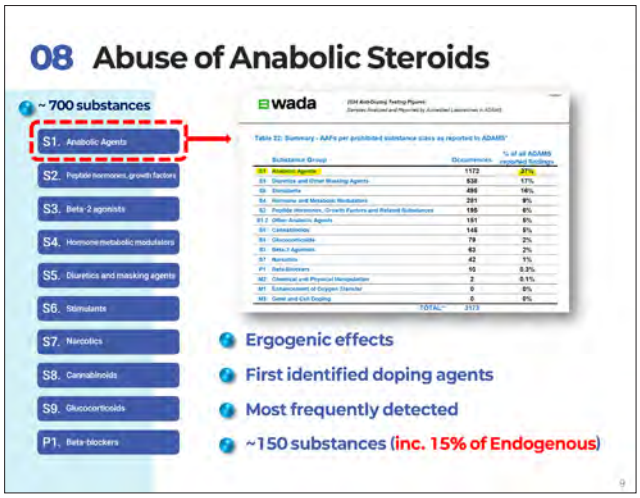


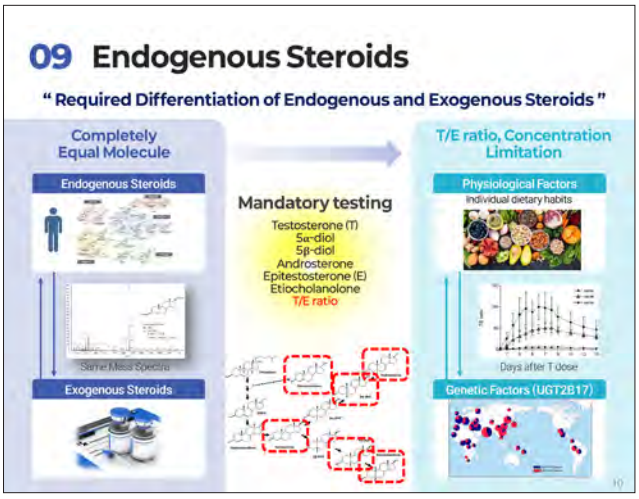


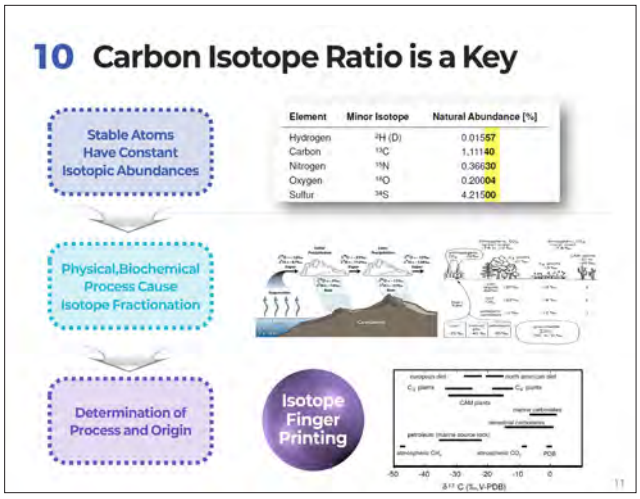

05 Prohibited List
~ 700 substances
S1. Anabolic Agents
S2. Peptide hormones, growth factors
S3. Beta-2 agonists
S4. Hormone metabolic modulators
S5. Diuretics and masking agents
S6. Stimulants
S7. Narcotics
S8. Cannabinoids
S9. Glucocorticoids
P1. Beta-blockers
Chromatography-Mass spectrometry
(> 90% substances covering)
GC-QQQ
GC-C/IRMS
GC-HRMS
X 8 ea
X 2 ea
LC TSQ
UHPLC-Orbitrap MS/MS
X 10 ea
X 9 ea
Gamma Counter
Autolumat Plus
Advia centaur
Fujifilm LAS-3000
Sysmex
Cobas

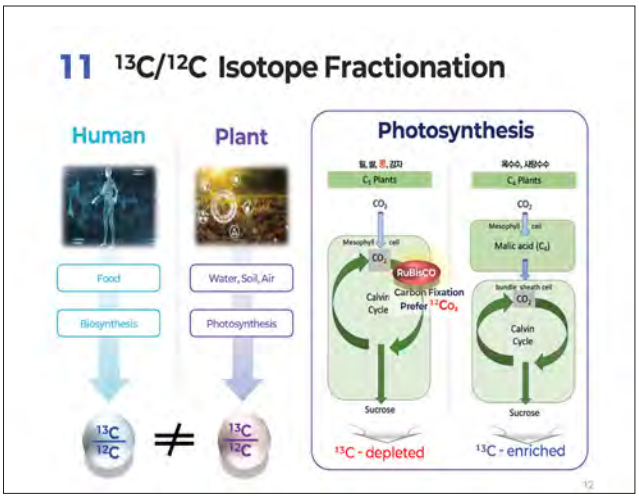

06 Mass Spectrometric Analysis
Sample Preparation
Solid Phase Extraction
Liquid Liquid Extraction
Enzyme Hydrolysis
β-glucuronidase
Morphine
6-glu
Derivatization
MSTFA
Analysis
GC-MS/MS
LC-MS/MS

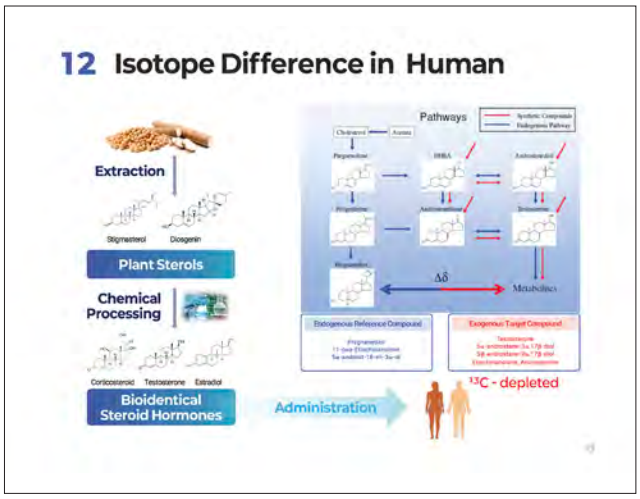

07 Data Interpretation
Screening analysis
Presumptive Adverse Analytical Findings (PAAF)
Confirmation analysis
PQC
Sample
Peak area ratio = Concentration ratio
Each ratio are equal
All peaks' times are equal
AAF

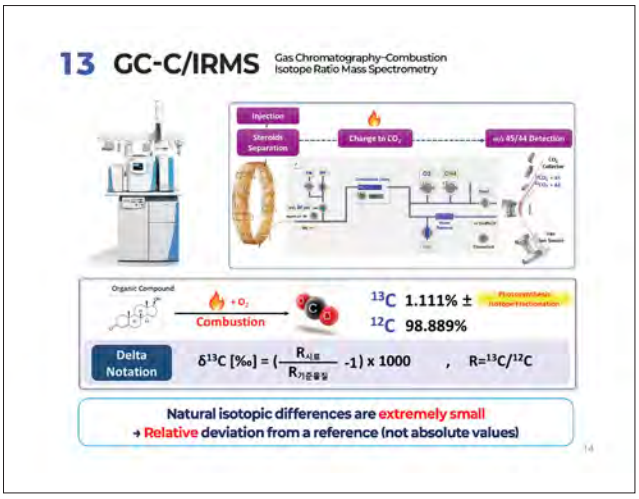

08 Abuse of Anabolic Steroids
~ 700 substances
S1. Anabolic Agents
S2. Peptide hormones, growth factors
S3. Beta-2 agonists
S4. Hormone metabolic modulators
S5. Diuretics and masking agents
S6. Stimulants
S7. Narcotics
S8. Cannabinoids
S9. Glucocorticoids
P1. Beta-blockers
wada
Ergogenic effects
First identified doping agents
Most frequently detected
~150 substances (inc. 15% of Endogenous)

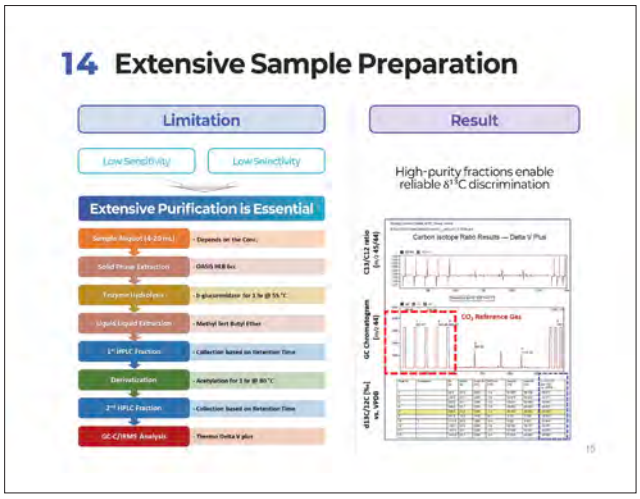

09 Endogenous Steroids
" Required Differentiation of Endogenous and Exogenous Steroids "
Completely Equal Molecule
Endogenous Steroids
Same Mass Spectra
Exogenous Steroids
Mandatory testing
Testosterone (T)
5α-diol
5β-diol
Androsterone
Epitestosterone (E)
Etiocholanolone
T/E ratio
T/E ratio, Concentration Limitation
Physiological Factors
Individual dietary habits
Days after T dose
Genetic Factors (UGT2B17)

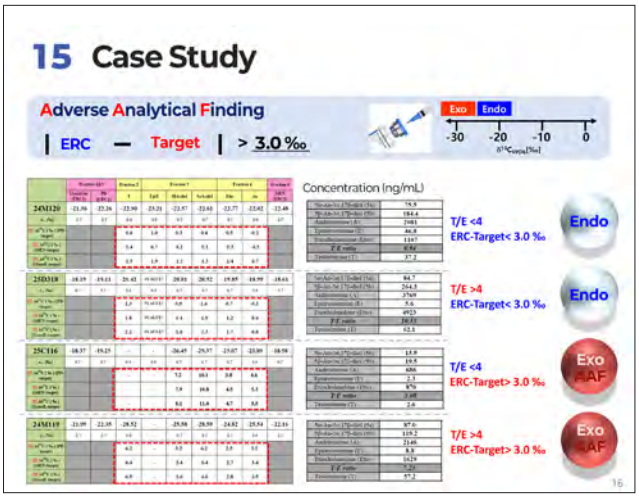

10 Carbon Isotope Ratio is a Key
Stable Atoms Have Constant Isotopic Abundances
Physical,Biochemical Process Cause Isotope Fractionation
Determination of Process and Origin
Isotope Finger Printing
Element
Minor Isotope
Natural Abundance [%]
Hydrogen
Carbon
Nitrogen
Oxygen
Sulfur

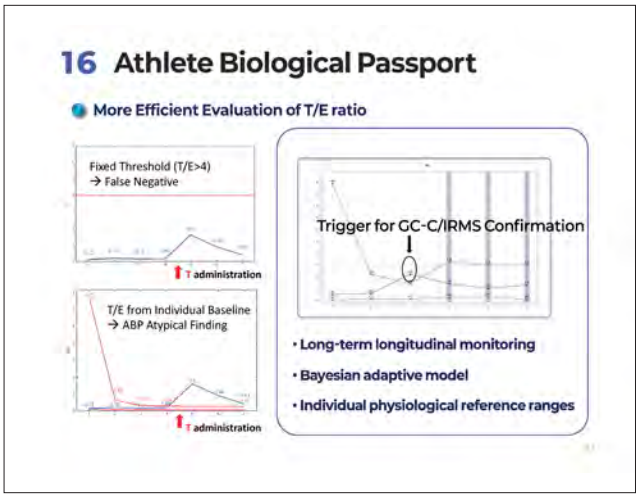

11 13C/12C Isotope Fractionation
Human
Plant
Photosynthesis
Food
Water, Soil, Air
Biosynthesis
Photosynthesis
Calvin Cycle
Carbon Fixation Prefer 12CO2
Sucrose
13C - depleted
13C - enriched

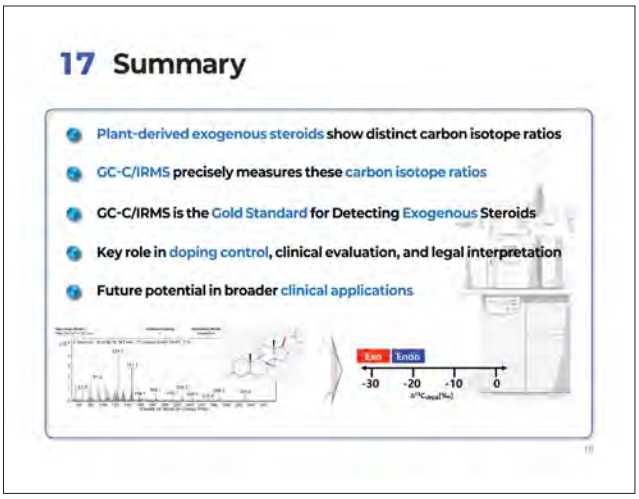

12 Isotope Difference in Human
Extraction
Plant Sterols
Chemical Processing
Bioidentical Steroid Hormones
Pathways
Metabolites
Administration
13C - depleted


13 GC-C/IRMS
Gas Chromatography-Combustion Isotope Ratio Mass Spectrometry
Injection
Steroids Separation
Change to CO2
m/z 45/44 Detection
Combustion
13C 1.111% ±
12C 98.889%
Delta Notation
Natural isotopic differences are extremely small
→ Relative deviation from a reference (not absolute values)


14 Extensive Sample Preparation
Limitation
Low Sensitivity
Low Selectivity
Extensive Purification is Essential
Result
High-purity fractions enable reliable δ13C discrimination


15 Case Study
Adverse Analytical Finding
ERC — Target | > 3.0 ‰
Exo Endo
Concentration (ng/mL)
T/E <4
ERC-Target< 3.0 ‰
Endo
T/E >4
ERC-Target< 3.0 ‰
Endo
T/E <4
ERC-Target> 3.0 ‰
Exo AAF
T/E >4
ERC-Target> 3.0 ‰
Exo AAF


16 Athlete Biological Passport
More Efficient Evaluation of T/E ratio
Fixed Threshold (T/E>4)
→ False Negative
T administration
T/E from Individual Baseline
→ ABP Atypical Finding
T administration
Trigger for GC-C/IRMS Confirmation
• Long-term longitudinal monitoring
• Bayesian adaptive model
• Individual physiological reference ranges


17 Summary
Plant-derived exogenous steroids show distinct carbon isotope ratios
GC-C/IRMS precisely measures these carbon isotope ratios
GC-C/IRMS is the Gold Standard for Detecting Exogenous Steroids
Key role in doping control, clinical evaluation, and legal interpretation
Future potential in broader clinical applications
Exo
Endo
-30
-20
-10
0


KIST
한국과학기술연구원
Thank you for your attention

성창민

학력

전남대학교 생명과학기술학부 이학사

서울대학교 공과대학원 바이오엔지니어링 협동과정 공학박사

주요 경력

2016.06 ~ 2018.03 KIST 도핑콘트롤센터, 연구원

2018.02 평창 동계올림픽/패럴림픽 도핑분석 전문가

2018.03 ~ 2025.02 KIST 도핑콘트롤센터, 선임연구원

2021.07 도쿄 하계올림픽/패럴림픽 국제 초빙 반도핑분석 전문가

2022.02 베이징 동계올림픽/패럴림픽 국제 초빙 반도핑분석 전문가

2026.01 세계반도핑기구(WADA) 유전자반도핑 분야 자문그룹

현재 소속 및 직위

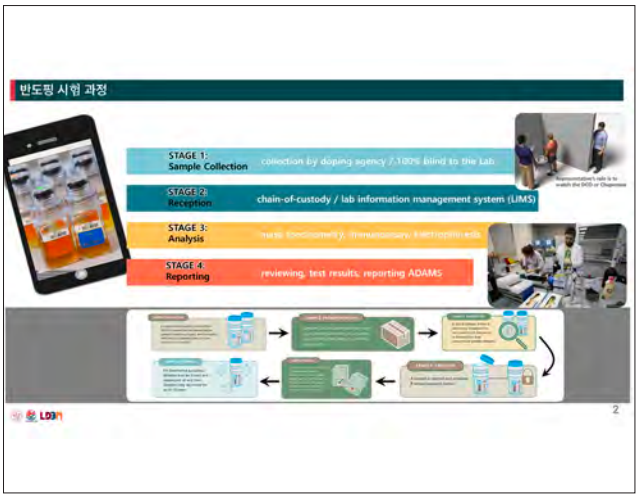
KIST 도핑콘트롤센터, 책임연구원

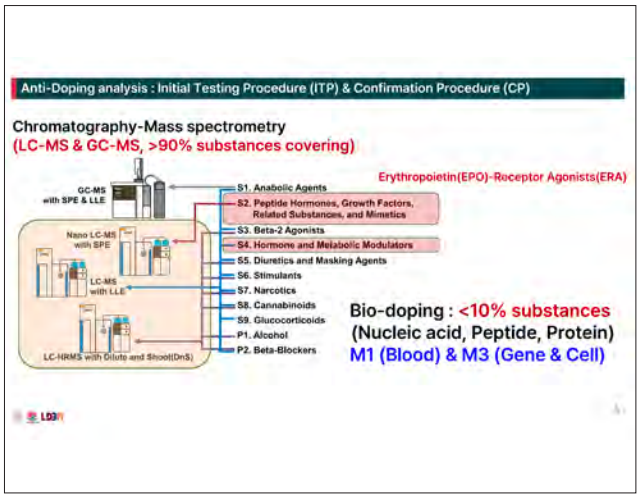
대표논문

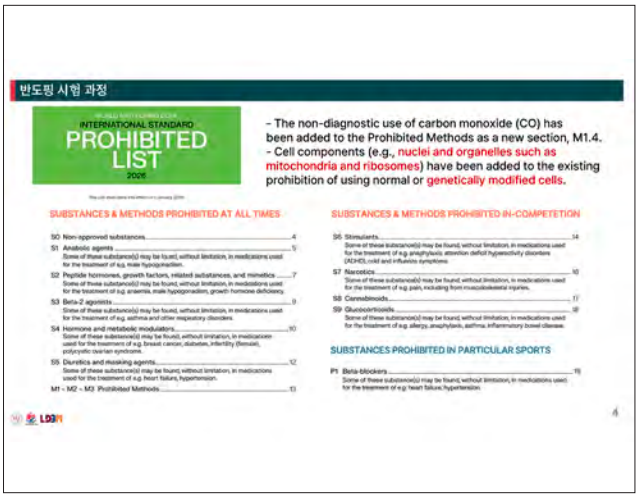
1. Yi JY, Choi H, Kim M, Jeong Y, Hahn JS, Son B, Park HH, Sung C. High-throughput multiplexed gene and cell doping analysis through CRISPR-Cas12a system integrated with blood direct PCR. Sci Adv. 2025 Jul.
2. Yi JY, Park S, Kim M, Jeong Y, Shin H, Cho Y, Jeon M, Oh MK, Sung C. Emerging wound-healing injectable polydeoxyribonucleotide: potential as a prohibited doping method and its simple detection via CRISPR/Cas12a system. Int J Biol Macromol. 2025 May.
3. Yi JY, Ryu J, Jeong Y, Cho Y, Kim M, Jeon M, Park HH, Hwang NS, Jeong HJ, Sung C. One-step detection of procollagen type III N-terminal peptide as a fibrosis biomarker using fluorescent immunosensor (quenchbody). Anal Chim Acta. 2024 Aug.

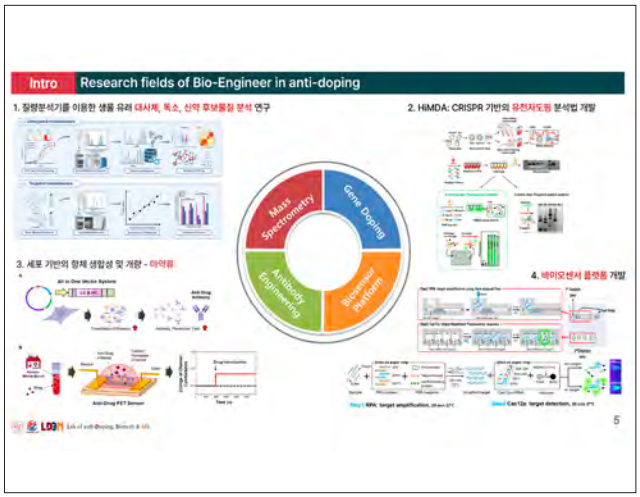
바이오도핑의 최신 동향 및 유전자 도핑 기술 개발
Recent Trends in Bio-Doping and Development of Gene-Doping Technology

KIST/도핑콘트롤센터
성창민









WADA scientific research

Part 1

Development of all-in-one gene doping detection paper chip based on Multiplexed Recombinase Polymerase Amplification and CRISPR/Cas12a sensing system

유전자 도핑이란?

유전자 도핑 (Gene Doping)의 정의

WADA 금지 예측 M3

치료 목적이 아닌 운동능력 향상을 위해 유전자·세포를 사용하는 행위

기술적 난제

Endogenous vs Exogenous

도핑으로 만들어진 단백질과 체내 자연 생성 단백질 간의 아미노산 서열이 동일하여 단백질 분석으로 구분이 어려움.

전체 분석 지침에 한계

PCR 기반 유전자 도핑 분석은 전처리 과정 (추출·정제) 필요

WADA 요구사항

검출한계 (LOD) <10 copies

혈액/소변 매트릭스 내 안정성 확보

Genomic DNA vs Complementary DNA

Genomic DNA (Endogenous)



Complementary DNA (cDNA, Exogenous doping)



탐지 타겟: 엑손-엑손 접합부 (Exon-Exon Junction, EEJ)

EEJ는 도핑 유전자에서만 유일하게 존재.

WADA laboratory guidelines (PCR)

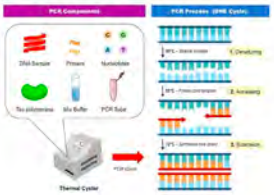
EEJ target sequence를 핵심 타겟으로 명시하고 있음.

유전자 도핑 분석법

qPCR 2021 WADA guideline

PCR 기반 표적 유전자 검출

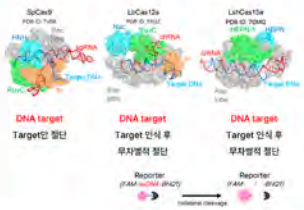
primer를 이용해 표적 유전자를 선택적으로 증폭 후 RT-PCR



HiMDA

CRISPR/Cas 기반 표적 유전자 검출

특정 서열의 유전자를 표적으로 할 수 있는 CRISPR/Cas 단백질



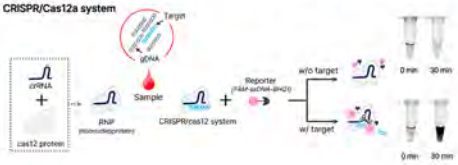
RPA-CRISPR/Cas12 system

Recombinase Polymerase Amplification (RPA) reaction



전반적인 PCR 단계를 enzymes가 대체하여 등온 증폭 (39 °C)

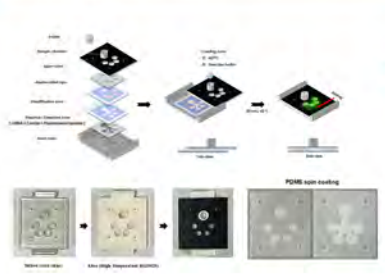
CRISPR/Cas12a system



Goal

Paper chip 위에서 RPA reaction, CRISPR reaction 구현

CRISPR/Cas12 system in paper chip





Goal

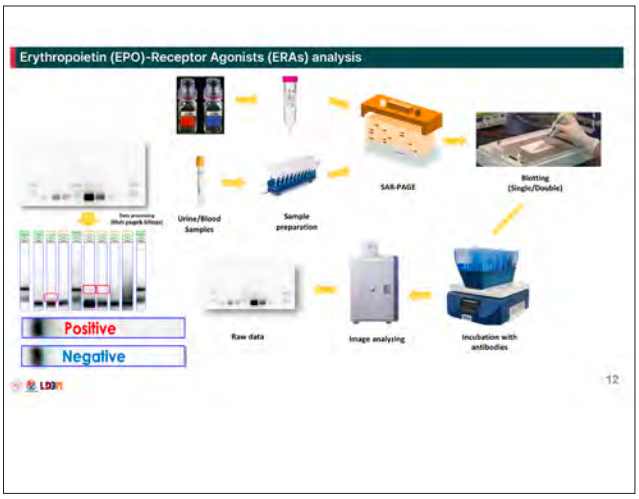
10 copy 이하 검출한계 확보

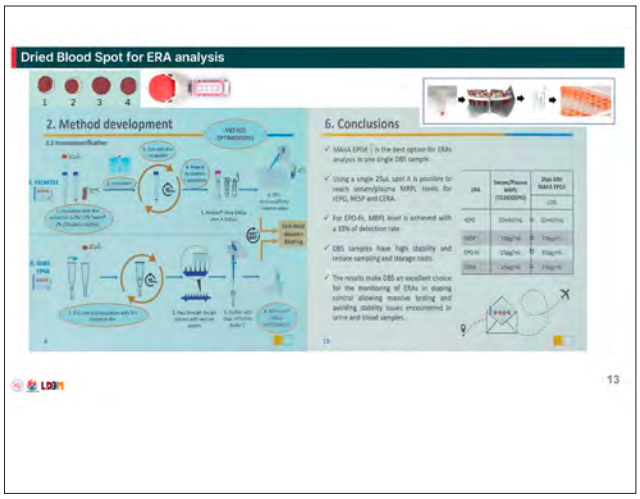
혈액/소변 매트릭스 내 안정성 확보

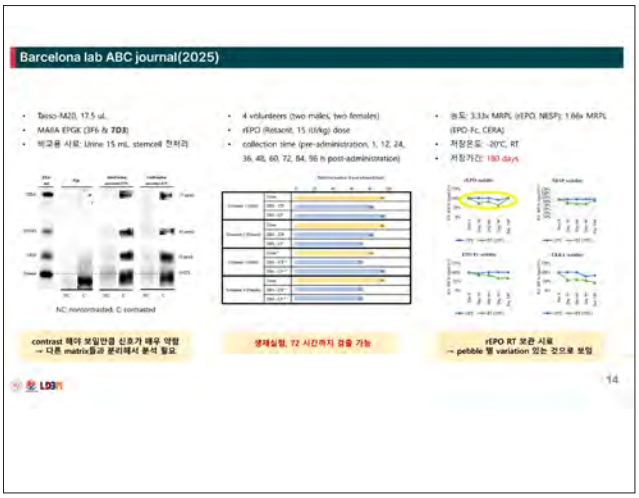
EPO analysis in DBS

Part 2

Optimization of ERA analysis using dried blood spot


Erythropoietin (EPO)-Receptor Agonists (ERAs) analysis
Urine/Blood Samples
Sample preparation
SAR-PAGE
Blotting (Single/Double)
Raw data
Image analyzing
Incubation with antibodies
Positive
Negative
12


Dried Blood Spot for ERA analysis
2. Method development
6. Conclusions
13


Barcelona lab ABC journal(2025)
14


THANK YOU
https://ldbm.tistory.com/
scm@kist.re.kr
KSBB-AFOB Conference 2025
15

임철환

학력

한림대학교 체육학과 학사

한국체육대학교 사회체육대학원 석사

주요 경력

대한보디빌딩협회 사무국장

아시아소프트볼연맹 서울사무국 국장

부산 및 도하 아시아경기대회 조직위원회 소프트볼 종목 담당관

현재 소속 및 직위

한국도핑방지위원회 과학연구부 부장

대표논문

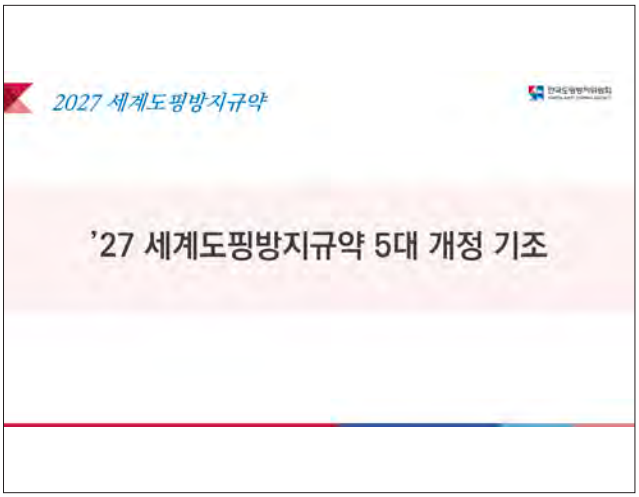
Jae SY, Franklin BA, Choi YH, Fernhall B. Metabolically healthy obesity and carotid intima-media thickness: effects of cardiorespiratory fitness. Mayo Clinic Proceedings. 2015 in press.

2027 세계도핑방지규약(CODE) 및 주요 국제표준 개정사항
2027 World Anti-Doping Code and Key International Standard Amendments

KADA/과학연구부장
임철환









2027 주요 국제표준

'27 주요 국제표준 변경사항



2027 주요 국제표준

교육 국제표준(ISE) 주요 개정 사항

1. (제5조) 스포츠 환경분석 및 위험도 평가 의무 ▶ 고위험 종목 도출 ▶ 교육계획 반영
2. (제6조) 우수선수, 지원선수요원 + 취약집단(미성년, 장애인) 포함 교육대상 확대
3. (제7조) 교육강사의 역량 기준 및 인증, 자격유지 조항 강화
4. (제10.3조) 가명기구간 eLearning 포함 사전 교육활동 상호인정
5. (제11조) IF, MEO + NODO 협력 ▶ 올림픽, 패럴림픽 사전교육 의무화
6. (제12조) 평가체계 강화: 모니터링 ▶ 학습평가 ▶ 성과평가 ▶ 영향분석
7. (제12조, 제16조) 교육 관련 기록 보관 등 평가 및 관리책임 의무 강화

2027 주요 국제표준

검사 국제표준(IST) 주요 개정 사항

1. (제4.2조) 위험도 평가 대상 확대 ▶ 장애인선수
2. (제5.1.3조) 미성년, 시각 및 지적 장애 선수의 대리인 불참시 휴대폰 영상통화 등 원격참여 허용
4. (제7.4.5조) 종목 규정상 성별 구별이 없을 경우 DCF "Unspecified" 표기 의무화
2. (Annex D~J) DBS 관리체계 전부 개정 ▶ 기술요건 강화
3. (Annex K) 팬데믹 및 격리 상황 등 비상상황에서의 가상 소변시료 채취 절차 신설

2027 주요 국제표준

결과관리 국제표준(ISRM) 주요 개정 사항

1. 오염된 제품 ▶ 오염된 원인(음식, 음료, 제3자 신체 접촉 등)으로 확대
2. NADO 운영상 독립성 신설
   - ✓ 정부나 체육단체의 부당 간섭 배제
   - ✓ 단, 정부의 감사 또는 감독기구 수준의 통제 가능
   - ✓ 정부나 체육단체에게 도핑관리 책임 위임 불가 명시
3. 제재기간 감경: 4년 이상 제재에 1년 감경 가능 ▶ 4년 이하 제재의 25% 감경 가능
4. 독립검토전문가(Independent Review Expert) 신설

감사합니다.



이승림

학력

서울대학교 의학과 학사

서울대학교 의과대학원 의학과 석사

서울대학교 의과대학원 의학과 박사

주요 경력

현 대한스포츠의학회 부회장

현 KADA TUE 위원장

전 국립경찰병원장

2026 밀라노코르티나 동계올림픽 국가대표 주치의

2024 파리하계올림픽 CMO(chief medical officer)

K리그, KHA, KLPGA, KBL 의무위원

2003 타르비시오, 2007 토리노. 2009 하얼빈 동계유니버시아드 주치의

현재 소속 및 직위

대한체육회 평창동계훈련센터 국가대표 주치의사

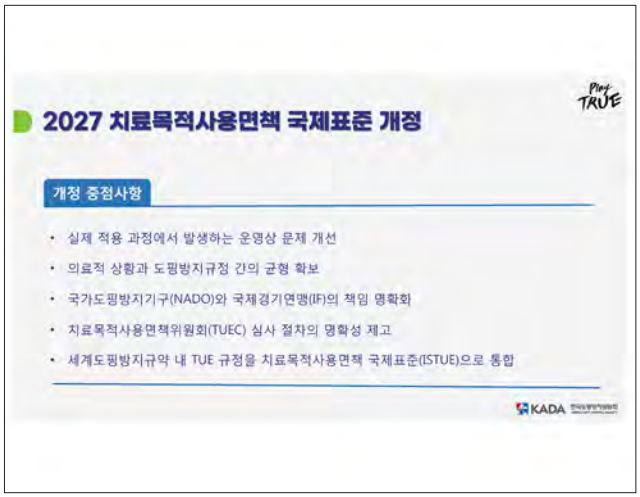
2027 치료목적사용면책 국제표준(ISTUE) 주요 개정사항
Key Amendments to the 2027 International Standard for Therapeutic Use Exemption

KADA/TUEC 위원장
이승림





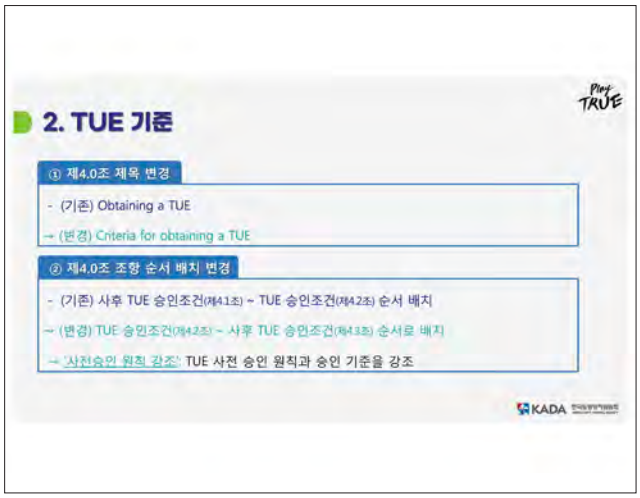


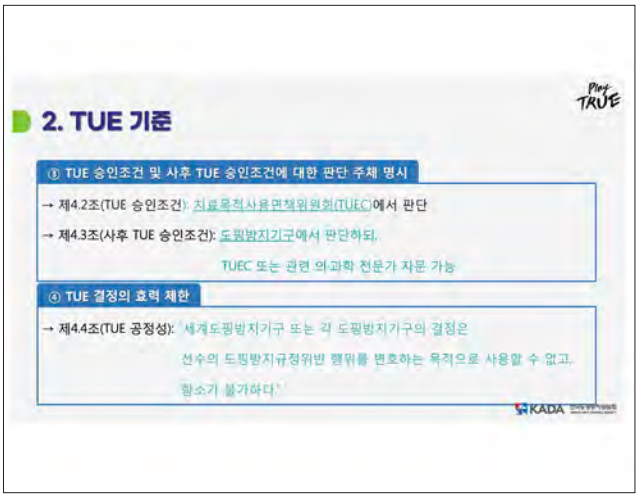



2027 ISTUE 주요 개정사항
1. 서론

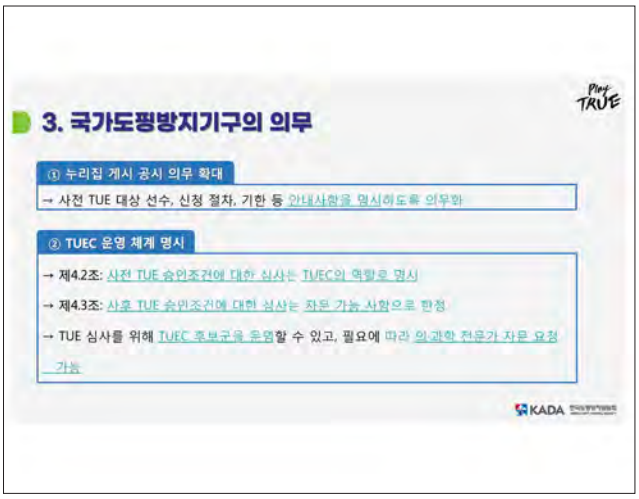

1. 서론
① '치료(Therapeutic)'의 정의
- (기존) 의학적 상태의 치료와 관련되거나 치료과정을 제공 또는 보조
→ (변경) 진단된 의학적 상태의 치료와 관련되거나 치료과정을 제공 또는 보조
② 승인 요건 중심으로 서술 강화
- (기존) 승인 요건을 "medical conditions(의학적 상태)"으로 표기
→ (변경) 승인 요건을 "criteria(승인 기준)"으로 표기
③ 영문 서술 변경
→ (변경) "shall"은 의무적 요구사항, "should"는 권고사항을 명시

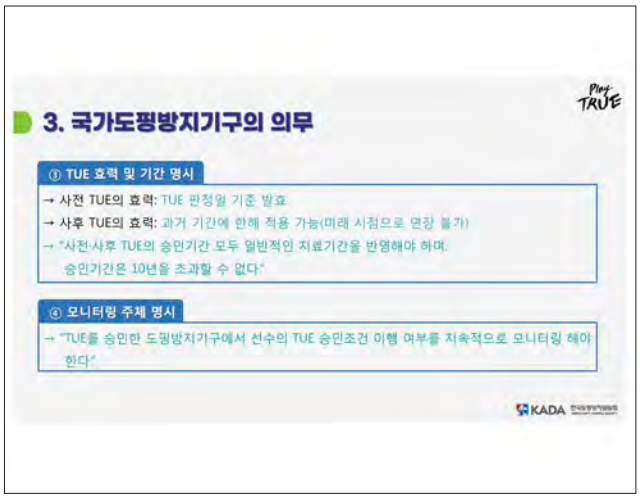

2027 ISTUE 주요 개정사항
2. TUE 기준


2. TUE 기준
① 제4.0조 제목 변경
- (기존) Obtaining a TUE
→ (변경) Criteria for obtaining a TUE
② 제4.0조 조항 순서 배치 변경
- (기존) 사후 TUE 승인조건(제4.1조) ~ TUE 승인조건(제4.2조) 순서 배치
→ (변경) TUE 승인조건(제4.2조) ~ 사후 TUE 승인조건(제4.3조) 순서로 배치
→ '사전승인 원칙 강조' TUE 사전 승인 원칙과 승인 기준을 강조

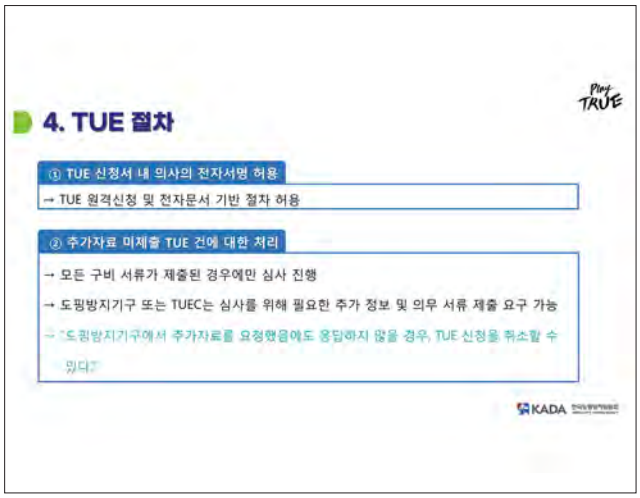

2. TUE 기준
③ TUE 승인조건 및 사후 TUE 승인조건에 대한 판단 주체 명시
→ 제4.2조(TUE 승인조건): 치료목적사용면책위원회(TUEC)에서 판단
→ 제4.3조(사후 TUE 승인조건): 도핑방지기구에서 판단하되,
TUEC 또는 관련 의과학 전문가 자문 가능
④ TUE 결정의 효력 제한
→ 제4.4조(TUE 공정성): '세계도핑방지기구 또는 각 도핑방지기구의 결정은
선수의 도핑방지규정위반 행위를 변호하는 목적으로 사용할 수 없고,
항소가 불가하다.'


2027 ISTUE 주요 개정사항
3. 국가도핑방지기구의 의무

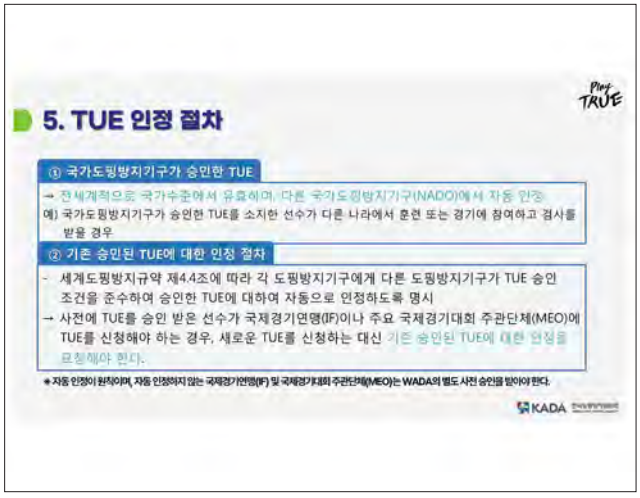

3. 국가도핑방지기구의 의무
① 누리집 게시 공시 의무 확대
→ 사전 TUE 대상 선수, 신청 절차, 기한 등 안내사항을 명시하도록 의무화
② TUEC 운영 체계 명시
→ 제4.2조: 사전 TUE 승인조건에 대한 심사는 TUEC의 역할로 명시
→ 제4.3조: 사후 TUE 승인조건에 대한 심사는 자문 가능 사항으로 한정
→ TUE 심사를 위해 TUEC 후보군을 운영할 수 있고, 필요에 따라 의과학 전문가 자문 요청 가능
KADA


3. 국가도핑방지기구의 의무
③ TUE 효력 및 기간 명시
→ 사전 TUE의 효력: TUE 판정일 기준 발효
→ 사후 TUE의 효력: 과거 기간에 한해 적용 가능(미래 시점으로 연장 불가)
→ "사전·사후 TUE의 승인기간 모두 일반적인 치료기간을 반영해야 하며, 승인기간은 10년을 초과할 수 없다."
④ 모니터링 주체 명시
→ "TUE를 승인한 도핑방지기구에서 선수의 TUE 승인조건 이행 여부를 지속적으로 모니터링 해야 한다."
KADA

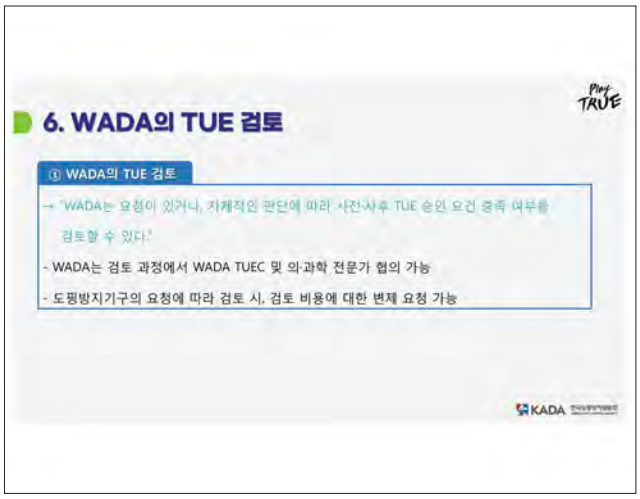

2027 ISTUE 주요 개정사항
4. TUE 절차
KADA


4. TUE 절차
① TUE 신청서 내 의사의 전자서명 허용
→ TUE 원격신청 및 전자문서 기반 절차 허용
② 추가자료 미제출 TUE 건에 대한 처리
→ 모든 구비 서류가 제출된 경우에만 심사 진행
→ 도핑방지기구 또는 TUEC는 심사를 위해 필요한 추가 정보 및 의무 서류 제출 요구 가능
→ "도핑방지기구에서 추가자료를 요청했음에도 응답하지 않을 경우, TUE 신청을 취소할 수 있다."
KADA


2027 ISTUE 주요 개정사항
5. TUE 인정 절차


5. TUE 인정 절차
① 국가도핑방지기구가 승인한 TUE
→ 전세계적으로 국가수준에서 유효하며, 다른 국가도핑방지기구(NADO)에서 자동 인정
예) 국가도핑방지기구가 승인한 TUE를 소지한 선수가 다른 나라에서 훈련 또는 경기에 참여하고 검사를 받을 경우
② 기존 승인된 TUE에 대한 인정 절차
- 세계도핑방지규약 제4.4조에 따라 각 도핑방지기구에게 다른 도핑방지기구가 TUE 승인 조건을 준수하여 승인한 TUE에 대하여 자동으로 인정하도록 명시
→ 사전에 TUE를 승인 받은 선수가 국제경기연맹(IF)이나 주요 국제경기대회 주관단체(MEO)에 TUE를 신청해야 하는 경우, 새로운 TUE를 신청하는 대신 기존 승인된 TUE에 대한 인정을 요청해야 한다.
* 자동 인정이 원칙이며, 자동 인정하지 않는 국제경기연맹(IF) 및 국제경기대회 주관단체(MEO)는 WADA의 별도 사전 승인을 받아야 한다.
KADA


2027 ISTUE 주요 개정사항
6. WADA의 TUE 검토
KADA


6. WADA의 TUE 검토
① WADA의 TUE 검토
→ 'WADA는 요청이 있거나, 자체적인 판단에 따라 사전·사후 TUE 승인 요건 충족 여부를 검토할 수 있다.'
- WADA는 검토 과정에서 WADA TUEC 및 의·과학 전문가 협의 가능
- 도핑방지기구의 요청에 따라 검토 시, 검토 비용에 대한 변제 요청 가능
KADA


2027 ISTUE 주요 개정사항
경청해 주셔서
감사합니다
KADA

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

심포지엄 11: 스포츠에서 발생하는 근건 손상의 도전: 근육 손상에서 난치성 건병증까지

Challenging Musculotendinous Injuries in Sports: From Muscle Injuries to Refractory Tendinopathy

좌장: 아산재건정형외과 조우신, 서을적십자병원 이경태



정규성

학력

한양대학교 의학과 학사

한양대학교 일반대학원 의학과 석사

한양대학교 일반대학원 의학과 박사

주요 경력

대한스포츠의학회 분과 전문의, 편집위원회 간사

K 리그 프로축구연맹 의무위원 (슬관절)

한국전력 빅스톰 프로배구단 팀닥터

대한핸드볼협회 의무위원회 필드닥터

평창동계올림픽 바이애슬론 의무지원

현재 소속 및 직위

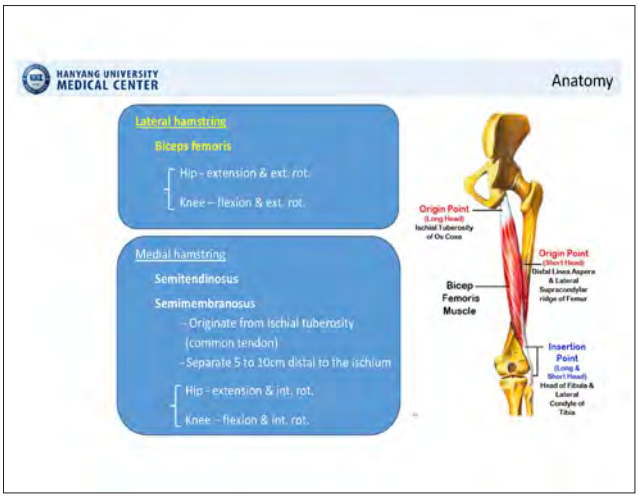
한양대학교 구리병원 정형외과 부교수

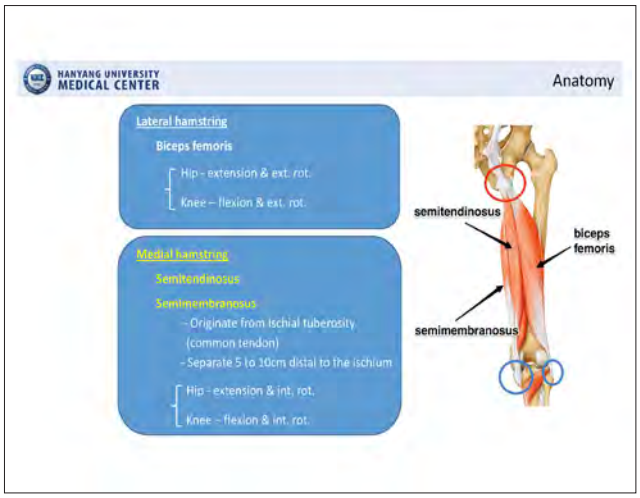
대표논문

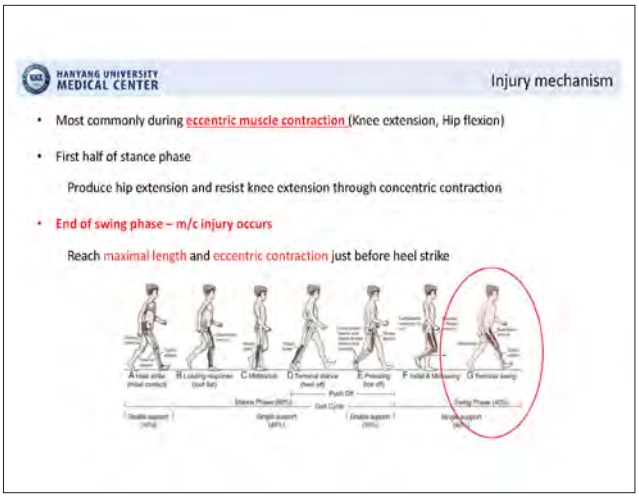
1. Comparison of Clinical and Radiologic Results Between Partial Meniscectomy and Refixation of Medial Meniscus Posterior Root Tears: A Minimum 5-Year Follow-up
   ; Chung KS, Ha JK, Yeom CH, Ra HJ, Jang HS, Choi SH, Kim JG
   ; Arthroscopy. 2015 Oct;31(10):1941-50
2. Are Muscle Strength and Function of the Uninjured Lower Limb Weakened After Anterior Cruciate Ligament Injury? Two-Year Follow-up After Reconstruction.
   ; Chung KS, Ha JK, Yeom CH, Ra HJ, Lim JW, Kwon MS, Kim JG
   ; Am J Sports Med. 2015 Dec;43(12):3013-21
3. Root Repair Versus Partial Meniscectomy for Medial Meniscus Posterior Root Tears: Comparison of Long-term Survivorship and Clinical Outcomes at Minimum 10-Year Follow-up.
   ; Chung KS, Ha JK, Ra HJ, Yu WJ, Kim JG
   ;Am J Sports Med. 2020 Jul;48(8):1937-1944

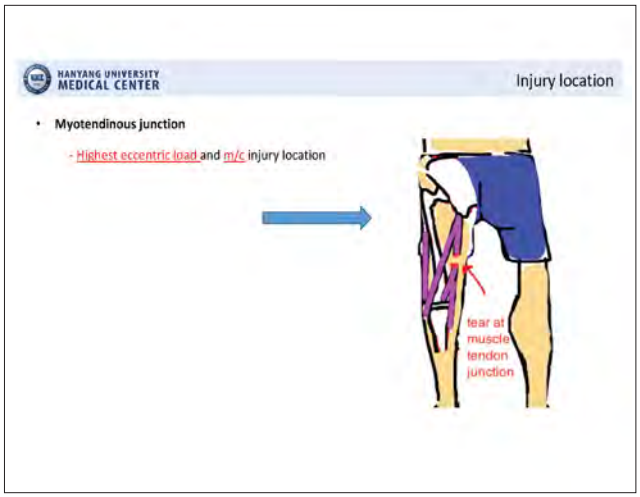
허벅지 뒤가 아프고 땡겨요 (슬괵근 손상)
Hamstring muscle injury

한양대 구리병원
정규성





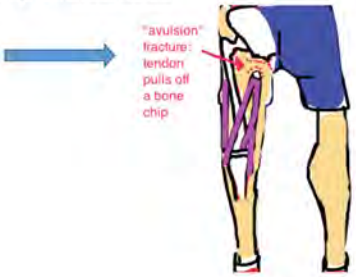




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Injury location

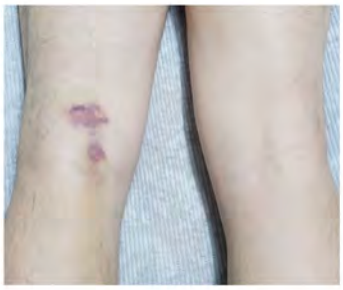
- **Proximal avulsion**
  - Through eccentric contraction with hip flexed and knee extended and occur with high energy



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Injury location

- **Distal avulsion** – very rarely



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Classification

Peetron classification

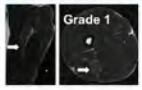
Grade 0
- **normal** ultrasound appearancein spite of the presence of local clinical findings

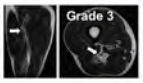
Grade 1
- subtle ultrasound findings may be observed
- including **ill-defined hyperechoic or hypoechoic** intramuscular areas or a swollen aponeurosis

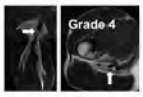
Grade 2
- **partial muscle tears**
- incomplete discontinuity of the muscle

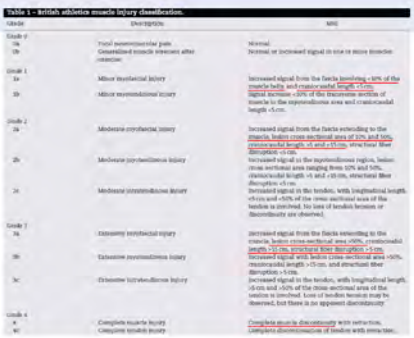
Grade 3
- **fully complete muscle tears**
- complete discontinuity of the muscle

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Clinical presentation

Acute, sudden sharp pain in posterior thigh
- Often with audible or palpable pop

Loss of hamstring flexibility

Proximal avulsion injuries -> Discomfort with sitting

Athletes describe difficulty in walking smoothly
- Stiff-legged gait to avoid simultaneous hip flexion and knee extension





Increasing popliteal angle

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Clinical presentation

- Puranen-Orava test
  - Active stretch hamstring with patient standing



- Bent-knee stretch test



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Radiologic evaluation

Plain X-ray



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Radiologic evaluation

Dynamic ultrasonography

Direct correlation with physical examination
Looking for movement of muscle tendon complex

Finding
Heterogenetity of hamstring
Surrounding edema

Biceps femoris > Semi M > Semi T





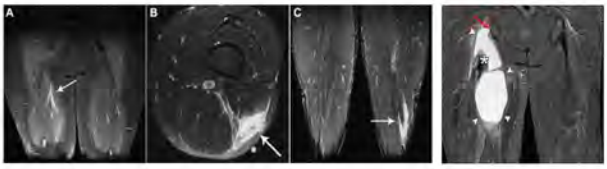
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Radiologic evaluation

MRI

Injury location, degree of damage,

Number of involved tendon, Extent of retraction



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Original research

Br J Sports Med 2023;**57**:218–224.

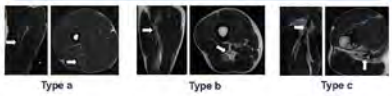
OPEN ACCESS

Epidemiology of MRI-detected muscle injury in athletes participating in the Tokyo 2020 Olympic Games

Hiroki Katagiri,[1,2] Bruce B Forster,[3] Lars Engebretsen,[4] Jae-Sung An,[5] Takuya Adachi[3] Yukihisa Saida,[6] Kentaro Onishi,[6,7] Hideyuki Koga [1]

2020 Olympic Games from clinical reports board-certified musculoskeletal radiologists at the IOC Polyclinic.

British Athletics Muscle Injury Classification (BAMIC)
Type a: myofascial injury in the peripheral aspect of the muscle
Type b: an injury within the muscle belly (myotendinous junction)
Type c: an injury which extends into the tendon (incomplete or complete rupture)





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Table 1 Demographics of athletes who sustained muscle injuries at the Tokyo 2020 Olympic Games

	Number of cases	Number of participants	Incidence proportion
Total	59	11 315	0.52%
Gender			
Female	19	5423	0.35%
Male	40	5892	0.68%
Age			
<19	2	483	0.42%
20–24	17	3242	0.52%
25–29	23	4237	0.54%
30–34	13	2408	0.50%
35–39	4	699	0.57%
40–	0	254	0.0%
Area			
Africa	8	971	0.82%
America	16	2323	0.69%
Asia	7	2112	0.33%
Europe	18	5104	0.35%
Oceania	9	776	1.16%
IOC Refugee Olympic Team	1	29	3.45%

Table 2 Characteristics of muscle injuries at the Tokyo 2020 Olympic Games

	Number of cases	Percentage in total cases
Laterality		
Left	30	51
Right	29	49
Injury location		
Upper extremities	4	7
Body	3	5
Lower extremities	52	88
Timing		
Training	19	32
Game	30	51
Other	3	5
Unknown	7	12
Competition		
Finished	35	59
Did not finish	7	12
Disqualified/no mark	2	3
Did not start/did not play	15	25

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Table 3 Incidence of muscle injuries for each sport in the Tokyo 2020 Olympic Games

	Number of cases	Number of participants	Incidence proportion (%)
Athletics	38	2026	1.5
Field hockey	6	388	1.5
Handball	3	348	0.9
Football	3	507	0.3
Tennis	3	191	1.0
Weightlifting	2	197	1.0
Wrestling	2	289	0.7
Basketball	2	352	0.6
Volleyball	2	384	0.5
Aquatics	2	1438	0.1
Equestrian	1	201	0.5
Fencing	1	225	0.4
Baseball/softball	1	234	0.4
Gymnastics	1	324	0.3
Judo	1	391	0.3
Total	59	11 315	0.5

56 MRI-detected muscle injuries
(40 male & 19 female).

24 athletes (41%) unable to fully compete

52 injuries (88%) - lower extremity muscles
: hamstring muscle - most common (32 of 59, 54%)

During participating in athletics; 30 of 59, 51%

Type a injuries; 21 athletes (35%)
Type b injuries; 14 athletes (24%)
Type c injuries; 24 athletes (41%)
: 18 (75%)- not complete their competition
(higher than types a and b (OR 14.50)

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Table 4

	Rectus femoris	Vastus medialis muscle	Biceps femoris	Semimembranosus	Semitendinosus	Gracilis	Sartorius	Gastrocnemius	Soleus	Plantaris	ADM	Total
Athletics	1	1	14	7	1		1	1	2			30
Field hockey			4									6
Handball			1									3
Football	1		2									3
Tennis	1											2
Weightlifting			1									2
Wrestling			1							1		2
Basketball			1						1			2
Volleyball	1											2
Acrobatics												2
Equestrian									1			1
Fencing												1
Softball												1
Gymnastics												1
Judo								1				1
Total	5	1	24	7	1	1	1	3	2	2	1	59

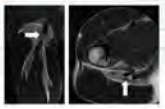
ADM, abductor dig



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Table 5 Olympic Games

Anatomical site	Gracilis	Rectus femoris	Vastus medialis muscle	Biceps femoris	Semimembranosus	Semitendinosus	Gastrocnemius	Sartorius	Soleus	Plantaris	ADM
Type a		3	1	6	2		2		1		
Type b		2		6	1					2	
Type c/ incomplete tears				12	2	1	1	1	1		1
Type c/ complete tears	1				2						
Total	1	5	1	24	7			1	2	2	1
Anatomical site of ADM, abductor di											



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Table 7 Competition completion results stratified by muscle injury site

Anatomical site of muscle injury	Finished	Did not finish	Disqualified/ no mark	Did not start/ did not play
Type a	16	0	1	4
Type b	13	1	0	0
Type c	6	6	1	11
Total	35	7	2	15

Anatomical site of muscle injury was classified as type a: myofascial, type b: muscle-tendon junction, type c: muscle injury which extends into the tendon.

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Table 7 Competition completion results stratified by muscle injury site

Anatomical site of muscle injury	Finished	Did not finish	Disqualified/ no mark	Did not start/ did not play
Type a	16	0	1	4
Type b	13	1	0	0
Type c	6	6	1	11
Total	35	7	2	15

Anatomical site of muscle injury was classified as type a: myofascial, type b: muscle-tendon junction, type c: muscle injury which extends into the tendon.



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What are risk factors of hamstring injuries in Athletes ?





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Intrinsic risk factors of non-contact quadriceps and hamstring strains in soccer: a prospective study of 100 professional players

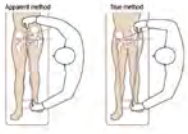
Br J Sports Med 2011;45:709–714

Konstantinos Fousekis,[1] Elias Tsepis,[1] Peter Poulmedis,[1] Spyros Athanasopoulos,[2] George Vagenas[2]

Table 5 Frequencies and logistic regression* results: intrinsic risk factors for hamstrings and quadriceps muscle strains in professional soccer players (N=100)

Intrinsic aetiological factors	Frequencies* (%)		Statistics		
	Low risk	High risk	OR	95% CI	p Value
Hamstrings muscle strains (16 vs 84)					
Eccentric hamstrings strength asymmetries	No strain 48	36	3.69	1.13 to 13.23	0.03
	Strain 5	11			
Functional leg length asymmetries	No strain 62	22	3.80	1.08 to 13.33	0.03
	Strain 9	7			
Previous hamstring strains	No strain 63	21	0.151	0.029 to 0.79	0.02
	Strain 14	2			
Quadriceps muscle strains (1 vs 99)					
Weight	No strain 55	39	10.70	0.73 to 156.37	0.08
	Strain 3	4			
Height	No strain 42	51	0.091	0.00 to 1.35	0.08
	Strain 4	3			
Quadriceps flexibility asymmetries	No strain 80	53	4.59	0.78 to 31.86	0.09
	Strain 4	3			
Eccentric quadriceps strength asymmetries	No strain 77	55	5.019	0.928 to 27.14	0.06
	Strain 3	4			

eccentric hamstring strength asymmetries (OR=3.88; 95% CI 1.13 to 13.23), functional leg length asymmetries (OR=3.80; 95% CI 1.08 to 13.33) and no previous hamstrings injuries (OR=0.15; 95% CI 0.029 to 0.79) were at greater risk of sustaining a hamstring muscle strain.



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Short biceps femoris fascicles and eccentric knee flexor weakness increase the risk of hamstring injury in elite football (soccer): a prospective cohort study

Br J Sports Med 2015;0:1–12.

Ryan G Timmins,[1] Matthew N Bourne,[2] Anthony J Shield,[2] Morgan D Williams,[3] Christian Lorenzen,[1] David A Opar[1]

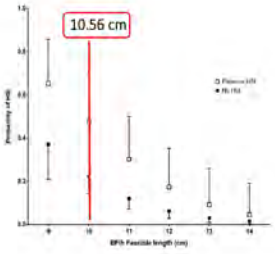
Biceps femoris long head fascicles

shorter than 10.56 cm

(RR=4.1; 95% CI 1.9 to 8.7)

significantly increased the risk

of a hamstring injuries.



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Short biceps femoris fascicles and eccentric knee flexor weakness increase the risk of hamstring injury in elite football (soccer): a prospective cohort study

Br J Sports Med 2015;0:1–12.

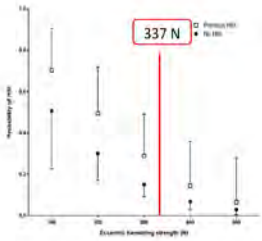
Ryan G Timmins,[1] Matthew N Bourne,[2] Anthony J Shield,[2] Morgan D Williams,[3] Christian Lorenzen,[1] David A Opar[1]

Eccentric knee flexor strength

below 337 N (RR=4.4; 95% CI 1.1 to 17.5)

significantly increased the risk

of a hamstring injuries.



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Open access Original research

BMJ Open Sport & Exercise Medicine

Risk factors for hamstring muscle injury in male elite football: medical expert experience and conclusions from 15 European Champions League clubs

Jan Ekstrand ,[1] Peter Lieblacker,[2] Wart Van Zoest,[3,4] Raymond Verheijen,[5] Bruno Vanhecke,[6,7] Maikel van Wijk,[8] Håkan Bengtsson[1,9]

Ekstrand J, *et al*. *BMJ Open Sp Ex Med* 2023;**9**:e001461. doi:10.1136/bmjsem-2022-001461

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Table 2 Perceived modifiable risk factors for hamstring injuries, divided between intrinsic factors (players) and extrinsic factors (coaching, team, club)

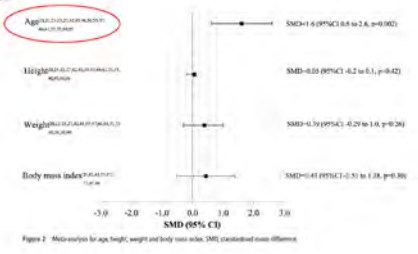
	Total group (n=15) Weighted average	Group LOW (n=7) Weighted average	Group HIGH (n=8) Weighted average
Intrinsic risk factors (players)			
Residual weakness after previous hamstring injury	3.5	3.6	3.5
Strength asymmetry of hamstrings (R/L ratio, Q/H ratio)	3.3	3.4	3.1
Lack of eccentric strength of the hamstrings	3.2	3.3	3.1
Fatigue	3.1	2.6	3.6
Poor core stability (lumbopelvic control)	3.1	2.9	3.3
Poor coordination	2.8	2.9	2.8
Player wellness (sleep patterns, relationships, etc)	2.5	2.0	3.0
Poor flexibility	2.4	2.1	2.6
Poor nutrition	2.1	2.3	2.0
Mean	26/9=2.9	25/9=2.8	27/9=3.0

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Extrinsic risk factors (coaching, team, club)			
Lack of communication between medical staff and coaching staff	3.7	3.6	3.8
Lack of regular exposure to high-speed football during training	3.6	3.8	3.5
Load on players	3.5	3.1	3.8
Lack of in-season recovery strategies	3.5	3.6	3.4
Lack of interest in prevention strategies in the team or club	3.4	3.3	3.5
Playing matches 2–3 times a week	3.3	3.4	3.3
Lack of regular exposure to strength training (eccentric/isometric/concentric)	3.2	3.4	3.0
Training/exercise surveillance by coaching staff	3.2	3.1	3.3
Off-season loading/recovery	2.7	2.4	3.0
No and expertise of the medical staff	2.7	2.3	3.1
Style of coach leadership	2.7	2.1	3.3
Medical budget	1.9	1.4	2.3

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Recalibrating the risk of hamstring strain injury (HSI): A 2020 systematic review and meta-analysis of risk factors for index and recurrent hamstring strain injury in sport



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Recalibrating the risk of hamstring strain injury (HSI): A 2020 systematic review and meta-analysis of risk factors for index and recurrent hamstring strain injury in sport

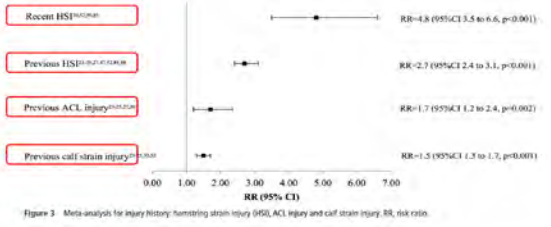


Figure 3 Meta-analysis for injury history: hamstring strain injury (HSI), ACL injury and calf strain injury. RR, risk ratio.

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Risk factors of recurrent hamstring injuries: a systematic review

HM de Visser, M Reijman, MP Heijboer, PK Bos

Br J Sports Med 2017;46:124–130.

Peetrons classification

Grade 0
- normal ultrasound appearance in spite of the presence of local clinical findings

Grade 1
- subtle ultrasound findings may be observed, including ill-defined hyperechoic or hypoechoic intramuscular areas or a swollen aponeurosis

Grade 2
- partial muscle tears
- incomplete discontinuity of the muscle

Grade 3
- Fully complete muscle tears
- complete discontinuity of the muscle

Table 5 Determinants for recurrent hamstring injuries

Determinants	Study reference number	Best-evidence synthesis
Age	2, 5	Limited evidence
Height	2, 5	Limited evidence
Weight	2, 5	Limited evidence
Time to return to sports	All	Limited evidence
Size of the initial injury	1, 2	Limited evidence
Cross-sectional area of the initial injury	1, 2, 3, 5↑	Conflicting evidence
Volume of the initial injury	5↑	Limited evidence
Grade 1 injuries according to Peetrons	1↑, 3↑	Limited evidence
Muscle involved	2, 3, 5	Limited evidence
Location in the muscle*	2, 3, 5	Limited evidence
Pain severity score (VAS) 12–18 h after the initial injury	5	Limited evidence
Presence of a haematoma	3	Limited evidence
Dominant leg injured	5	Limited evidence
Previous hamstring injury†	2	Limited evidence
Previous ACL reconstruction	2↑	Limited evidence
Rehabilitation 'agility and stabilisation'‡	4↓	Limited evidence
Outcome functional tests§	4	Limited evidence

1=Gibbs *et al*[6]; 2=Koulouris *et al*[7]; 3=Malliaropoulos *et al*[8]; 4=Sherry and Best[9]; 5=Verrall *et al*[10]
↑=Risk factor for re-injury.
↓=Protective factor for re-injury.

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How can we manage hamstring injuries ?



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"Not all hamstring injuries are the same"

Two different types of acute hamstring strains

1. Sprinting type :
- high-speed running
- mainly involving the biceps femoris long head
- initially appearing severe type
- not prolonged return to play

2. Stretch type :
During movements to extensive lengthening of the hamstrings (such as high kicking, sliding tackle, sagittal split)
- involving the free proximal tendon of semimembranosus
- initially appearing less severe than the sprinting type
- however, prolonged return to play

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Clinical management

Reduction or pause of sports activity

Medication (NSADIs, pain killer, muscle relaxant ...)

Physical therapy
- Cryotherapy – reduction of metabolic rate
- Therapeutic ultrasound(TUS) – excites cellular activity
- Low level laser therapy(LLLT) – trigger the production of ATP
- Therapeutic exercises – eccentric exercise
- soft tissue mobilization

New biological therapies
- PRP (Platelet rich plasma)
- Growth factors - Bioactive molecules(TGF-b, FGF, EGF, PDGF, VEGF) By stimulating myogenesis & neoangiogenesis
- Cell theraphy

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Clinical management

Generally, **Low grade & Acute**

- RICE (rest, ice, compression, elevation) protocol
  : initial inflammatory response, controlling edema & hemorrhage

- Gradual mobilization
  Regeneration
  Orientation
  Alignment of the injured muscle fibers

- Return to sport
  4 to 6 weeks

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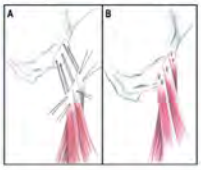
Operation

Proximal hamstring avulsion
- 2 tendon retracted >2cm
- 3-tendon avulsion









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Clinical management

Reduction of pain in the early days after hamstring injury
- to reduce the neuromuscular inhibition associated with pain
- to encourage early muscle activation
(particularly eccentric exercise at longer muscle lengths)

→ early return to running with rapid progression to high-speed running

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Clinical management

Rehabilitation - Lengthening eccentric exercises
- Nordic hamstring exercise (NHE)
- Romanian dead lift
- Askling's 'extender', 'diver' and 'glider' exercises











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Acute hamstring injuries in Swedish elite football: a prospective randomised controlled clinical trial comparing two rehabilitation protocols

Br J Sports Med 2013;47:953–959

Carl M Askling,[1,2] Magnus Tengvar,[3] Alf Thorstensson[1]

Lengthening exercise (L type) vs Conventional exercises (C type)







Figure 1 L-1 'The Extender'. The player should hold and stabilise the high of the injured leg with the hip flexed approximately 90° and then perform slow knee extensions to a point just before pain is felt. Twice very day, three sets with 12 repetitions (online supplementary video 1) access the article online to view this figure in colour.

Figure 2 L-2 'The Diver'. The exercise should be performed as a simulated dive, that is, as a hip flexion (from an upright trunk positi the injured, standing leg and simultaneous stretching of the arms fo and attempting maximal hip extension of the lifted leg while keepin pelvis horizontal; angles at the knee should be maintained at 10–20 the standing leg and at 90° in the lifted leg. Owing to its complexity exercise should be performed only closely in the beginning. View a vid

Figure 3 L-3 'The Glider'. The exercise is started from a position wit upright trunk, one hand holding on to a support and legs slightly split All the body weight should be on the heel of the injured (here left) leg with approximately 10–20° flexion in the knee. The motion is started by gliding backward on the other leg (note low friction sock) and stopped before pain is reached. The movement back to the starting

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Acute hamstring injuries in Swedish elite football: a prospective randomised controlled clinical trial comparing two rehabilitation protocols

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Lengthening exercise (L type) vs Conventional exercises (C type)



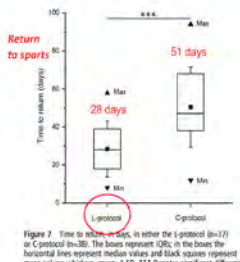




Figure 6 C-3 Pelvic lift. This exercise is started in a supine position with the body weight on both heels and then the pelvis is lifted up and down slowly. Start with the knee in 90° of flexion. The load is increased by putting more of the body weight on the injured leg and by having a greater extension in the knee. Ultimately, only the slightly bent injured leg is carrying the load. Every third day, three sets with eight repetitions (online supplementary video 6). Access the article online to view this figure in colour.

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Emphasising lengthening type of exercises



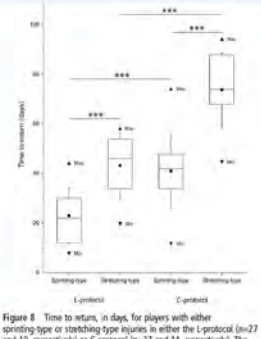
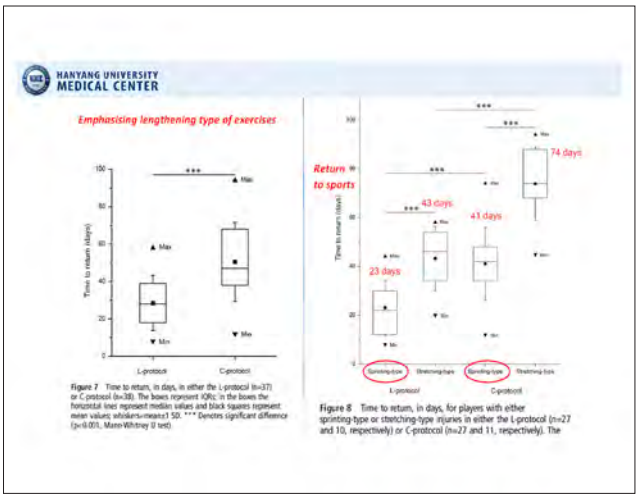
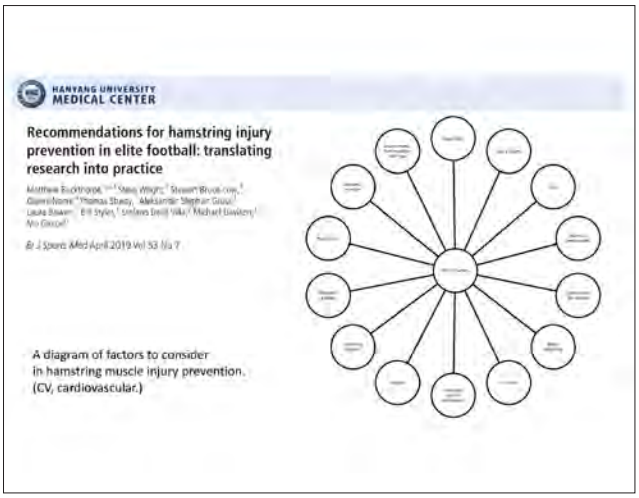


Figure 7 Time to return, in days, in either the L-protocol (n=37) or C-protocol (n=38). The boxes represent IQRs; in the boxes the horizontal lines represent median values and black squares represent mean values; whiskers=mean±1 SD. *** Denotes significant difference (p<0.001, Mann-Whitney U test).

Figure 8 Time to return, in days, for players with either sprinting-type or stretching-type injuries in either the L-protocol (n=27 and 10, respectively) or C-protocol (n=27 and 11, respectively). The

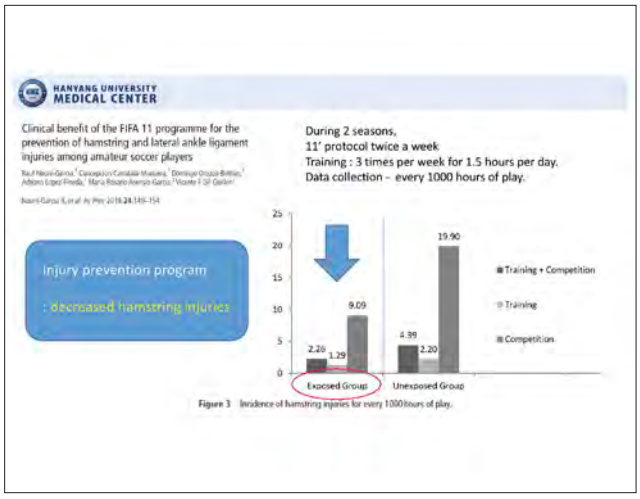

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Emphasising lengthening type of exercises
Return to sports
23 days
43 days
41 days
74 days

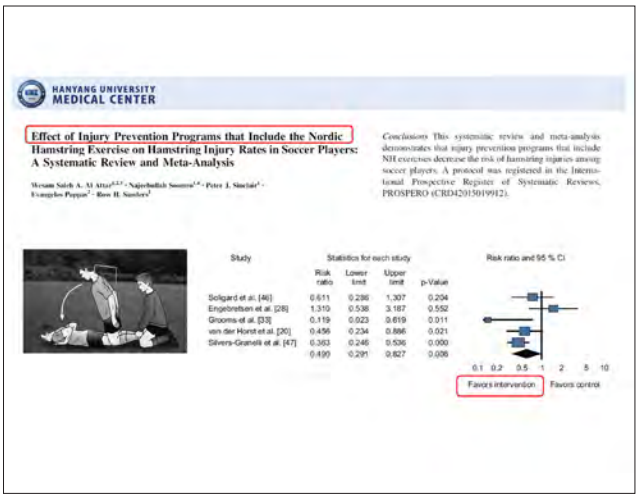

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Injury prevention
Program
&
Return to Sports

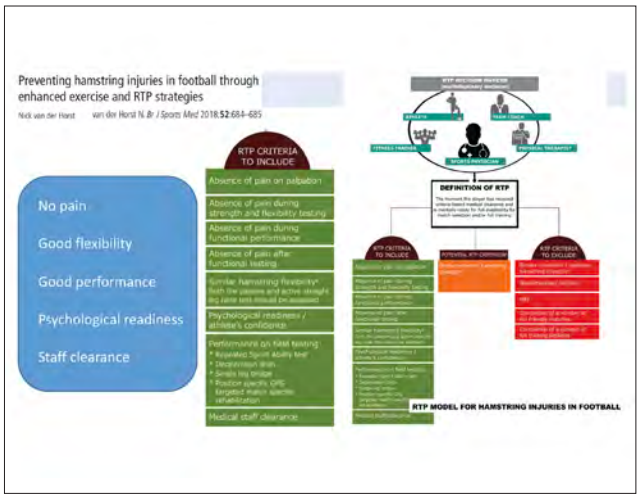

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Recommendations for hamstring injury prevention in elite football: translating research into practice
A diagram of factors to consider in hamstring muscle injury prevention. (CV, cardiovascular.)


HANYANG UNIVERSITY MEDICAL CENTER
BMJ Sports Medicine
Recommendations for Hamstring Injury Prevention in Elite Football (Soccer): Translating Research Into Practice
Important Considerations When Designing an Injury Prevention Programme
RISK FACTOR ANALYSIS AND PROGRAMME PLANNING
GAIN BUY-IN FROM KEY STAKEHOLDERS
TARGET INTERVENTIONS AT THE INDIVIDUAL PLAYER
IMPLEMENT A HOLISTIC PROGRAMME INCLUDING HAMSTRING INJURY PREVENTION
Five-point Strategy to Hamstring Injury Prevention in Elite Football (Soccer)
STRENGTHEN THE HAMSTRING MUSCLES
MONITOR PLAYER LOAD AND RECOVERY
PRESCRIBE LUMBOPELVIC CONTROL EXERCISES
INCORPORATE A FOCUS ON MOVEMENT QUALITY
DEVELOP PLAYERS' PHYSICAL CONDITIONING
Created by Adam Virgile


FIFA 11+
THE "11+"
MANUAL
STRENGTH · PLYOMETRICS · BALANCE · 10 MINUTES


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Clinical benefit of the FIFA 11 programme for the prevention of hamstring and lateral ankle ligament injuries among amateur soccer players
During 2 seasons,
11' protocol twice a week
Training : 3 times per week for 1.5 hours per day.
Data collection – every 1000 hours of play.
Injury prevention program
: decreased hamstring injuries
2.26
1.29
9.09
4.99
2.20
19.90
Training + Competition
Training
Competition
Exposed Group
Unexposed Group
Figure 3 Incidence of hamstring injuries for every 1000 hours of play.


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Effect of Injury Prevention Programs that Include the Nordic Hamstring Exercise on Hamstring Injury Rates in Soccer Players: A Systematic Review and Meta-Analysis
Conclusions This systematic review and meta-analysis demonstrates that injury prevention programs that include NH exercises decrease the risk of hamstring injuries among soccer players. A protocol was registered in the International Prospective Register of Systematic Reviews, PROSPERO (CRD42015019912).
Study
Statistics for each study
Risk ratio
Lower limit
Upper limit
p-Value
Risk ratio and 95 % CI
Soligard et al. [46] 0.611 0.296 1.307 0.204
Engebretsen et al. [28] 1.310 0.538 3.187 0.552
Grooms et al. [33] 0.119 0.023 0.619 0.011
van der Horst et al. [20] 0.456 0.234 0.886 0.021
Silvers-Granelli et al. [47] 0.353 0.246 0.506 0.000
0.490 0.291 0.827 0.006
0.1 0.2 0.5 1 2 5 10
Favors intervention
Favors control


Preventing hamstring injuries in football through enhanced exercise and RTP strategies
Nick van der Horst
van der Horst N. Br J Sports Med 2018;52:684-685
No pain
Good flexibility
Good performance
Psychological readiness
Staff clearance
RTP CRITERIA TO INCLUDE
Absence of pain on palpation
Absence of pain during strength and flexibility testing
Absence of pain during functional performance
Absence of pain after functional testing
Similar hamstring flexibility*
Both the passive and active straight leg raise test should be assessed
Psychological readiness / athlete's confidence
Performance on field testing:
* Repeated Sprint Ability test
* Nordbord strength
* Single leg bridge
* Position specific GPS targeted match specific rehabilitation
Medical staff clearance
DEFINITION OF RTP
RTP MODEL FOR HAMSTRING INJURIES IN FOOTBALL


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사단법인 대한스포츠의학회
The Korean Society of Sports Medicine
제68차 춘계학술대회
THANK YOU FOR YOUR ATTENTION
drokokboy@hanmail.net
궁금한 점이나
문의 사항 있으면
언제나 연락주세요

김기천

학력

한양대학교 의학과 학사

한양대학교 의학대학원 석사

한양대학교 의학대학원 박사

주요 경력

제주 유나이티드 FC 책임 주치의 : 2010-01-01 ~ 2012-03-31

2015 타오위안아시아태평양농아인경기대회 주치의 : 2015-10-03 ~ 2015-10-09

KSSM & JSCSM Travelling fellowship : 2018-10-29 ~ 2018-11-04

대한 스포츠의학회 : 국제위원회 간사 2017~2018

IOWA 주립대학 정형외과 연수 : 2022.1 ~ 2022. 12

2023년 투어 주치의 활동이력 : 2023-04-06 ~07 롯데렌터카 여자오픈

2024년 투어 주치의 활동이력 : 2024-10-25 서울 경제 레이디스 클래식

2025년 투어 주치의 활동이력 : 2025-08-16~17 메디힐 · 한국일보 챔피언십

2026년 : 장애인 육상 등급 분류사

현재 소속 및 직위

서울의료원 정형외과 과장 (2013~)

대표논문

1. The preliminary report about the modified supramalleolar tibial osteotomy for asymmetric ankle osteoarthritis. Koo JW, Park SH, Kim KC, Sung IH.J Orthop Surg (Hong Kong). 2019 Jan-Apr;27(1):2309499019829204. doi: 10.1177/2309499019829204
2. Factors Associated With Recurrent Fifth Metatarsal Stress Fracture. Foot and Ankle International. Kyung-tai Lee, MD, PhD, Young-uk Park, MD, PhD, Hyuk Jegal, MD, KiChunKim,MD,Ki-wonYoung,MD,PhD,Jin-suKim,MD,PhD,1645-1653,Nov,2013
3. Midterm Outcome of Modified Kidner Procedure. Foot and Ankle International. Kyung Tai Lee, MD ; KiChunKim,MD; YoungUkPark,MD; SeungMinPark,MD; YoungKooLee,MD,122-127,Feb,2012

종아리 뒤가 아프고 땡겨요 (비복근 및 가자미근 손상)
Gastrocnemius and soleus injury

서울의료원
김기천

Introduction

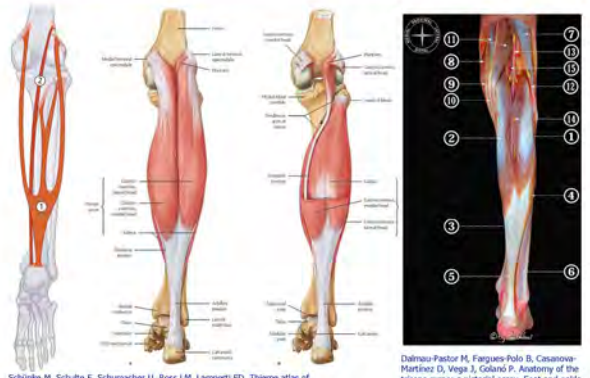
- Tennis leg : Powell (1883)
- Incidence (발생률) : /team and /season



- 나이 : 22 ~38
- 남자
- 재발률 : 19~33% (exp, First 2 months of initial injury)

CALF STRAIN IN ATHLETES

해부학



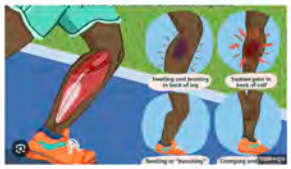
Schünke M, Schulte E, Schumacher U, Ross LM, Lamperti ED. Thieme atlas of anatomy: general anatomy and musculoskeletal system. Thieme Medical Publishers, Incorporated; 2014.

Dalmau-Pastor M, Fargues-Polo B, Casanova-Martínez D, Vega J, Golanó P. Anatomy of the triceps surae: a pictorial essay. Foot and ankle clinics. 2014 Dec 1;19(4):603-35.

손상기전

- (Passive) stretching + Active contraction
- Sudden eccentric loading : Knee extension state + Ankle Dorsiflexion

	GCN	Soleus
Mechanism	Knee extension + Sudden AK DF	Knee flexion + repeated passive AK DF
	Acute Rapid m contraction	Subacute Overuse injury
Others	Rupture at MT junction	Uphilll runner





Case 1 : 정○ ○ (M/40)

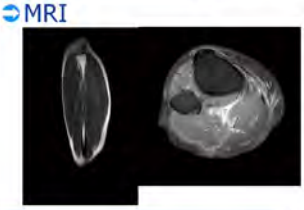
- CC : 우측 하퇴부 통증
- Onset : 약 2일전
- Cause : 축구하다가
- P/I : 축구를 하다 힘을 준 후 우측 종아리에 파열음과 함께 통증 발생하여 ER 내원함
- VAS : 3



- US

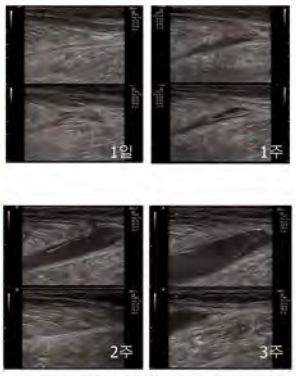


- MRI



Case 2. 김○ ○ (M/39)

- CC : 좌측 하퇴부 통증
- Onset : 약 1개월전
- Cause : 축구하다가
- P/I : 인근 병원에서 근육 파열이라 들음. 반깁스, PT, ESWT 3주 치료 흡인술시행. 혈액 소견. 다시 재발하여 흡인술 재시행. 장액성 액체 소견. 상급 병원 전원 및 MRI 권유 받음. 걸어다니면 약간 쑤시다.
- VAS : 1



부산건우정형외과 곽희철 선생님 증례

임상

- 주 병력
  - 운동 중 갑자기 '퍽'하는 느낌.
  - 운동 중 누가 내 종아리를 차는 것 같았다.
- 증상
  - 종아리에 둔한 통증이 있다.
  - 그런 중에 안쪽 중간 또는 그 위가 아프다.
- 이학적 검사
  - 반상 출혈 (ecchymosis) : 종아리 내측
  - 종아리 내측 압통 및 결손 : GCN 손상

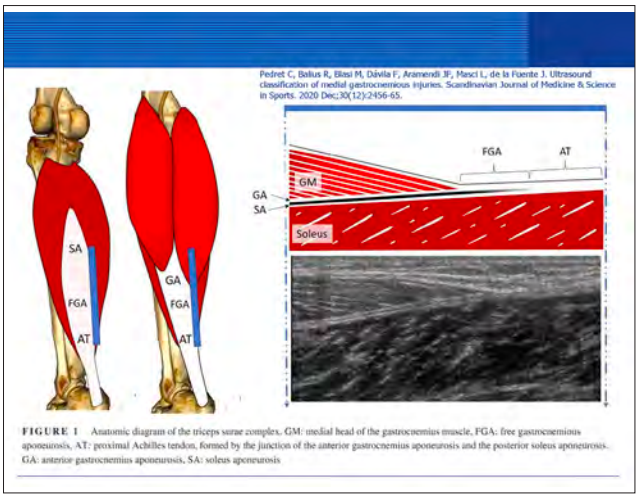
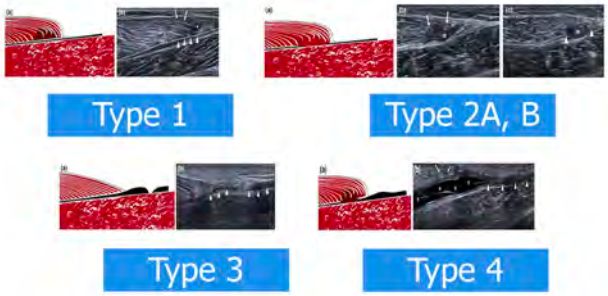
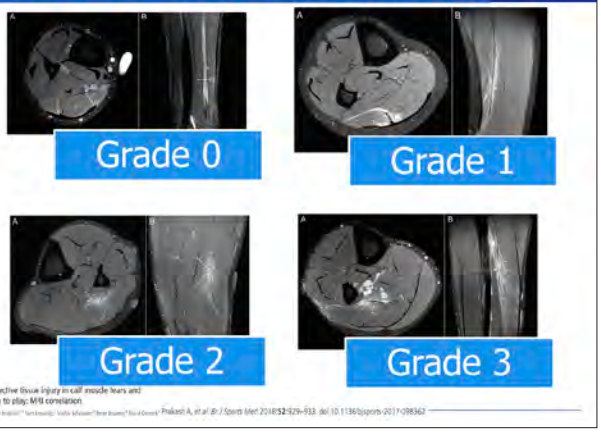


FIGURE 1 Anatomic diagram of the triceps surae complex. GM: medial head of the gastrocnemius muscle, FGA: free gastrocnemious aponeurosis, AT: proximal Achilles tendon, formed by the junction of the anterior gastrocnemius aponeurosis and the posterior soleus aponeurosis. GA: anterior gastrocnemius aponeurosis, SA: soleus aponeurosis

GCM injury Classification by US



MRI of Calf muscle tear, GCN (Olympic Park system)



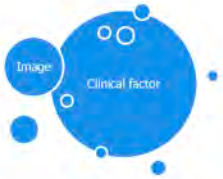
Connective tissue injury in calf muscle tears and return to play: MRI correlation



Calf Strains in Athletes: A Narrative Review of Management, Injury Grading, and Return to Sport

Pagan-Rosado et al. Sports Medicine - Open (2025) 11:158
https://doi.org/10.1186/s40798-025-00960-4

- Location, integrity of the aponeuroses : better predictor of RTP than size
  - Tendinous involvement (aponeurotic disruption) : prolonged RTP program
- MRI and US : Dx, F/U
- RTP
  - Tenderness (-)
  - M weakness (-)



Acute Management

- Post-injury #2 (3) days ~ 2 weeks
- MRI, US
- R.I.C.E (rest, ice, compression, elevation) → POLICE (Protection, Optimal Loading, Ice, Compression, Elevation) → PEACE (Protect, Elevate, Avoid anti-inflammatories, Compression, Education) [Recovery LOVE (Load, Optimism, Vascularisation, Exercise)]
- NSAIDs, AAP, COX-2 inhibitor: first 24–72 h
- Gentle active ROM exercises and Isometric contractions : case by case
- Red flag sign
  - DVT ; worsening pain, swelling, and tenderness
  - Compartment syndrome : pain disproportionate to injury, pallor, paresthesia, palpable tenseness, and pulselessness
- High grade injuries : loss of synchronicity of the GCN and soleus complex
  - Immobilization : walking boot or crutches
  - Aspiration of hematoma : ↓

Rehabilitation

Post-injury # 2~3weeks	Post-injury # 3~4weeks	Final phase
• Early-loading strategies • Light calf stretches • isometric single-leg calf raises • Light walking • Eccentric strengthening exercises	• light strengthening exercises • Knee extension (GCN), and flexion (Soleus) state exercise • ↑ Loading	• Incorporation of sport-specific movements

- Mild to moderate injuries : accelerated rehabilitation course (2–6 weeks)

Acute Management and Rehabilitation

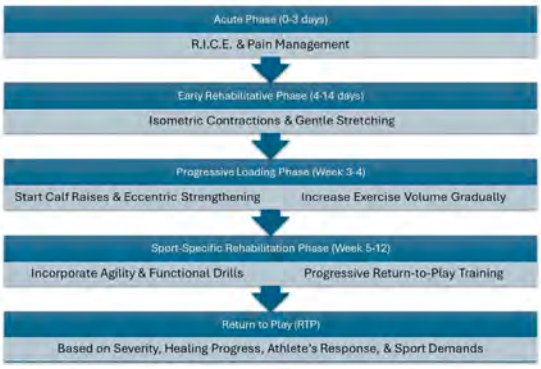


Fig. 2 Flowchart summarizing the key stages in the rehabilitation process for calf strains, outlining the progression from the acute phase to return to play

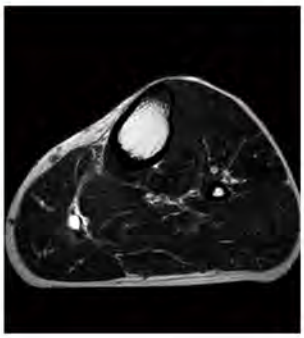
Case 1



- POD #2M
  - 우측 종아리가 아침마다 당긴다.
  - 많이 아프거나 간헐적으로 인근 병원 간다.
- POD #3M
  - 평상시 종아리 괜찮다. 아침에 일어나서 조금 불편.
  - 발은 이제 안 아프다.

Case 2 : 수상후 4주 MRI





Case 2 : 초음파

수상후 5주



수상후 7주



Summary

- 재발률 : 10명중 2~3명
- 운동중 갑자기 '퍽'하는 느낌, 뒤에서 누가 종아리는 차는 느낌이 나면 Calf strain을 의심한다.
- 상기 병력과 함께 종아리 근육부위의 반상출혈, 압통이 있으면 Calf strain을 의심한다.
- 초음파, MRI등을 통해 확진
- 초기 치료 : POLICE
- 대부분 보존적 치료를 한다.
- 건, 인대 손상 동반시 치료가 더 오래 걸리고 예후가 좀 더 안좋은 것으로 보인다.
- 대체로 약 3개월 이내에 RTP가 가능하다.



송하헌

학력

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원광대학교 의과대학원 석사

전북대학교 의과대학원 박사

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현) 한국프로축구연명 의무위원회 위원

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2001-2002 미국 뉴욕 The Hospital for Special Surgery 정형외과 연수

2006 아시아 스포츠 의학회(Asian Federation of Sports Medicine) 선발 해외 장학생

현재 소속 및 직위

전주 새강병원 정형외과

대표논문

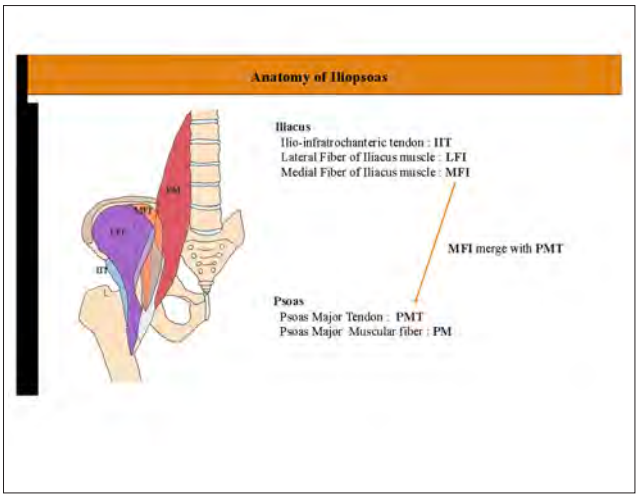
유청소년 축구선수의 과사용 부상 예방가이드북 군자출판사 2021

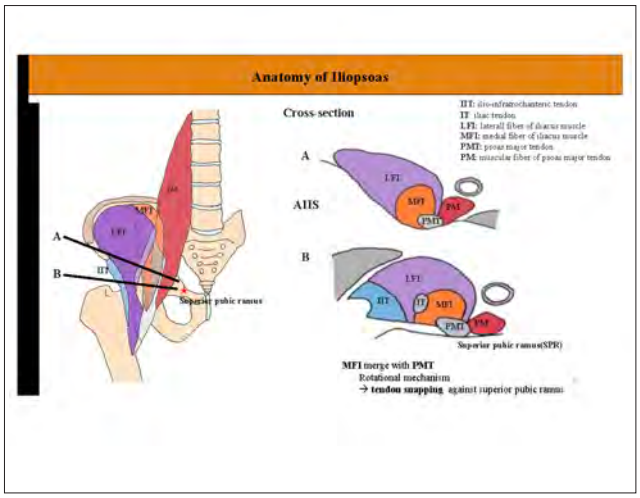
족부족관절학 교과서(대한족부족관절학회) 2020

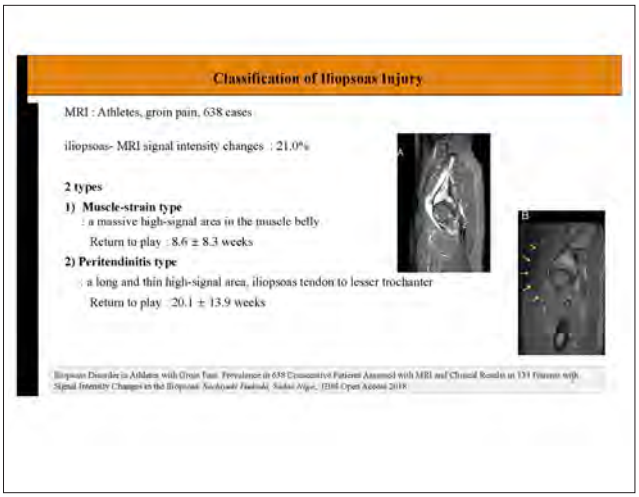
족부조관절질환에서 주사치료는 얼마나 효과가 있을까? 대한족부족관절학회지 2021

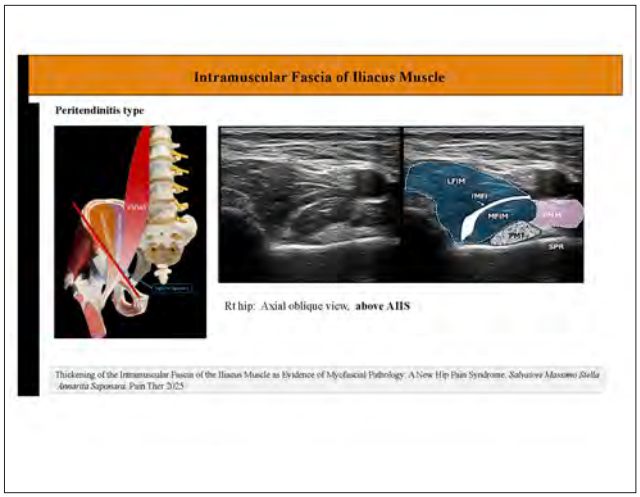
골반부위가 아프고 땡겨요 (장요근 손상)
Iliopsoas injury

전주새강병원
송하헌





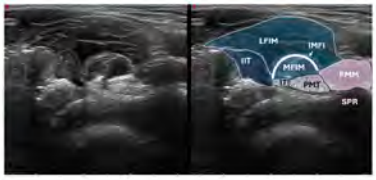




Intramuscular Fascia of Iliacus Muscle

Peritendinitis type



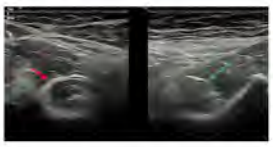


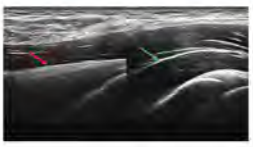
Rt hip: Axial oblique view, **below** of AIIS

Thickening of the Intramuscular Fascia of the Iliacus Muscle as Evidence of Myofascial Pathology: A New Hip Pain Syndrome. *Salvatore Massimo Stella Annarita Saponara.* Pain Ther 2025

Intramuscular Fascia of Iliacus Muscle

Thickening





Rt groin pain control Rt groin pain control

iliacus muscle, intramuscular fascia - **Thickening**
possible snapping on FABER position
(Flexed, Aabducted & Externally Rotation)

Intramuscular Fascia of Iliacus Muscle

Active iliopsoas snapping test



Hip flexion



abduction & external rotation



extension & neutral

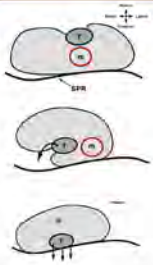




FABER ↔ neutral extension position
: tendon moves medially or laterally & flipping
snapping against pubic bone

The snapping iliopsoas tendon: new tricks for an old lesion using dynamic sonography. *Deslandes M, Guillin R, Cardinal E.* Am J Roentgenol 2008

Iliopsoas Tendon Snapping



Transverse oblique view

Rotational mechanism ; iliopsoas tendon & iliac muscle

Hip : FABER position
iliopsoas tendon : rolls laterally over iliac muscle
iliac muscle: **interposed** between tendon & superior pubic ramus

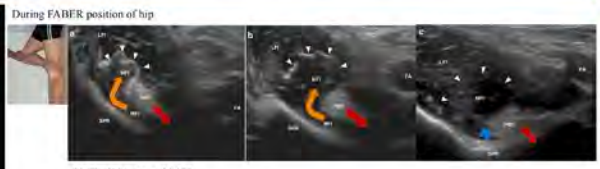
back to neutral position
tendon rolls medially & posteriorly
muscle is **trapped** between tendon & superior pubic ramus

muscle is suddenly released laterally,
abrupt return of tendon against pubic bone
producing **audible snap**

The snapping iliopsoas tendon: new mechanisms using dynamic sonography. *Deslandes M, Guillin R, Cardinal E.* Am J Roentgenol 2008

Dynamic US of Iliopsoas

During FABER position of hip



PMT glide around MFI
MFI entrapped between PMT and SPR.

In latest phase of external rotation,
snapping of tendon around MFI

Clinical examination and ultrasound of self-reported snapping hip syndrome in elite ballet dancers. *Winston P, Awan R.* Am J Sports Med 2007

MRIof Iliopsoas

Iliopsoas-refated pain : 12– 36% of groin pain in athletes

Iliopsoas: MRI signal intensity changes - 21.0%



Follow-up MRI scans after 4 weeks
peritendinitis : signal intensity changes 9.1% → 4.5 %
muscle-strain : 6.2% → 0

Long-standing groin pain in sportspeople falls into three primary patterns: a "clinical entity" approach. *Holmich P.* Br J Sports Med. 2007
Hip joint pathology as a leading cause of groin pain in the sporting population. *Ranawat AT, Bhashyam CM, Cohen M.* Am J Sports Med. 2015
Diagnosis of acute groin injuries. *Semet A, Tol JL, Jomaah N, Weir A, Whiteley R, Holmich P.* Am J Sports Med. 2015

Cause of Iliopsoas Disorder

No clear history of trauma

68.2% peritendinitis changes

77.9% muscle-strain changes

Inappropriate training

: excessive abdominal-muscle exercise

excessive stair-running exercise

long kicking

Iliopsoas Disorder in Athletes with Groin Pain: Prevalence in 638 Consecutive Patients Assessed with MRI and Clinical Results in 114 Patients with Signal Intensity Changes in the Iliopsoas. Sadanori Tomioka, Soshun Niwa, Tetsuhiro Nibu. JBJS Open Access 2018

Cause of Iliopsoas Disorder

Coexisting other lesion – MRI SI changes

Muscle-strain changes : 27.9%

Peritendinitis changes : 53.0%

→ **Multiple lesions:**

Pubic superior ramus BMI

Avulsion fracture: AIIS, ASIS, ischial tuberosity

Fatigue fracture: inferior pubic ramus, femoral shaft

Muscle injury : Adductor, obturator, Abdominal oblique, Rectus abdominis

Labral tear and femoroacetabular impingement

Multiple coexisting other lesion :

peritendinitis ↑↑ → longer RTP

Iliopsoas Disorder in Athletes with Groin Pain: Prevalence in 638 Consecutive Patients Assessed with MRI and Clinical Results in 114 Patients with Signal Intensity Changes in the Iliopsoas. Sadanori Tomioka, Soshun Niwa, Tetsuhiro Nibu. JBJS Open Access 2018

Physical Exam of Iliopsoas

Palpation



Thomas test

: Knee flexion

tightness of the iliopsoas.



Knee flexion



Hip flexor stretching

Strength test

: pain & weakness of iliopsoas

resisted hip flexion 90



Treament

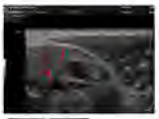
1)Muscle-strain type

Rehabilitation program

Phase I (7 Days) ①Pain control
②Mobilization
③Isometric Ex with progressive intensity increase

Phase II (7 Days) ① Active & passive stretching
② Concentric Ex
③ Straight run & sprinting training
④ Proprioceptive training
⑤ MRI & US imaging - **hematoma aspiration**

Phase III (7 Days) ① pain or tenderness during muscle palpation(-)
② pain on passive & active stretching(-)
③ pain on isometric, concentric & eccentric contractions(-)
④ Completion of the rehabilitation program.
⑤ MRI &nd US imaging - **hematoma aspiration**





Treatment

2) Tendinitis or Snapping

iliopsoas-specific dynamic stretching & strengthening
range of motion exercises, pelvic mobilization

US-guided steroid injection of the iliopsoas



Arthroscopic release of the iliopsoas tendon



Rehab of Iliopsoas

Iliopsoas

: Hip flexion of 30–60°, active straight leg raise (ASLR) Ex. : increasingly activation

MVIC activity : ASLR, 60°hip flexion : >60%

ASLR, 45°hip flexion : 40–60%

Increased hip flexion Ex. : greater activation of iliopsoas

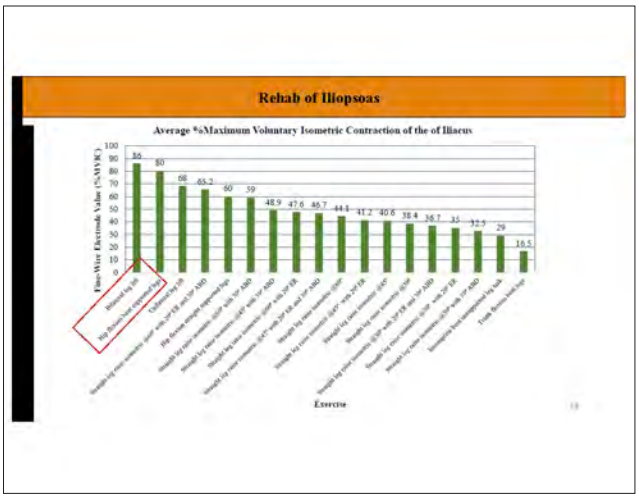
Straight leg isometric of hip flexion at 30, 60

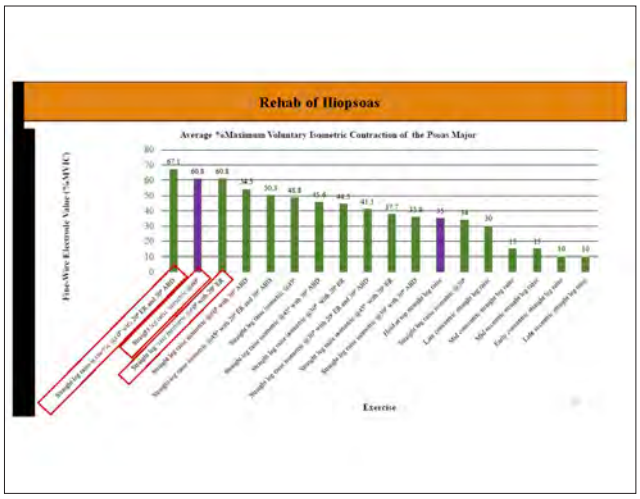


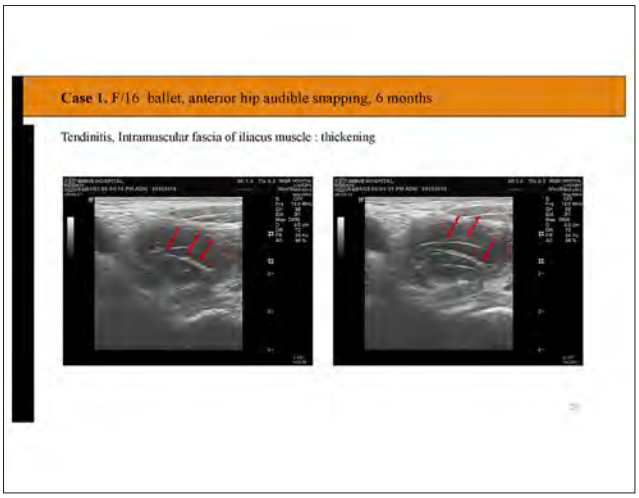
Standing ipsilateral hip flexion isometric at 30, 60

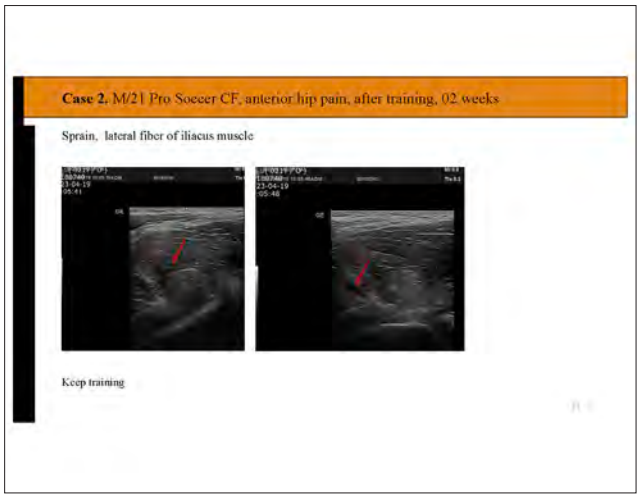


Hip Flexor Muscle Activation During Common Rehabilitation and Strength Exercises. Jessica Juan, Gretchen Leff, Kate Kerwhker J. Clin. Med. 2021.

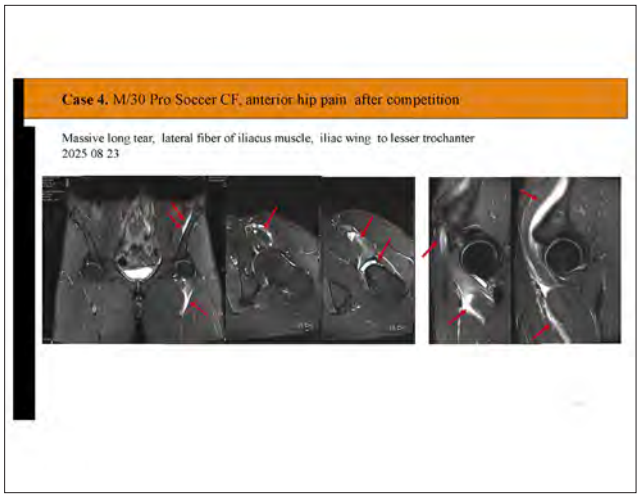

Rehab of Iliopsoas
Average %Maximum Voluntary Isometric Contraction of the of Iliacus
Fine-Wire Electrode Value (%MVIC)
Exercise


Rehab of Iliopsoas
Average %Maximum Voluntary Isometric Contraction of the Psoas Major
Fine-Wire Electrode Value (%MVIC)
Exercise


Case 1. F/16 ballet, anterior hip audible snapping, 6 months
Tendinitis, Intramuscular fascia of iliacus muscle : thickening


Case 2. M/21 Pro Soccer CF, anterior hip pain, after training, 02 weeks
Sprain, lateral fiber of iliacus muscle
Keep training


Case 3. M/19 Univ. Soccer, MF, Rt inguinal pain after Kick training
Strain, Medial fiber of iliacus muscle around PMT
RTP : 3 weeks


Case 4. M/30 Pro Soccer CF, anterior hip pain after competition
Massive long tear, lateral fiber of iliacus muscle, iliac wing to lesser trochanter
2025 08 23

Case 4. M/30 Pro Soccer CF, anterior hip pain after competition

Massive long tear, lateral fiber of iliacus muscle, iliac wing to lesser trochanter
2025 08 28


Hematoma on LFI

aspiration

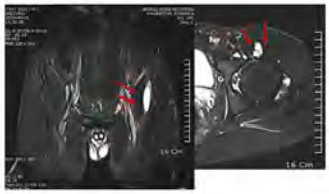
2025 09 05


Hematoma on LFI

aspiration

Case 4. M/30 Pro Soccer CF, anterior hip pain after competition

Massive long tear, lateral fiber of iliacus muscle, iliac wing to lesser trochanter
2025 09 25



Hematoma on LFI

aspiration

Case 4. M/30 Pro Soccer CF, anterior hip pain after competition

Massive long tear, lateral fiber of iliacus muscle, iliac wing to lesser trochanter
2025 10 27



RTP : 8 weeks

Conclusion

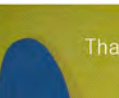
Athletes with groin pain
- **iliopsoas** : MRI SI change - 21.4%

Longer time to Return to play
- Pectendinitis >> Muscle strains
- Coexisting other lesions : multiple lesions >> single etiology

iliopsoas tendon snapping
- FABER → neutral position
- Intramuscular Fascia of Iliacus Muscle - thickening

Rehab : active straight leg raise, hip flexion Ex. 30-60° Ex
greater activation of iliopsoas

Thanks for your attention !!



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2026 Saegang SPC



2026 전북 현대 모터스 FC Medical Team




N team 박인혁

U18 송진범

U15 오인석

제갈혁

학력

한양대학교 의과대학 의학과 학사

주요 경력

(재) 전문무용수지원센터 무용재활트레이너 양성과정 전문강사
유니버셜발레단 줄리아발레아카데미 주치의
국립현대무용단 자문의
(사) 대한스포츠의학회 대의원

현재 소속 및 직위

본본정형외과 대표원장

대표논문

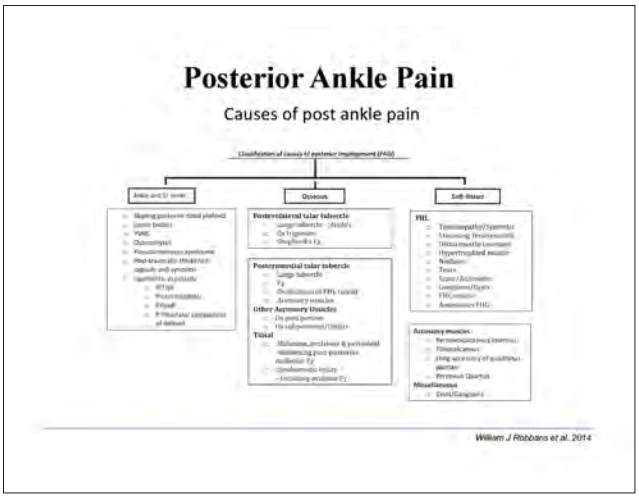
Jegal H, Park YU, Kim JS et al. Accessory navicular syndrome in athlete vs general population. Foot Ankle Int. 2016.

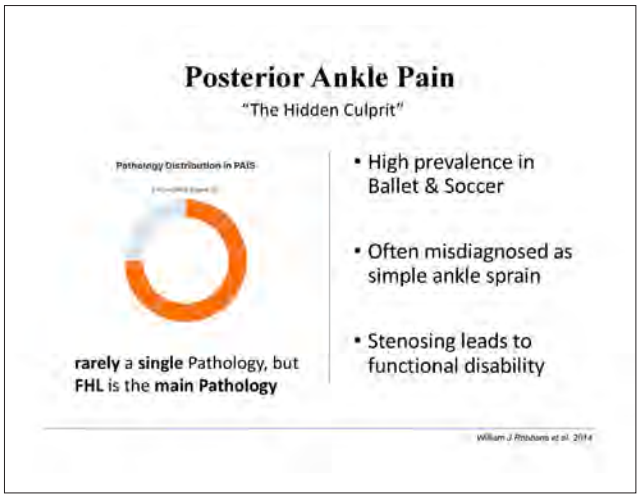
Lee KT, Jegal H, Kim KC et al. Conservative treatment of refractures after modified tension band wiring of fifth metatarsal base stress fractrues in athletes. J Orthop Surg. 2020.

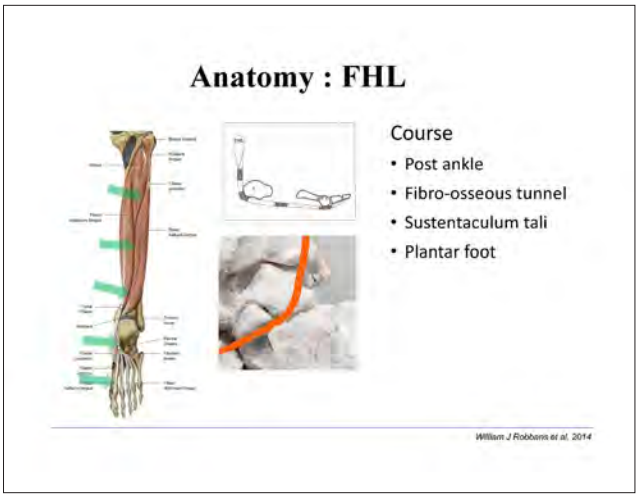
Lee KT, Jegal H, Kim SJ. Return to play after open calcaneoplasty for insertional achilles tendinopathy with haglund deformity in competitive professional athletes. Orthop J Sports Med. 2021.

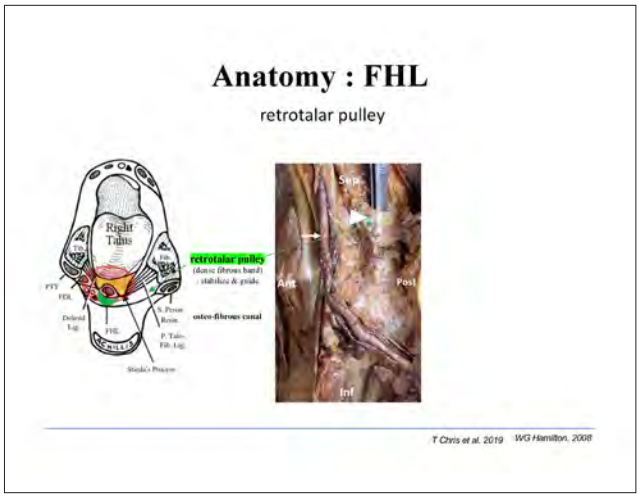
발목 뒤가 아프고 땡겨요 (장무지굴건염)
Flexor hallucis longus tendinitis

부천 본본정형외과
제갈혁









Dancer's Achilles tendon



The **FHL tendon** keeps this **alignment alive**

- *"achilles of the foot"*
- *"dancer's achilles tendon"*

"overuse syndrome"

Don Quixote – Kitri Solo variation, Marianela Nunez, Royal Ballet and Opera

Pathophysiology, FHL

움직이는 건과, 고정된 pulley사이에서 생기는 **"dynamic impinge"**



1. (Repeated) maximal plantarflexion (abrupt direction change of FHL tendon)
2. ↑contract pressure (compression/ shearing force) btw FHL & pulley (dense fibrous band btw medial/ lateral tubercles) at the pulley zone
3. inflammation between the tendon and synovial sheath.
4. Synovial tenosynovitis (to microtrauma : fraying, partial attrition)
5. Impingement developes

T Chris et al. 2019

Pathophysiology

움직이는 건과, 고정된 pulley사이에서 생기는 **"dynamic impinge"**



6 ballet dancer,
3.0T open MRI in en-pointe position

1) **incongruent** talocrural joint.
2) **anterior translation of talus**
secondary to the fulcrum and lever system created by the bones articulating posteriorly.
3) fluid collection, small ganglion cysts

Jeffery A Russell, 2015

Pathophysiology

(static) **Stenosing tenosynovitis** in tunnel



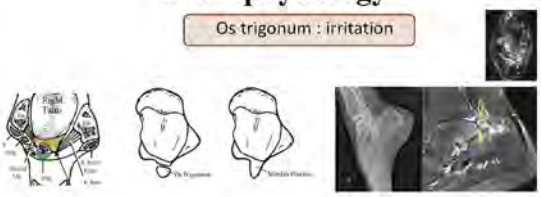
Chronic friction drives **synovial hypertrophy,** inflammation, edema
Narrowing and fibrous adhesion within fibrous osseous tunnel of S. tali

This results in **"mechanical stenosis tenosynovitis"** like ***"de Quervain dz."***

Ankle Joint Arthroscopy, Springer

Pathophysiology

Os trigonum : irritation

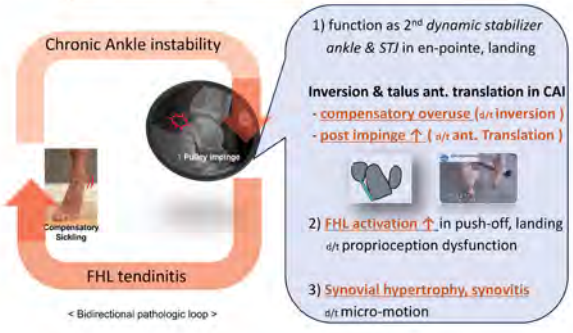


1. **Occupying effect** : decrease retrotalar space → **aggravate pulley impinge**
2. **Soft tissue impinge** : post. capsule, ligaments btw tibia & OT
3. Obstacle between tibia & calcaneus (**Nutcracker mechanism**)
bone to bone impinge, stress reaction

Berdia Z et al 2015, Peterson et al. 2003, WG Hamilton, 2008

Combined with Chronic ankle instability

Dynamic malalignment + compensatory FHL overload



< Bidirectional pathologic loop >

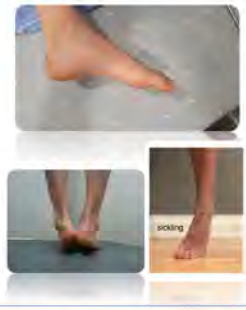
1) function as 2nd *dynamic stabilizer ankle & STJ* in en-pointe, landing

Inversion & talus ant. translation in CAI
- compensatory overuse (d/t inversion)
- post impinge ↑ (d/t ant. Translation)

2) FHL activation ↑ in push-off, landing
d/t proprioception dysfunction

3) Synovial hypertrophy, synovitis
d/t micro-motion

Symptom



- Posteromedial ankle pain
- Pain during push-off
- Hallux motion pain
- Snapping sensation

- Floor to heel height difference
- Impaired performance

Rietveld ABMD et al. 2018 Russel et al. 2008

P/Ex. & x-ray



Diagnosed clinically

- Tenderness on posteromedial ankle
- **Thomasen sign** : ankle P/F + 1st MTP joint D/F : pain (-)
  ankle D/F + 1st MTP joint D/F : pain (+)



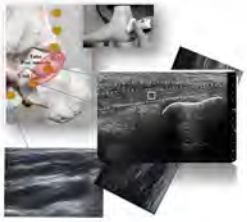
- **FHL stretch test** : ankle D/F + 1st MTP joint D/F
  < 10 degree : *FHL entrapment* in fibro-osseous tunnel
- **Pointe provocation test** : painful at ankle plantar flexion
  os trigonum

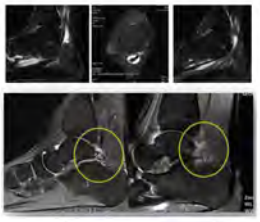


demi-pointe position in x-ray
- check *bony approximation*
- check the size, OT / Stieda process

Michelson JD et al. 2021 Rietveld ABM et al. 2018. Brad R. Moser. 2011

Ultrasound/ MRI



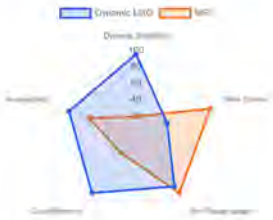


fluid collection
Increased thickness (>3mm)
Hypoechoic

HIS in bone, soft tissue
: edema & inflammation
synovial hypertrophy

Mikkelsen P et al. 2024 KT Lee et al. 2013

Ultrasound/ MRI



MRI
- tenosynovitis
- Tendon thickening
- Fluid, edema

Dynamic USG
- Tendon motion
- Crepitus
- Stenosis detection

Mikkelsen P et al. 2024 KT Lee et al. 2013

Conservative Treatment

friction 감소 + 활주 회복, tendon load 감소

- **Activity modification, Biomechanical unloading**
  - restrict en-pointe, releve position or control the strength exercise modification (dose control)
  reduce forefoot overload strengthening exercise, intrinsic foot muscle

- **Tendon (low load) stretching**

RS Zeller et al. 2011

Clinical Orthopaedics and Related Research®

What Is the Efficacy of a Nonoperative Program Including a Specific Stretching Protocol for Flexor Hallucis Longus Tendonitis? *Level of Evidence: Level III, therapeutic study.*

James D. Michelson MD*, Jacob W. Bernknopf BA†, Mark D. Charlson MD*, Stephen J. Mercer DPM‡, Lara M. Stone DPM‡

스트레칭 프로토콜 : 1st MTP joint D/F on small book + ankle D/F with knee bending, foot sole kept on the ground · 30 seconds, 3 times, 3~4 times / day, 6주

Q1) what proportion of patients thus treated opted not to have surgery?

Success rate : **44%** (**180**/409)

Surgery avoidance

56% (**164**/259) in stretching

14% (**16**/114) in non-stretching

Q2) The factors associated with patient's decision to undergo surgery

Table 4. Multivariable regression for predictive factors for the decision to have surgery*

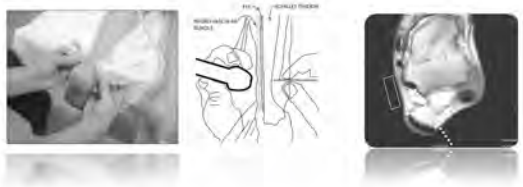
Predictive factor	OR (95% CI)	p value
Posteromedial ankle pain	1.78 (1.12-2.83)	0.01
Arch tenderness	0.56 (0.34-0.92)	0.02
max VAS (before treatment)	1.15 (1.06-1.25)	0.001
Clinical hallux rigidus†	3.4 (1.16-4.97)	0.02
FHL stretches	0.15 (0.06-0.27)	< 0.001
Predictive value	67.5%	

Conservative Treatment

friction 감소 + 활주 회복, tendon load 감소

- Medication
- Physical therapy

Injection

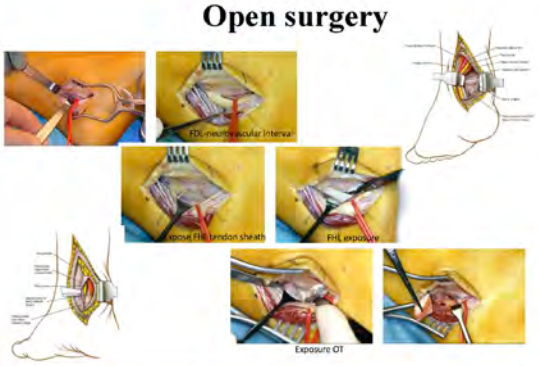


RS Adler et al 2007

Surgical Treatment

- **Failure to conservative** Tx. For 3~6 months
  - triggering with bigtoe ROM
  - depending on the cause.
    ; os trigonum, low-lying muscle belly, cyst etc.
    associated dz. : CAI
- **Open surgery**
  only post impingement ; posterolateral approach
  only FHL or combination with FHL and impingement ;
  posteromedial
- **Arthroscopic release**

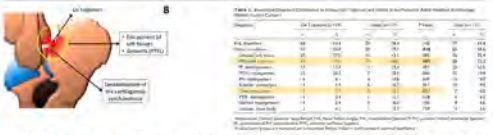
Open surgery



Textbook: Surgical exposures in foot and ankle ankle surgery Rietveld ABMD et al. 2018 Hyer J et al. 2016

Arthroscopic release

Superior visualization in identifying and addressing associated lesions.



PAIS is often multifactorial, and arthroscopy allows thorough evaluation and treatment of these concomitant conditions

Naoime Salmao Barbachan Mansur et al. 2024
Berman Z et al. 2016



access to concomitant FHL pathology is limited

Chamnni Rungprai et al. 2015

Return to performance

Pointe Functional Tests

- **Turning Control**
  : Topple test
  1 success
- **Lower limb Stability**
  : Airplane test
  > 4 success in 5
- **Jump & Landing capacity**
  : Saute test
  > 8 success in 16



J Chris Coetzee et al. 2015

Summary

- **FHL pathology**
  pain originate from friction impingement at retrotalar pulley

often progress to stenosing tenosynovitis
interface pathology, tendon hypertrophy
os trigonum is a aggravator & co-lead actor

- **First, conservative Treatment**
  target gliding restoration and decompression load control
  stretching / strengthening exercise, ESWT, injection
- **Surgical Treatment when conservative Tx. Fails**
  decompression and address combined pathology
  posterolateral approach : shortest approach to OT
  posteromedial approach : superior visualization FHL
  arthroscopic release : identify associated pathology


" Understand the mechanics,
address the pathology and
bring the dancer back to the
stage "

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

3월 21일(토요일)

Room B



The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

심포지엄 3:

밀라노·코르티나담페초 동계올림픽을 위한 맞춤형 스포츠과학지원

Customized Sports Science Support for the Cortina d'Ampezzo Winter Olympics (스포츠과학위원회1)

좌장: 동국대학교 정진욱, 대구대학교 이종삼



임정준

학력

상명대학교 스포츠건강관리학과 학사

서울대학교 사범대학 체육교육과 석사

서울대학교 사범대학 체육교육과 박사

주요 경력

한국운동생리학회 상임이사

대한스포츠의학회 스포츠과학위원회 위원

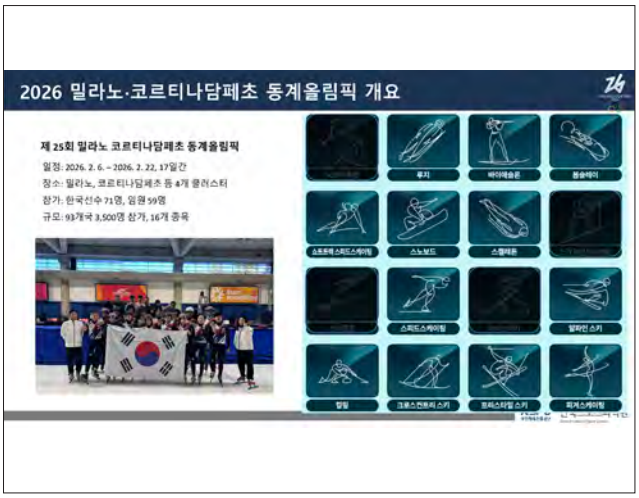
전) 서울대학교 체육교육과 연구교수

현재 소속 및 직위

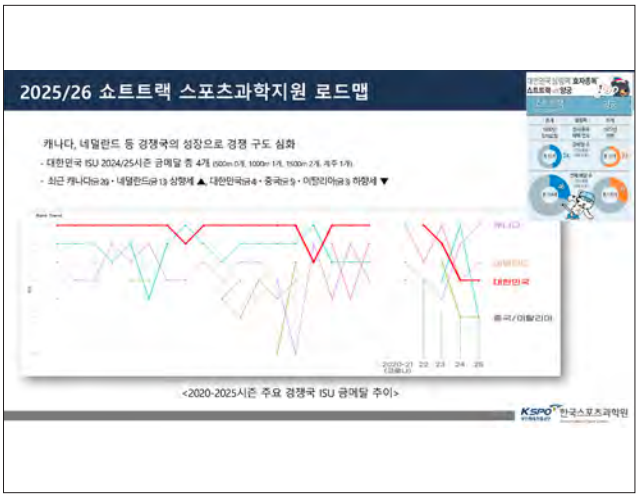
한국스포츠과학원 국가대표스포츠과학지원센터 연구위원

쇼트트랙 선수를 위한 체력 & 컨디셔닝 지원
Physical Fitness & Conditioning Support for Short Track Athletes

한국스포츠과학원
임정준









2025/26 쇼트트랙 스포츠과학지원 로드맵

쇼트트랙 전담팀 편성을 통한 집중 지원 체계 구성: Total Care

- 다전공 간 융합을 통한 스포츠과학 집중지원 및 고도화 전략 마련 목표
- 총 14명 편성 지원(연구위원 3명, 분석연구원 11명)



2025/26 쇼트트랙 스포츠과학지원 로드맵



스포츠과학 현장지원 세부내용

국가대표 선수의 일일 훈련 스케줄

06:00 - 08:00 새벽 훈련 13:30 - 16:00 오후 훈련 16:30 - 18:00 지상 훈련 20:00 - 보강 훈련



퍼포먼스 & 컨디션 모니터링 데이터 수집

1. Conditioning monitoring

- 설문지(피로, 수면, 영양 등)
- 안정 시 & 훈련 전-중-후 심박수 변화
- 혈액지표 분석 (젖산염, 크레아틴 키나아제)
- 운동자각도
- Countermonvement Jump, CMJ

CMJ는 퍼포먼스와 컨디션 평가를 위해 최근 가장 많이 활용되는 가성비 측정



퍼포먼스 & 컨디션 모니터링 데이터 수집 [CMJ]

☑ 스프린트와 CMJ의 상관관계

- 육상, 축구, 농구, 럭비 등 여러 종목에서 검증된 도구
- CMJ **점프 높이와 스프린트:** 부적상관 (r = -0.56 ~ -0.73, p< 0.01)
- CMJ **최대 파워와 스프린트:** 부적상관 (r = -0.61 ~ -0.86, p< 0.01)

☑ 신경근 피로와 CMJ간의 관계

- CMJ는 신경근 피로의 평가의 매우 주요한 요인으로 인정
- 다양한 연구에서 높은 신뢰도 지표(ICC ≥ 0.88, CV ≤ 5%) 보고



퍼포먼스 & 컨디션 모니터링 데이터 수집 [CMJ]

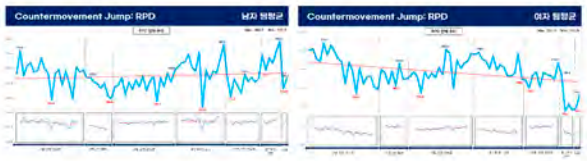
국가대표 선수 전원을 대상으로 지면반력기 활용
CMJ 주 5일 추적 관찰(2025. 07~ 2026. 01)

* **Jump height:** 근파워 향상의 대표적인 추적 지표
* **Peak Power:** 높은 폭발력 훈련의 효과 감지
* **Mean Power:** 훈련 누적 효과의 모니터링 용이
* **Reactive Strength Index (RSI):** 피로 누적시 빠르게 감소
* **Rate Power Development (RPD):** 피로, 비대칭성 평가



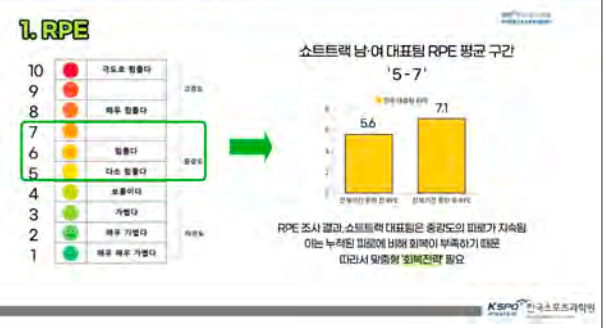
KSPO 한국스포츠과학원

퍼포먼스 & 컨디션 모니터링 데이터 수집 [CMJ]



KSPO 한국스포츠과학원

국가대표 선수의 피로 누적 호소



KSPO 한국스포츠과학원

2026 밀라노•코르티나담페초 동계 올림픽: Fast Recovery



2026 밀라노•코르티나담페초 동계 올림픽: 영양



KSPO 한국스포츠과학원

2026 밀라노•코르티나담페초 동계 올림픽: 영양

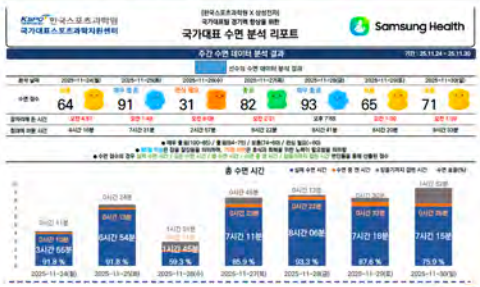


KSPO 한국스포츠과학원

2026 밀라노•코르티나담페초 동계 올림픽: 수면



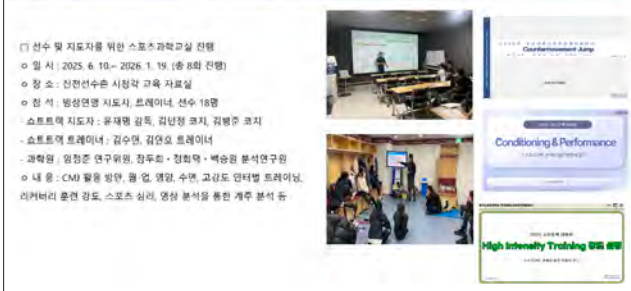
2026 밀라노•코르티나담페초 동계 올림픽: 쇼트트랙



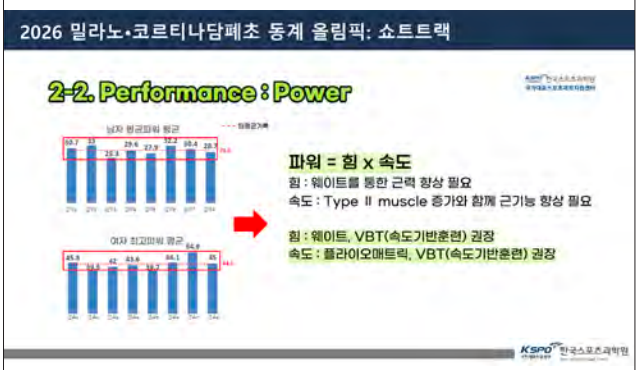
2026 밀라노•코르티나담페초 동계 올림픽: 쇼트트랙



지도자-선수 소통을 위한 스포츠과학교실 운영



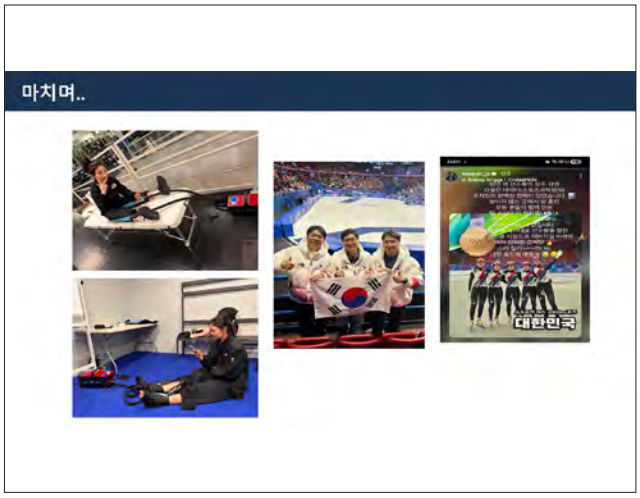
2026 밀라노•코르티나담페초 동계 올림픽: 쇼트트랙



2026 밀라노•코르




유산소 능력 강화를 '개인화 훈련프로그램' 제공
초개인화, 정밀훈련
반응자
= 체력 향상
= 경기력 향상
① 훈련 강도 설정
② 훈련 강도 변동성
③ 컨디셔닝(영양, 회복)
무반응자
= 체력 유지/저하
= 경기력 유지/저하
KSPO 한국스포츠과학원


마치며..
대한민국


한계를 넘어서는 순간
"스포츠과학, 문제와 답은 현장에 있다"
"경기력 향상을 위한 1%에 최선을 다하겠습니다."

박상헌

학력

한국체육대학교 노인체육복지학과 학사
한국체육대학교 일반대학원 체육학과(운동역학전공) 석사
한국체육대학교 일반대학원 체육학과(운동역학전공) 박사

주요 경력

한국운동역학회 이사, 한국스포츠코칭학회 상임이사, 한국체육학회 청년위원회 위원,
아시아운동역학회 최우수발표자상(The Best Oral Presentation) 수상,
한국운동역학회 우수발표자상(The Excellent Presentation) 수상

현재 소속 및 직위

국민체육진흥공단 한국스포츠과학원 차세대스포츠과학지원센터, 선임연구위원

대표논문

1. Park et al. The Effects of Kinematic Variables and Sequence during Horizontal Bar Swing in Gymnastic: a Case Study. Korean Journal of Applied Biomechanics. 2023.
2. Kim, Kil, Lee, Jang & Park. Analysis of the Force Characteristics of Seoi-nage based on the Performance Height of Elite Male Judo Athletes. International Journal of Applied Sports Sciences. 2022.
3. Park & Yoon. Validity Evaluation of an Inertial Measurement Unit (IMU) in Gait Analysis Using Statistical Parametric Mapping (SPM). Sensors. 2021.

롱트랙 스피드 스케이팅 선수를 위한 운동 역학적 지원
Biomechanical Support for Long Track Speed Skating Athletes

한국스포츠과학원
박상헌









現 차세대 스피드스케이팅 선수(국가대표, 국가대표 후보, 청소년 대표 등)

종목별 동작 분석을 통하여 그 특징을 파악하고,
선수들의 세부 종목 선정 및 훈련을 위한 기초정보를 제공하는데 있음



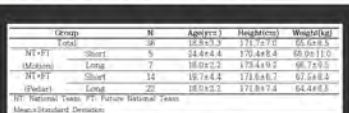


한국스포츠과학원

사단법인 대한스포츠의학회
The Korean Society of Sports Medicine

연구방법

- (대상자) 現 대한민국 국가대표, 후보 및 청소년 대표 선수(국가대표 10명(남3, 여7), 후보 및 청소년 대표 선수 26명(남 16, 여 10)), 총 36명
- 최근 6개월간 근골격계 상해 無
- 생명윤리위원회(IRB) 승인, 충분한 설명과 동의서 작성 후 진행



Group		N	Age(yrs)	Height(cm)	Weight(kg)
Total		36	15.8±3.3	171.7±7.0	65.6±8.5
NT+FT (Makers)	Short	5	14.4±4.4	170.4±8.4	68.9±11.0
	Long	7	16.0±2.2	173.4±9.2	66.7±9.5
NT+FT (Pedar)	Short	14	15.7±4.4	171.6±6.7	67.5±8.4
	Long	22	16.0±2.2	171.8±7.4	64.4±8.3

NT: National Team, FT: Future National Team
Mean±Standard Deviation



Group		N	Sex
NT+FT (Makers)	500m	Male	2
		Female	1
	3,000m	Male	3
		Female	4
NT+FT (Pedar)	500m	Male	7
		Female	7
	3,000m	Male	13
		Female	15

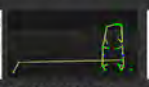
NT: National Team, FT: Future National Team
Mean±Standard Deviation

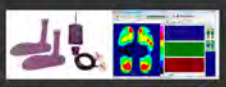
연구방법

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- 생명윤리위원회(IRB) 승인, 충분한 설명과 동의서 작성 후 진행

- 국가대표 : (장비) 적외선카메라(Oqus 300+, Qualysis, Sweden: 200 Hz), 족저압측정장비(Pedar, Novel, Germany: 100 Hz),

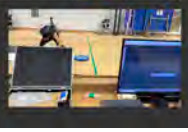






슬라이드보드(60cm×240cm, GOLD ICE, Korea)





연구방법

- (대상자) 現 대한민국 국가대표, 후보 및 청소년 대표 선수(국가대표 10명(남3, 여7), 후보 및 청소년 대표 선수 26명(남 16, 여 10)), 총 36명
- 최근 6개월간 근골격계 상해 無
- 생명윤리위원회(IRB) 승인, 충분한 설명과 동의서 작성 후 진행

- 후보 및 청소년 대표 선수 : (장비) 관성센서(IMU,Noraxon, USB: 400 Hz), 족저압측정장비(Pedar, Novel, Germany: 100 Hz),

IMU 장비, 분석에서 "품질 저하" 제외
- (오차 누적) 장거리 선수들의 경우 1분 이상의 데이터 취득으로 캘리브레이션 drift 오차 누적
(데이터 화곡) 슬라이드 보드 사이드 터치로 인한 핵심 발분절의 데이터 화곡

슬라이드보드(60cm×240cm, GOLD ICE, Korea)



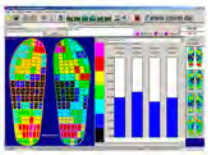


연구방법

- (측정프로그램) Qualisys Track Mansger(Qualysis, Sweden)

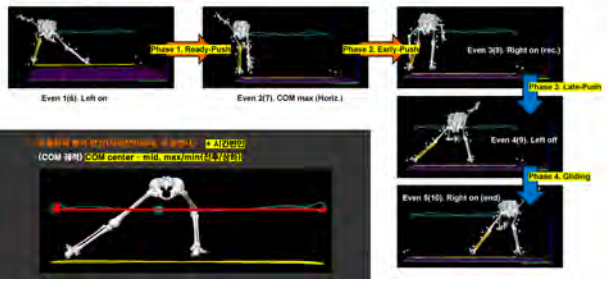


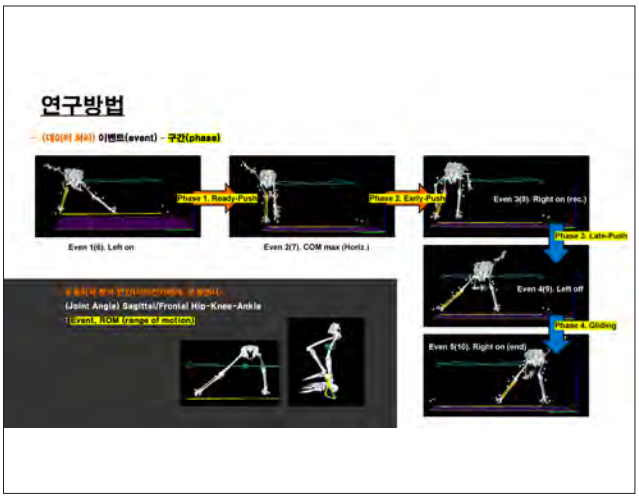
Pedar-X(Novel, Germany)

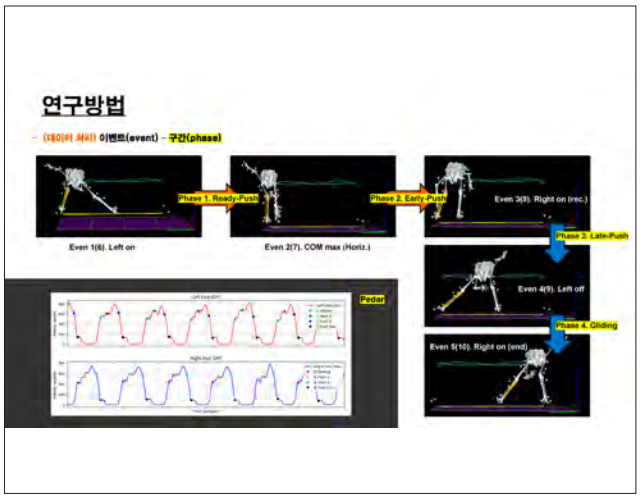


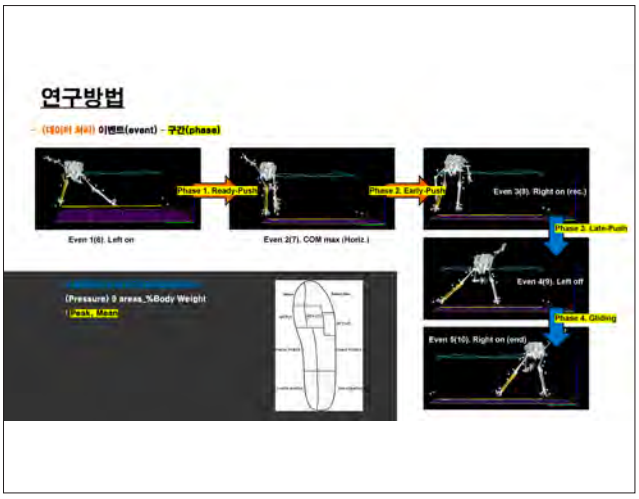
연구방법

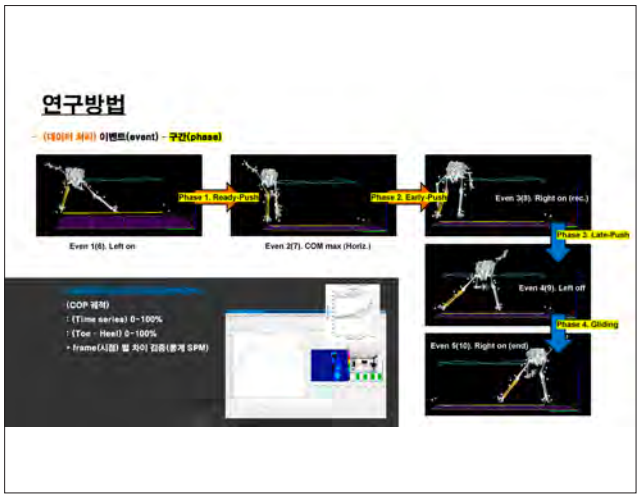
- (데이터 처리) 이벤트(event) - 구간(phase)

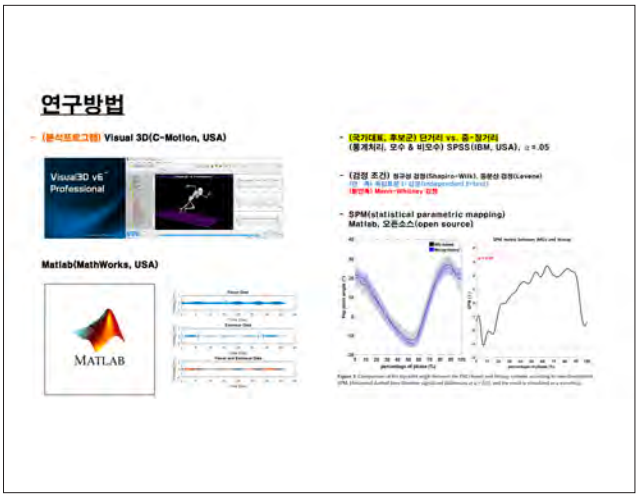



연구방법
- (데이터 처리) 이벤트(event) - 구간(phase)
Phase 1. Ready-Push
Phase 2. Early-Push
Phase 3. Late-Push
Phase 4. Gliding
Even 1(6). Left on
Even 2(7). COM max (Horiz.)
Even 3(8). Right on (rec.)
Even 4(9). Left off
Even 5(10). Right on (end)
(Joint Angle) Sagittal/Frontal Hip-Knee-Ankle
(Event, ROM (range of motion)


연구방법
- (데이터 처리) 이벤트(event) - 구간(phase)
Phase 1. Ready-Push
Phase 2. Early-Push
Phase 3. Late-Push
Phase 4. Gliding
Even 1(6). Left on
Even 2(7). COM max (Horiz.)
Even 3(8). Right on (rec.)
Even 4(9). Left off
Even 5(10). Right on (end)
Pedar


연구방법
- (데이터 처리) 이벤트(event) - 구간(phase)
Phase 1. Ready-Push
Phase 2. Early-Push
Phase 3. Late-Push
Phase 4. Gliding
Even 1(6). Left on
Even 2(7). COM max (Horiz.)
Even 3(8). Right on (rec.)
Even 4(9). Left off
Even 5(10). Right on (end)
(Pressure) 9 areas_%Body Weight
Peak, Mean

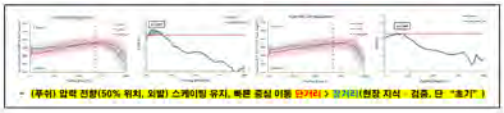

연구방법
- (데이터 처리) 이벤트(event) - 구간(phase)
Phase 1. Ready-Push
Phase 2. Early-Push
Phase 3. Late-Push
Phase 4. Gliding
Even 1(6). Left on
Even 2(7). COM max (Horiz.)
Even 3(8). Right on (rec.)
Even 4(9). Left off
Even 5(10). Right on (end)
(COP 궤적)
: (Time series) 0~100%
: (Toe - Heel) 0~100%
* frame(시점) 별 차이 검증(본계 SPM)


연구방법
- (분석프로그램) Visual 3D(C-Motion, USA)
Visual3D v6 Professional
Matlab(MathWorks, USA)
MATLAB
- (독립대응, 후보군) 단거리 vs. 장-장거리
(통계처리, 오수 & 비오수) SPSS(IBM, USA), α=.05
- (검정 조건) 정규성 검정(Shapiro-Wilk), 등분산 검정(Levene)
- SPM(statistical parametric mapping)
Matlab, 오픈소스(open source)


연구결과 및 논의(동작분석)
Sprinter
Long distance
- (시간 변인)
- (신체질량중심)
"유의한 차이 없음"
"유의한 차이 없음"
- (관절각도, Push)
(Event 4&9) 왼쪽 발목 저측굴곡각(-) 단거리(-19.12±3.17) > 장거리(-11.38±7.05)
(Phase 2) 왼쪽 엉덩관절 관상면 가동범위 단거리(34.61±9.38) > 장거리(24.67±4.84)
- (분절각도, Gliding)
(Phase 4) 왼쪽 골반분절 관상면 가동범위 단거리(4.94±1.51) > 장거리(2.95±1.01)
- Event 4&9 : 보드 끝에 붙어있던 발이 떨어지는 시점(최종 푸쉬-이탈)
- Phase 2 : Recovery 이후 푸쉬 시작 구간(심질적인 푸쉬)
* (푸쉬) 측면 움직임(관상면, 엉덩관절)이 강조된 스케이팅, 이상적인 푸쉬 이탈(시상면, 발목관절)
- Phase 4 : 실질적으로 글라이딩을 하는 구간(이동 방향으로의 가동일)
* (글라이딩) 글라이딩 방향으로의 골반-몸통 가동일

연구결과 및 논의(족저압)

	Sprinter	Long distance
- (시간 변인)	"유의한 차이 없음" 족저압의 발현 시간은 단거리가 짧은 경향(파워적인 측면)	
- (최대 족저압, Push) 이산변인	"유의한 차이 없음"	
- (COP 위치변화, Push) 연속변인	(foot; mm) "유의한 차이 없음" (foot; %) 왼발 : 2~18% 구간, 단거리(전방위치) > 장거리(후방위치) (foot; %) 오른발 : 18~19% 구간, 단거리(전방위치) > 장거리(후방위치)	



- (푸쉬) 압력 전환(50% 위치, 외발) 스케이팅 유지, 빠른 중심 이동 단거리 > 장거리(현장 지식 = 검증, 단 "초기")

연구결과 및 논의(족저압)

	Sprinter	Long distance
	- Phase 4 : 실질적으로 글라이딩을 하는 구간(전족의 족저압 강하게 나타남)	
- (최대족저압, Gliding) 이산변인	오른발 소족지 족저압(발끝) 단거리(32.76±12.85) > 장거리(24.05±16.65)	
- (COP 위치변화, Gliding) 연속변인	(foot; mm) "유의한 차이 없음" (foot; %) "유의한 차이 없음" CoP 위치의 변화는 Push (foot) 에서 주요 할 수 있음 (단, Gliding시 외발 유지 시간 등을 주의해서 살펴볼 필요가 있음)	



결론 및 제언

◆ (경기력 결정요인)

현장 생균원 테스

- (주요인) Push 시 발목 관절 시상면(자측) 각도▲, 엉덩 관절 관상면(가동범위) 각도▲, CoP 전방위치(초기)
  Gliding 시 골반 본절 관상면 가동범위▲(진행방향), 최대족저압 누름(전족)
- (부요인) 실제 동작 시간_외발▲(동작분석), 힘을 가하는 시간▼(족저압, 파워), 신체질량중심의 높이▼ 등

◆ (현장형 연구 추진)

- 비디오 분석만으로 가능한 대회 중 국제 우수선수들의 핵심 시간 이벤트 시계열 분석(클랩(clap), 발 동작 등)
- 스케이트 블레이드(날)의 개발 및 경기장 환경에 따른 최적화 연구

◆ (제한점)

- 관성센서의 오류 개선 및 슬라이드 보드(빅) 외 현장 적용 확대, 현장 의견(블레이드 등)을 반영한 근거기반 문제 해결 연구 등



장태석

학력

명지대학교 체육학과 학사

충남대학교 교육대학원 스포츠심리학 석사

성균관대학교 일반대학원 스포츠심리학 박사

주요 경력

2024 파리올림픽 사격 대표팀 스포츠심리 지원

2026 밀라노코르티나 동계올림픽 컬링 대표팀 스포츠심리지원

(현)한국스포츠심리학회 상임이사

(전)파라아이스하키협회 경기력 향상위원

현재 소속 및 직위

한국스포츠과학원(선임연구위원)

컬링 선수를 위한 심리지원
Mental Health Support for Curling Athletes

한국스포츠과학원
장태석

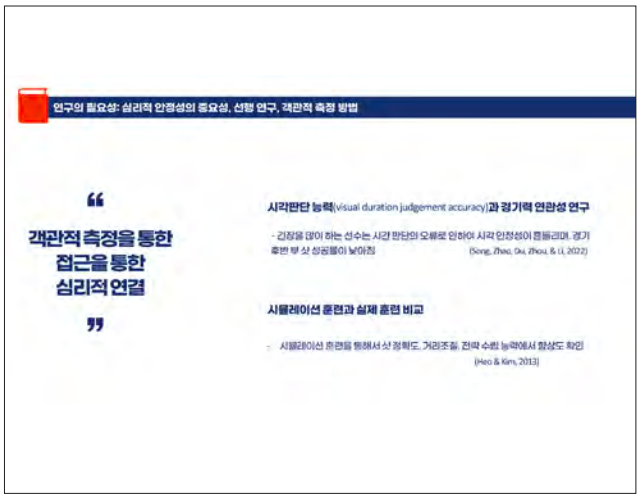


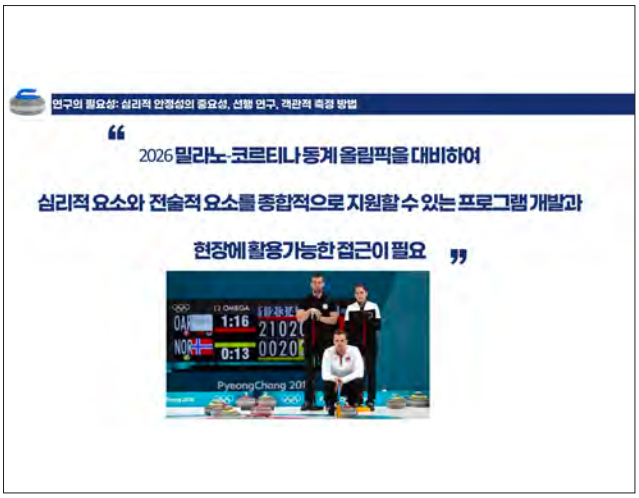







연구의 필요성: 심리적 안정성의 중요성, 선행 연구, 객관적 측정 방법
컬링과 스포츠심리
스포츠 심리적 접근
컬링 종목 선수들의 심리적 안정성이 경기 수행에 밀접


연구의 필요성: 심리적 안정성의 중요성, 선행 연구, 객관적 측정 방법
객관적 측정을 통한 접근을 통한 심리적 연결
시각판단 능력(visual duration judgement accuracy)과 경기력 연관성 연구
시뮬레이션 훈련과 실제 훈련 비교

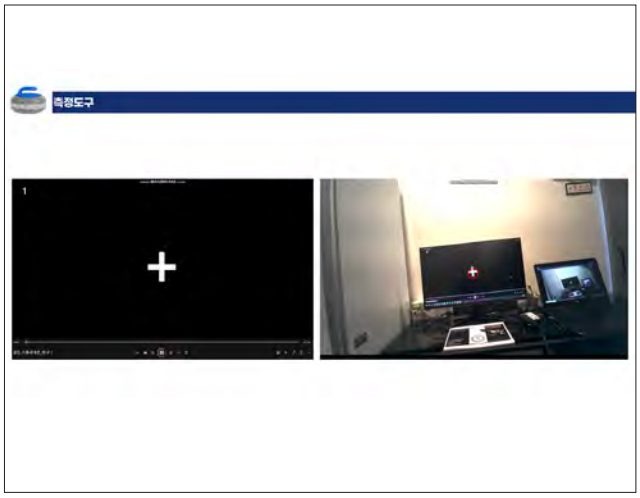

연구의 필요성: 심리적 안정성의 중요성, 선행 연구, 객관적 측정 방법
2026 밀라노-코르티나 동계 올림픽을 대비하여
심리적 요소와 전술적 요소를 종합적으로 지원할 수 있는 프로그램 개발과
현장에 활용가능한 접근이 필요


연구 목적: 심리프로그램 적용 및 효과 검증, 경기력 향상을 위한 심리적 안정성 확득
심리프로그램 개발 및 적용
- 국가대표팀 대상 프로그램 개발
- 밀라노-코르티나 올림픽 대비
- 과학적 데이터 기반 접근
경기력 향상을 위한 심리적 안정성 확득
- 객관적 측정 도구 활용
- 의사소통
- 팀 심리적 안정성 향상


연구 방법
연구 대상
- 여자 컬링대표팀 5명
- 컬링국가대표 감독 1명
[프로그램 제작]
• 세계선수권 및 그랜드 슬램 경기 200경기 수집
• 양방향 영상 촬영(스캠각도 및 라드_세컨서드)
[시뮬레이션 훈련 전 활입 목적]
• 360도 카메라로 올림픽 테스트 이벤트 촬영
• VR 시뮬레이션 훈련 프로그램 제작
자료 수집


측정도구 및 연구 절차
코르티나 경기장 VR 훈련
시뮬레이션 훈련 시 안구움직임 추적 측정
캐나다, 스코틀랜드, 스위스 대응 전술훈련


측정도구


측정도구

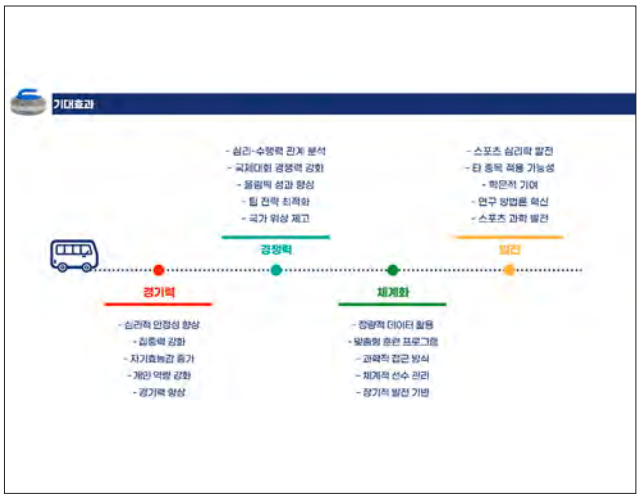

측정도구
CANADA
2022 Beijing Olympic
CANADA
End 10 선공 상황
스킵, 두번째 샷
Canada 6 : 3 Great Britain


연구 절차
1단계:
자료 수집
- 경기 영상 분석
- 선수 인터뷰
- 문헌 조사
WORLD CURLING
[세계 컬링연맹 자료 수집]
- 세계선수권 및 그랜드 슬램 경기 200경기 수집
- 올림픽 기준 10엔드 경기만 선택
- 캐나다 스위스 스코틀랜드 한국 경기 수집
[선수·지도자 인터뷰 진행]
- 상황, 시기에 따른 의사소통 어려움 요소 파악

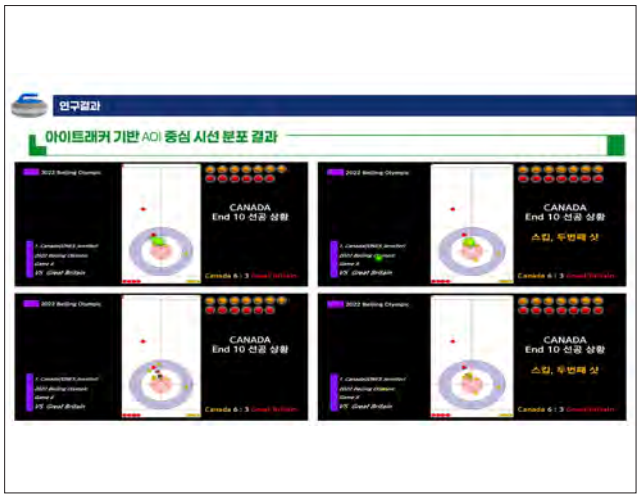

연구 절차
[코르티나 테스트이벤트]
[Gothru 프로그램 제작]
2단계:
프로그램 개발
- VR 시뮬레이션
- 심리기술훈련
- 전문가 검증
(컬링 선수출신 2명, 대표팀 감독)


연구 절차
3단계:
프로그램 적용
- 10회기 진행
- 팀 전체 참여
- 데이터 수집


자료 분석 방법
시선행동 패턴 분석
- Tobii pro lab
- AOI 설정
- 시선고정반도
- 시선이동확수
의사소통 설문지 분석
- 사전-사후 비교
- 평균 비교 분석
- 전문가 검증
심층면담 분석
- 녹음 및 전사
- 데이터 정제
- 내용분석
논리적 분석
- 대응표본 t-검증
- 히트맵 분석
- 사람스 패턴


기대효과
- 심리-수행력 관계 분석
- 국제대회 경쟁력 강화
- 올림픽 성과 향상
- 팀 전략 최적화
- 국가 위상 제고
경쟁력
- 스포츠 심리학 발전
- 타 종목 적용 가능성
- 학문적 기여
- 연구 방법론 혁신
- 스포츠 과학 발전
발전
경기력
- 심리적 안정성 향상
- 집중력 강화
- 자기효능감 증가
- 개인 역량 강화
- 경기력 향상
체계화
- 정량적 데이터 활용
- 맞춤형 훈련 프로그램
- 과학적 접근 방식
- 체계적 선수 관리
- 장기적 발전 기반


연구결과
VR(Virtual Reality) 기반 경기장 사전 노출 훈련
실제 경기 환경에 대한
심리적 현존 상태 형성


연구결과
아이트래커 기반 AOI 중심 시선 분포 결과
CANADA
End 10 선공 상황
스킵, 두번째 샷

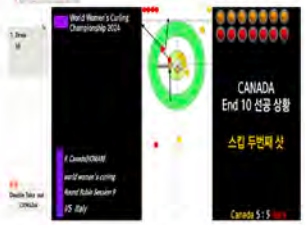

연구결과
아이트래커 기반 AOI 중심 시선 분포 결과
CANADA
End 10 선공 상황


연구결과
팀 전술 판단 및 의사소통 분석 결과
CANADA_7
CANADA_10
CANADA
End 10 선공 상황
스킵 두번째 샷
스킵 첫번째 샷

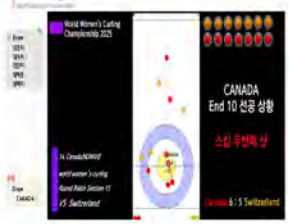
연구결과

팀 전술 판단 및 의사소통 분석 결과

CANADA_9



CANADA_14



종합논의

"경기 맥락 사전 인식 기반 심리·전술 시뮬레이션 훈련의 핵심 효과"

- VR훈련을 통한 *경기 환경 및 상황에 대한 사전 맥락 인식* 형성
- 전술 판단 시 시선과 주의가 *핵심 정보 영역 중심의 주의 조직화*
- *주의 배분 효율화 및 인지적 초점 안정화* 경향 확인

VR기반 시뮬레이션 훈련과 아이트래커 분석은 전술 판단 과정에서의 주의 배분과 인지적 초점 조직화에 기여할 수 있음

종합논의

"시선 조직화와 팀 전술 판단·의사소통의 관계"

- 전술 판단 상황에서 *심리적 안정성과 주의집중 수준 향상*
- 핵심 정보 중심의 시선 조직화를 통한 *집중력 및 판단 효율 강화*
- 공유된 주의 초점을 기반으로 *한 팀 의사소통 및 전술 합의 구조 강화*

시선 패턴의 안정화는 전술 판단에서 심리적 안정과 집중도를 높여 팀 의사소통 및 전술 합의를 용이하게 하는 것으로 해석 됨

스포츠 심리학 및 스포츠 과학 발전에 기여

"연구 기대효과"

컬링 종목 선도적 연구
- 컬링 선수 심리 특성 체계적 이해
- 맞춤형 훈련 프로그램 개발
- 과학적 접근 방식 구축

↕

타 종목으로의 적용 가능성
- 전략적 판단이 중요한 종목 적용
- 양궁, 골프, 사격 등에 활용
- 스포츠 심리학 연구 확장

연구 결과의 활용방안



"활용 방안 제시"

다양한 분야 적용 가능성
- 국가대표팀 훈련 프로그램 적용
- 스포츠 과학 기반 훈련 시스템 구축
- 스포츠 심리학 교육 자료로 활용
- 심리 훈련과 스포츠 기술 융합
- 타 종목 선수 훈련에 응용
- AI 기반 맞춤형 프로그램 개발
- 스포츠 팀 경기력 향상 도구로 활용

연구 결과의 활용방안



The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

심포지엄 5: 골프 관련 부상으로 인한 만성 근골격계 문제에 대한] 운동 기반 접근법

Exercise-Based Approaches to Chronic Musculoskeletal Problems Resulting from Sports-Related Injuries in Golf

좌장: 서울아산병원 진영수, 양산부산대병원 이창형



서용곤

학력

삼육대학교 생활체육학과 학사

고려대학교 의용과학대학원 스포츠의학과 석사

고려대학교 일반대학원 사회체육학과 박사

주요 경력

현) 고려대학교 융합과학대학원 스포츠의학과 외래강사

현) 고려대학교 의용과학협동과정 스포츠·운동의학과 외래강사

현) 대한자세의과학협회 학술이사

현) 문화체육진흥원 자문위원

현) 대한건강운동관리사협회 이사

현재 소속 및 직위

삼성서울병원 척추센터 건강운동관리사

대표논문

1. Seo YG, Oh S, Park WH, Jang M, Kim HY, Chang SA, et al. Optimal aerobic exercise intensity and its influence on the effectiveness of exercise therapy in patients with pulmonary arterial hypertension: a systematic review. J Thorac Dis. 2021;13:4530-4540.
2. Seo YG, Park WH, Oh S, Jeon ES, Choi JO, Kim HY, et al. The effect of pre-transplantation center-based cardiac rehabilitation on the postoperative quality of life and adherence to exercise in patients undergoing heart transplantation. Rev Cardiovasc Med. 2022;23:68.
3. Seo YG, Oh S, Kim HY, Jang M, Jeon MH, Sung J. Effects of Change in 6-Minute Walking Distance on Hospital Clinical Events in Patients with Pulmonary Arterial Hypertension: A Retrospective Cohort Study. Korean J Sports Med. 2025;43:145-52.

골프에서 유발되는 요추 만성 통증의 운동 기반 관리 전략
Exercise-Based Management Strategies for Chronic Lumbar Pain Induced by Golf

삼성서울병원
서용곤

골프는 반복적인 회전 동작과 비대칭적 부하가 특징적인 스포츠로, 스윙 과정에서 요추부에 상당한 기계적 스트레스를 유발할 수 있다. 특히 골프 스윙 과정 중 백스윙에서 다운스윙으로 전환되는 과정에서 발생하는 급격한 회전 가속과 체중 이동은 요추부에 회전력, 전단력, 그리고 압축력이 동시에 작용하는 환경을 형성한다. 이러한 생체역학적 특성으로 인해 요추 통증은 골퍼에서 가장 흔하게 보고되는 근골격계 문제 중 하나이며, 반복적인 미세 손상과 과사용에 의해 만성 요통으로 발전할 가능성이 높다. 최근의 생체역학 연구들은 골프 스윙 동안 발생하는 몸통 회전 속도와 요추부 토크가 요통 발생과 밀접하게 관련되어 있음을 보고하고 있으며, 특히 다운스윙 단계에서 나타나는 높은 회전 모멘트가 요추 구조물에 상당한 부하를 유발하는 것으로 알려져 있다.

골프 스윙은 하지에서 시작되어 골반, 흉추, 상지로 전달되는 운동 사슬(kinetic chain)을 기반으로 이루어지는 복합적인 전신 움직임이다. 그러나 고관절 가동성 제한이나 코어 안정성 저하와 같은 기능적 문제가 발생한 경우 이러한 운동 사슬이 원활하게 이루어지지 못하고, 그 결과 회전 움직임이 요추부에서 보상적으로 증가하게 된다. 이전 연구에서는 고관절 회전 가동성 감소와 몸통 근육의 근신경 조절 기능 저하가 golfer의 요통 발생 위험과 관련이 있는 것으로 보고되고 있으며, 이러한 요인은 골프 스윙 중 요추부에 기계적 부하를 증가시키는 주요 요인으로 제시되고 있다. 또한 최근의 연구에서는 골퍼의 움직임 패턴과 하지 기능이 요추부 부하와 밀접하게 연관되어 있으며, 특히 고관절 및 하지의 기능적 제한이 있는 경우 요추부에 전달되는 회전 토크가 증가할 수 있다는 점이 강조되고 있다.

이러한 배경에서 스포츠의학 및 재활 분야에서는 골프 관련 요추 통증의 관리에 있어 단순한 통증 감소 보다는 기능적 회복과 재발 예방을 목표로 하는 운동 기반 관리 전략을 강조하고 있다. 선행 연구에 따르면 코어 안정성 향상, 고관절 및 흉추 가동성 개선, 그리고 회전 동작에서의 근신경 조절 능력을 향상시키는 운동 프로그램은 golfer의 요추부의 통증 감소와 기능적 수행 능력 향상에 긍정적인 영향을 미칠 수 있는 것으로 보고되었다. 특히 단계적인 안정화 운동과 스포츠 특이적 움직임 훈련을 결합한 프로그램은 요추부에 집중되는 기계적 부하를 감소시키고 보다 효율적인 운동 사슬을 형성하는 데 도움이 된다.

따라서 골프에서 유발되는 요추 만성 통증의 예방과 관리를 위해서는 골프 스윙의 생체역학적 특성과 요추부 부하 기전을 이해하

는 것이 중요하며, 이를 기반으로 코어 안정성, 고관절 가동성, 그리고 회전 안정성을 통합적으로 고려한 운동 기반 관리 전략이 필요하므로 본 강의에서는 이러한 부분에 대해서 논의해 보고자 한다.

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5. Quinn SL, Olivier B, McKinon W. Lower quadrant swing biomechanics identifies golfers with increased risk of low back pain: a prospective longitudinal cohort study. J Sport Rehabil. 2022;31:1041-1051.
6. Zemková E. Amiri B, Horníková H, et al. Potential neurophysiological and biomechanical risk factors for low back pain in golfers. Sports Med Health Sci. 2024;6:123-138.
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임민우

학력

구미대학교 물리치료학과 전문학사

고려대학교 융합과학대학원 스포츠의학과 석사 수료

주요 경력

물리치료사 11년차성모튼튼정형외과

물리치료사 실장선한목자병원

물리치료 팀장강서 솔병원 / 물리치료사

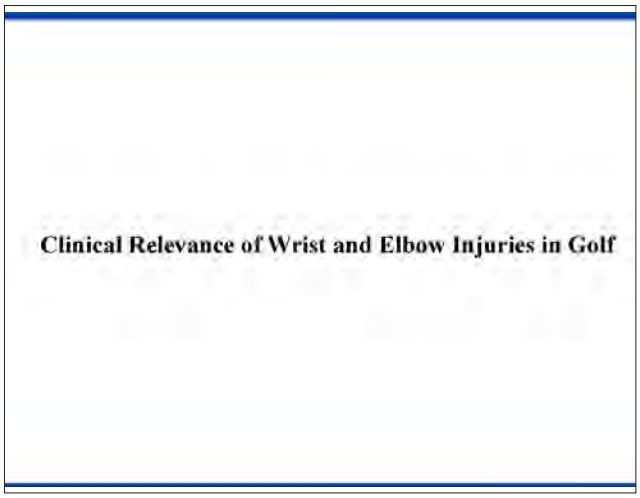
현재 소속 및 직위

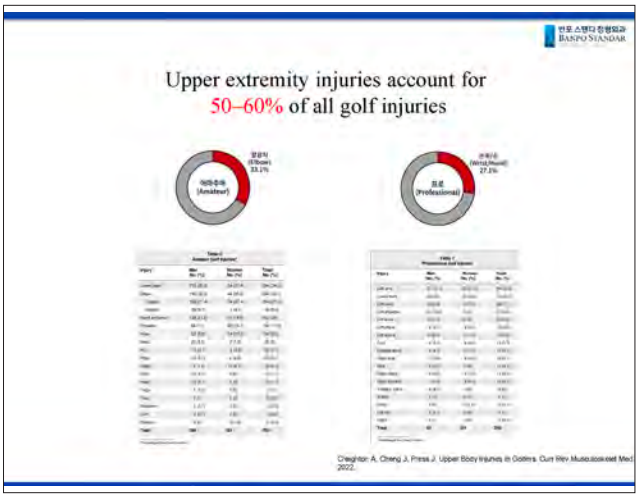
반포스탠다정형외과 물리치료실 실장

골프에서 유발되는 팔꿈치/손목 만성 통증의 운동 기반 관리 전략
Exercise-Based Management Strategies for Chronic Elbow/Wrist Pain Caused by Golf

반포스탠다 정형외과
임민우









Golf Swing–Related Wrist and Elbow Injury Mechanisms

Back swing
Top of Backswing

- **Lead-arm**
  - End-range repetition · Over-cocking → ↑ radial-sided wrist stress (De Quervain's)

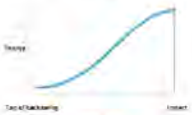


Golf Swing–Related Wrist and Elbow Injury Mechanisms

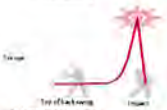
Down swing



- **Lead-arm**
  - Arm-dominant down swing / casting → ulnar-sided wrist stress → TFCC-ECU overload
  - Torque increases monotonically from early downswing
  - Trajectory guidance



- **Trail-arm**
  - sharp torque rise
  - energy transfer preparation
  - flexor-pronator loading begins



Golf Swing–Related Wrist and Elbow Injury Mechanisms

Impact

- Fat shots / divots / ground resistance → sudden deceleration + impact

→ ↑ ulnar-sided & palmar wrist stress (TFCC / ECU / hook of hamate)
→ ↑ medial & lateral epicondyle stress (ECRB/ flexor group eccentric loading)



- **Lead-arm**



Rotation(torsion) ↑
Eccentric loading ↑

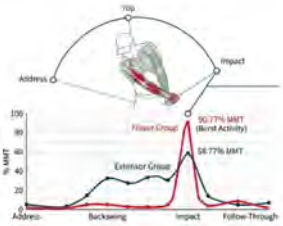
Excessive Grip ↑

Golf Swing–Related Wrist and Elbow Injury Mechanisms

Impact

- **Trail-arm**
  - Right-hand torque is approximately threefold greater than left-hand torque.
  - Peak energy transfer occurs at impact. (burst flexor activation)
  - It acts as the primary engine generating club rotational speed.





Exercise-Based Management Strategies

The Need for Exercise-based Strategies

- Repetitive load + sudden deceleration + high torque
- Tendinopathy rather than simple inflammation
- Exercise-based loading is guideline-supported
- Load–capacity matching
- Progressive exposure
- Kinetic-chain rehabilitation

Exercise-based management strategies for the wrist and elbow

1

Phase 1 | Start within the patient's pain tolerance

- Isometric wrist extension/flexion/pronation/supination: 30–45 s × 4–5 sets
- Scapular and trunk stabilization exercises
- Goal: symptom control + introduction of initial loading



Exercise-based management strategies for the wrist and elbow

2

Phase 2 | Capacity restoration through slow resistance loading

- Progressive resistance to restore tendon and muscle load capacity
- Slow, controlled loading with symptom monitoring
- Wrist extensor/flexor and forearm pronation–supination strengthening
- Grip endurance and proximal kinetic-chain integration



Exercise-based management strategies for the wrist and elbow

3

Phase 3 | Reactive swing-based movement and sport-specific integration

- Plyometric exercise
- Retraining eccentric braking and rebound through short stretch-recoil movements







Thank you for your attention

문찬웅

학력

장안대학교 운동처방과 전문학사

차의과학대학교 스포츠의학과 학사

주요 경력

23년 어반 컨디셔닝 선수 트레이닝 센터

23년 성북구청 직원 대상 근골격계질환 예방 교육 프로그램 실시

24년 대한건강운동관리사협회 제1회 학술대회 근감소증 발표

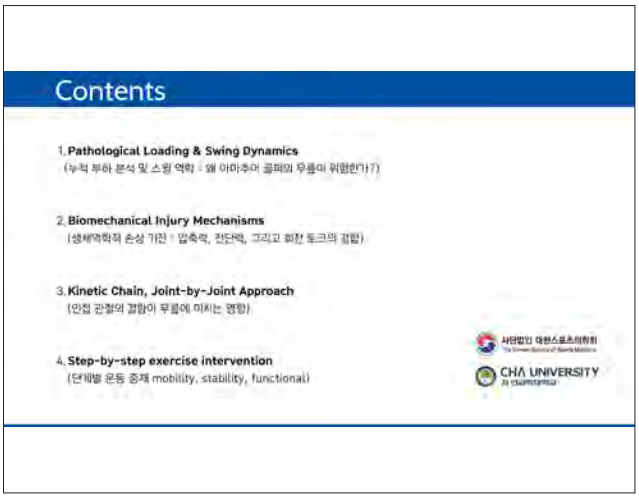
23.11 ~ 25.07 삼성서울병원 흉부외과, 호흡기내과, 신경과 소속 학부 연구원

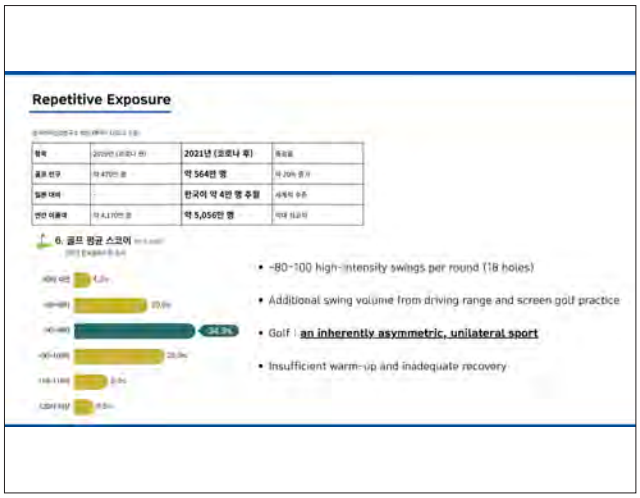
24.03 ~ 25.07 삼성서울병원 흉부외과, 호흡기내과, 신경과 소속 폐암, 식도암, COPD, 불면증 환자 대상 운동 지도 (신경과 근기능 강화 운동 프로그램 등)

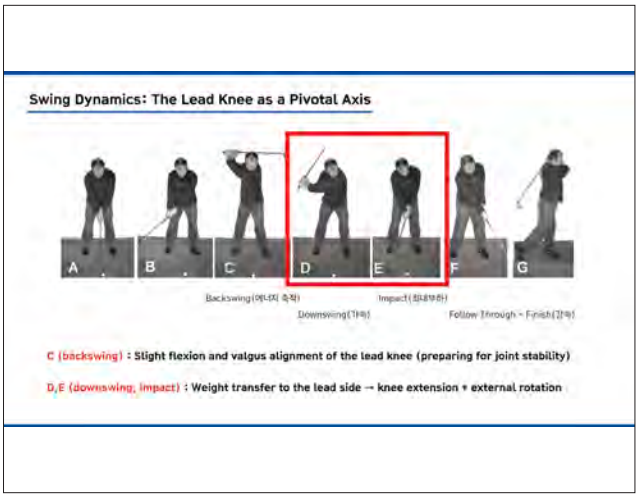
25년 베트남 호치민 팜 응옥탁 의과대학 카데바 실습 수료 및 베트남 보건복지부 수료증

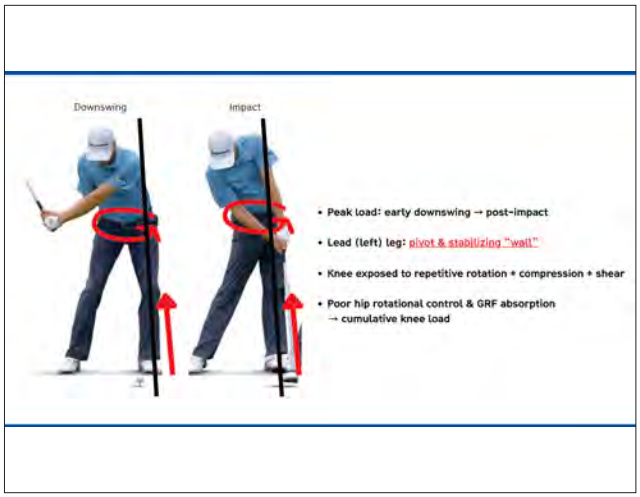
골프에서 유발되는 무릎 만성 통증의 운동 기반 관리 전략
Exercise-Based Management Strategies for Chronic Knee Pain Caused by Golf

차의과학대학
문찬웅









Knee Loading: Peak Forces at Impact

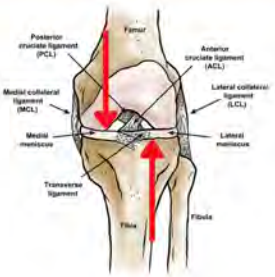
Golf injuries: a review of the literature

McHardy A et al. Sports Med. 2006;
88 (5.1 Knee injuries 48%)

"Hosea et al. [77] measured knee forces...
The peak compressive forces produced in the lead knee were **4.4 and 4.0 times body weight for professional and amateur golfers,** respectively... Anterior shear forces reached 0.5 times body weight in the lead knee."

✓ **Lead knee compressive load :**
4.0–4.4 × body weight

Injury Mechanism I:
Compressive and Shear Forces



Importance of the meniscus

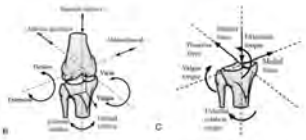
Axial loading
+
Rotational loading
= Internal shear stress



"The peak anterior shear force on the lead knee occurred just after impact and averaged **0.51 ± 0.16 BW (Body Weight)** with some individual values reaching as high as **1.0 BW** depending on the participant's swing mechanics and clubhead speed."

✓ **This combines with the previously shown compressive force of 4.4 BW to generate substantial internal shear stress within the meniscus.**

Injury Mechanism II:
Rotational Torque and Combined Loading



Vector direction of compressive force and rotational torque exerted by the femur on the tibia

'Grinding Effect'

HHS Public Access

Meniscus repair and regeneration: A systematic review from a basic and translational science perspective

Axial compression + rotational forces
→ shear stress within the meniscus
→ meniscal injury/degeneration

Chronicity

Injury Mechanism I,II 반복

↓

Chronicity

OA(Osteoarthritis)
PFPS(Patellofemoral Pain Syndrome)
ITBS(Iliotibial Band Syndrome)
Risk of chronic progression

[RESEARCH REPORT]

Patellofemoral Joint Stress During Weight-Bearing and Non–Weight-Bearing Quadriceps Exercises

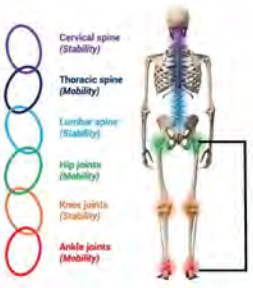
Osteoarthritis and Cartilage

Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis

Joint-by-Joint Approach

"The knee is the victim."

- Limited hip and ankle mobility
- Compensatory knee movement patterns
- Reduced knee stability ↓



Interventions Goals

Mobility → Stability → Functionality

Mobility	Stability	Functionality
Flexibility (mobility)	strengthening (+stability)	functional strengthening
• trunk rotation stretch • hamstring stretch • hip flexibility	• core muscles • hip abductors • gluteals • quadriceps	• rotation movement

Mobility interventions

3-5 Rep / 15-30 sec holding / both



90/90 Hip Flow



Hip flexor stretch



Quadruped Thoracic Ratation



Hamstring stretch

Stability interventions (strengthening)

3-5 Rep / 15-30 sec holding / both



Side-Lying Clamshell



Step down(slow)



Monster walk



Hip bridge

Functionality interventions

8-12 Rep / 2-4 set / both



Single leg Deadlift



Bulgarian Split Squat

Functionality interventions

8-12 Rep / 2-4 set / both



Kettlebell Side Rack Reverse Lunge

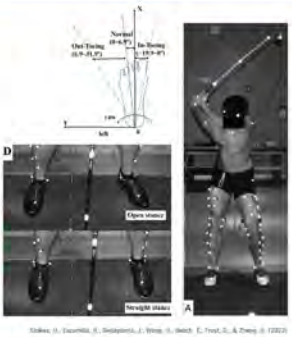


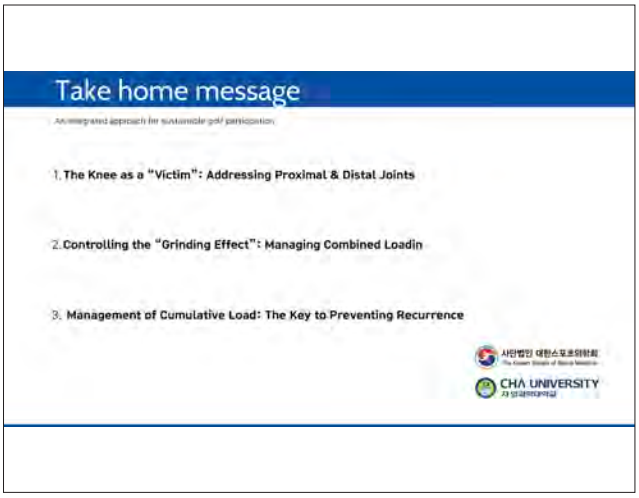
Kettlebell Rotational Lunge

Prevention

- 30° Open Stance: 28% Reduction
  in Lead Knee Internal Rotation (14.2° → 10.2°)
- A 30-degree open stance is not just a 'tip':
  it is a scientifically proven intervention to reduce joint loading.

(주) (Variable)	Neutral Stance (0°)	Open Stance (30°)	통계적 유의성 (P)
Max. Internal Rotation (-)	14.2±4.3	10.2±3.8	P=0.01
Internal Rotation Torque (Nm/kg)	0.11±0.04	0.10±0.03	P=0.05
Adduction Moment (Nm/kg)	1.25±0.35	1.18±0.33	P=0.05




Take home message
1. The Knee as a "Victim": Addressing Proximal & Distal Joints
2. Controlling the "Grinding Effect": Managing Combined Loadin
3. Management of Cumulative Load: The Key to Preventing Recurrence
CHA UNIVERSITY


Thank You For Your Attention
E-mail : moonepen00@daum.net
Instagram : @cf.hanung_
CHA UNIVERSITY

The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

심포지엄 7: 러닝의 부상 매커니즘 및 장비의 역학
Injury Mechanisms in Running and Equipment Dynamics

좌장: 계명대학교 김기진, 명지병원 임길병



남 용

학력

선문대학교 물리치료학과 학사

선문대학교 물리치료학과 석사

선문대학교 물리치료학과 박사과정

주요 경력

진천 국가대표선수촌 메디컬센터

SNU서울병원 스포츠재활센터 팀장 (2019-2025)

국제올림픽위원회(IOC) 스포츠 물리치료사 Diploma

마라톤 풀코스 및 철인3종 완주 15회

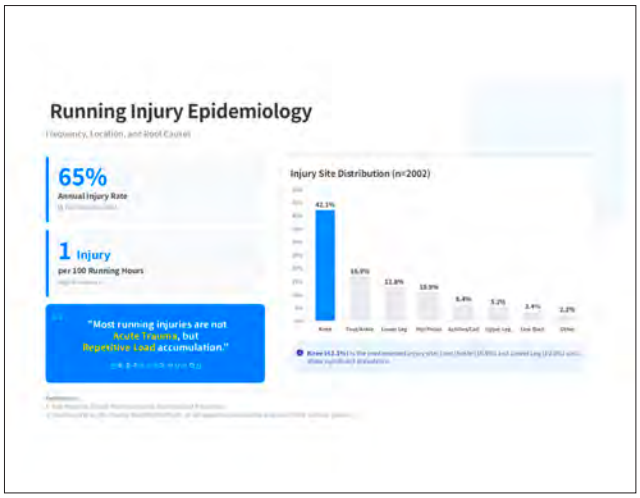
현재 소속 및 직위

R스포츠재활센터 / 대표

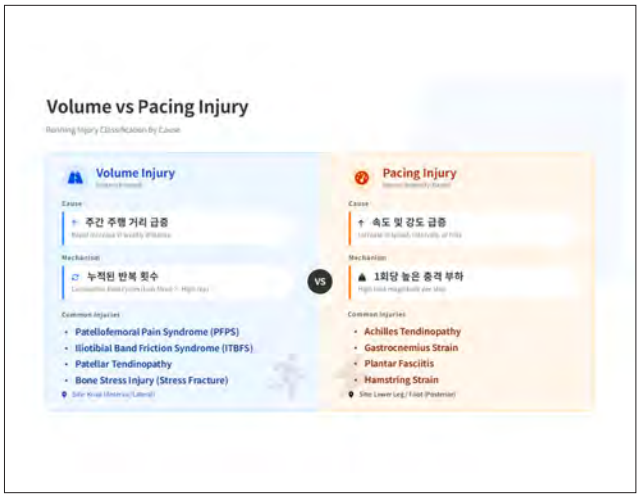
러닝 부상은 어떻게 시작되는가? – 반복 충격과 생체역학
How Do Running Injuries Begin?
– Repetitive Load and Biomechanics

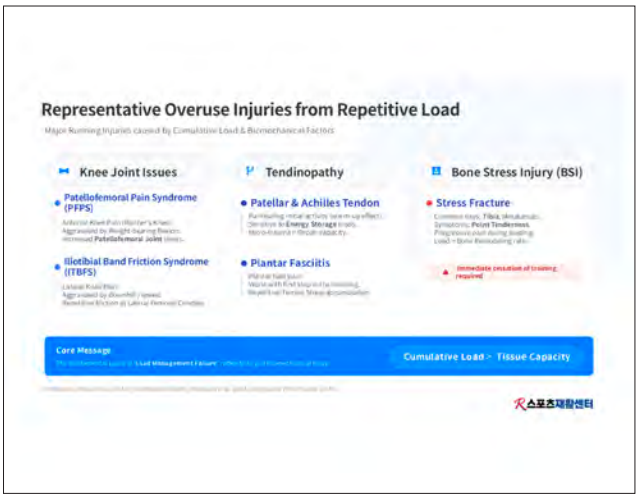
R스포츠재활센터
남 용



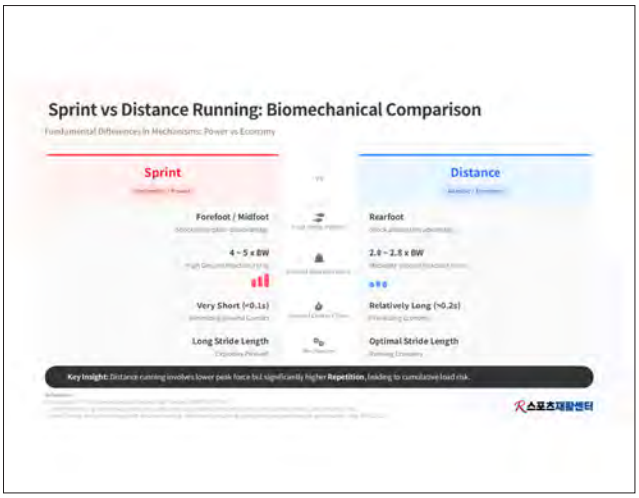


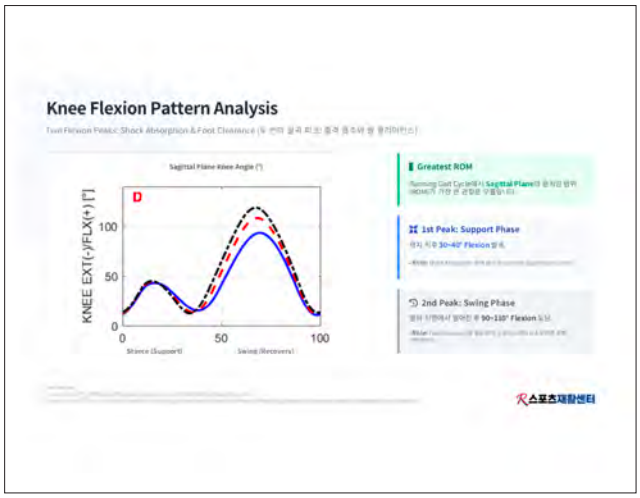


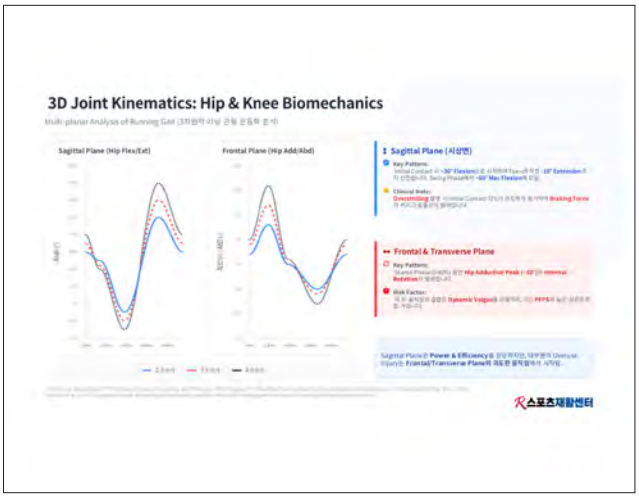


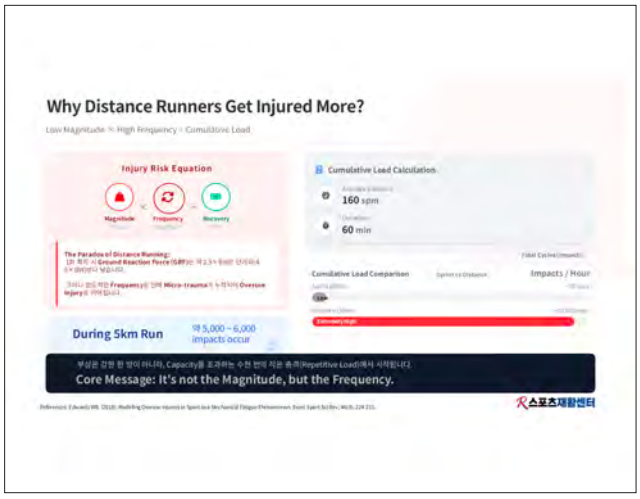

Representative Overuse Injuries from Repetitive Load
Knee Joint Issues
Patellofemoral Pain Syndrome (PFPS)
Iliotibial Band Friction Syndrome (ITBFS)
Tendinopathy
Patellar & Achilles Tendon
Plantar Fasciitis
Bone Stress Injury (BSI)
Stress Fracture
Core Message
Cumulative Load > Tissue Capacity
스포츠재활센터

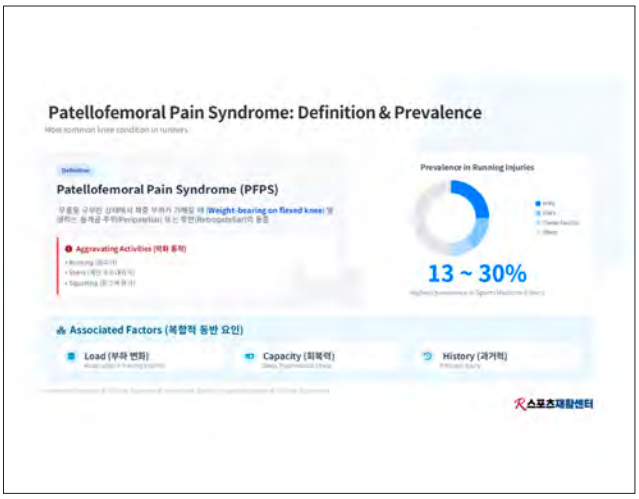

Running Gait Cycle Basics
Running Gait Cycle Phases
Stance Phase (40%)
Swing Phase (60%)
Initial Contact
Mid Stance
Toe Off
Mid Swing
Cadence
Ground Contact Time (GCT)
Speed = Stride Length × Cadence
스포츠재활센터

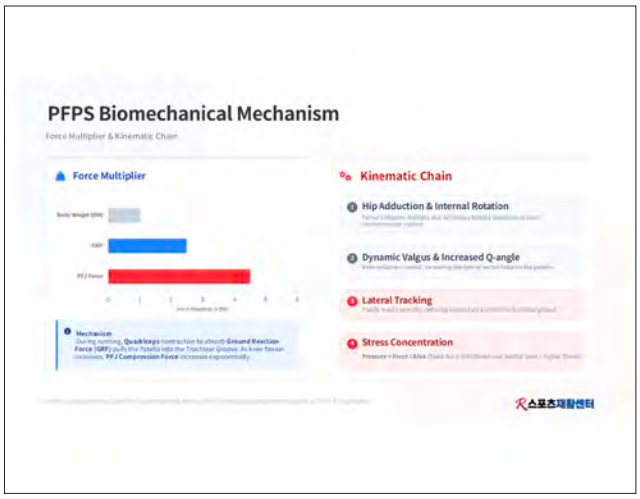

Sprint vs Distance Running: Biomechanical Comparison
Sprint
Distance
Forefoot / Midfoot
Rearfoot
4 ~ 5 x BW
2.0 ~ 2.8 x BW
Very Short (~0.1s)
Relatively Long (~0.2s)
Long Stride Length
Optimal Stride Length
스포츠재활센터

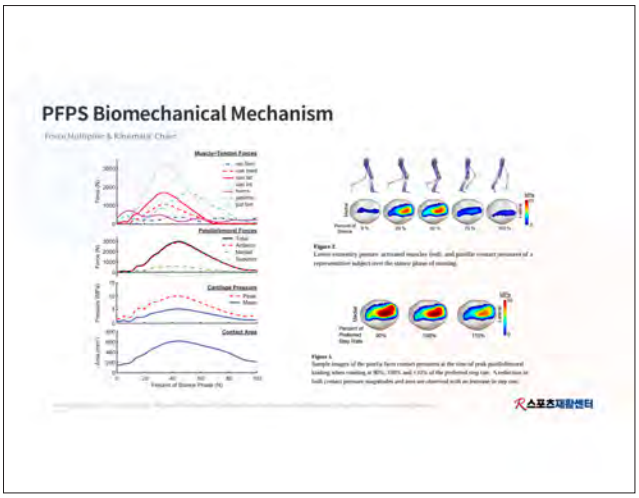

Knee Flexion Pattern Analysis
KNEE EXT(-)/FLX(+) [°]
Greatest ROM
1st Peak: Support Phase
2nd Peak: Swing Phase
스포츠재활센터

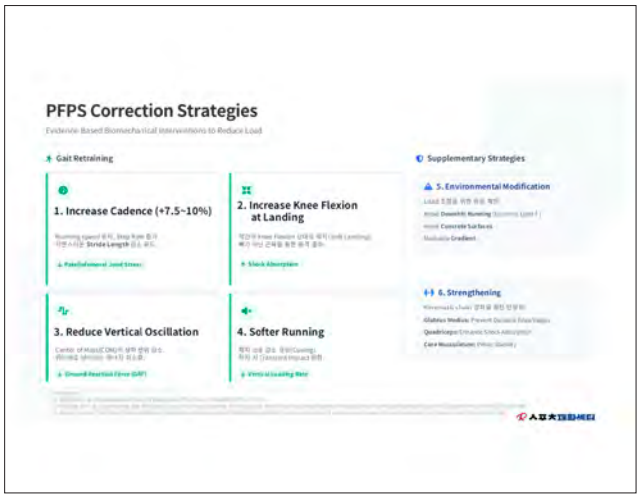

3D Joint Kinematics: Hip & Knee Biomechanics
Sagittal Plane (Hip Flex/Ext)
Frontal Plane (Hip Add/Abd)
Sagittal Plane
Frontal & Transverse Plane
스포츠재활센터

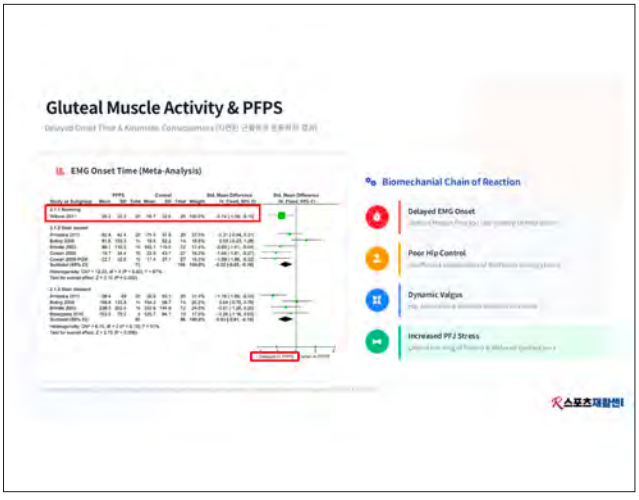

Why Distance Runners Get Injured More?
Injury Risk Equation
Magnitude
Frequency
Recovery
Cumulative Load Calculation
160 spm
60 min
During 5km Run
Core Message: It's not the Magnitude, but the Frequency.
스포츠재활센터

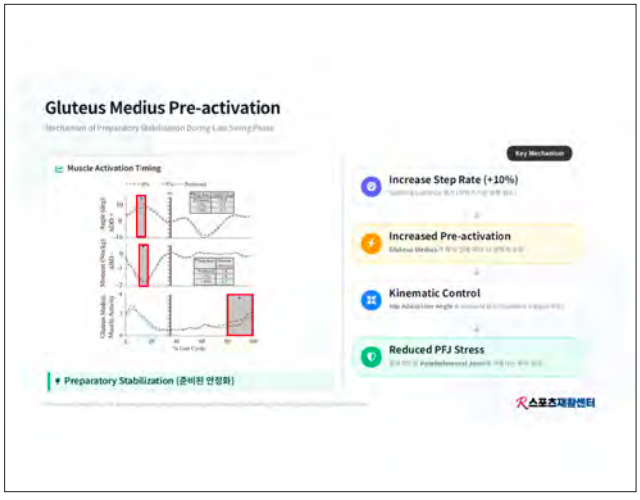

Patellofemoral Pain Syndrome: Definition & Prevalence
Patellofemoral Pain Syndrome (PFPS)
Prevalence in Running Injuries
13 ~ 30%
Aggravating Activities (악화 동작)
Associated Factors (복합적 동반 요인)
Load (부하 변화)
Capacity (회복력)
History (과거력)

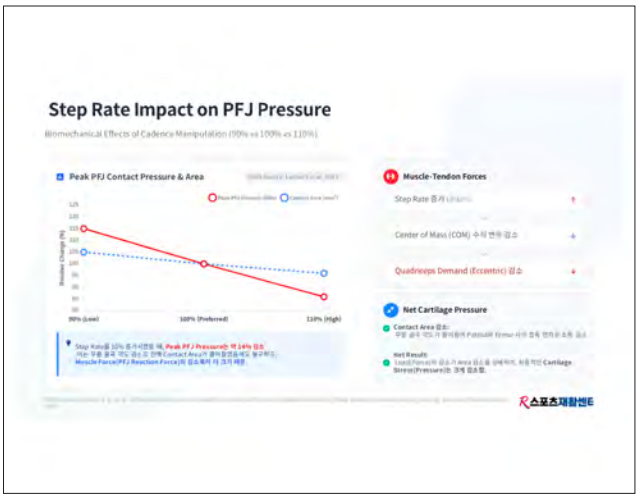

PFPS Biomechanical Mechanism
Force Multiplier
Kinematic Chain
Hip Adduction & Internal Rotation
Dynamic Valgus & Increased Q-angle
Lateral Tracking
Stress Concentration

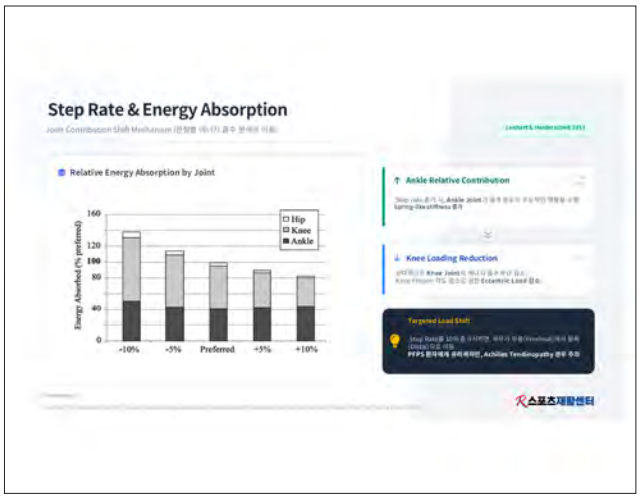

PFPS Biomechanical Mechanism

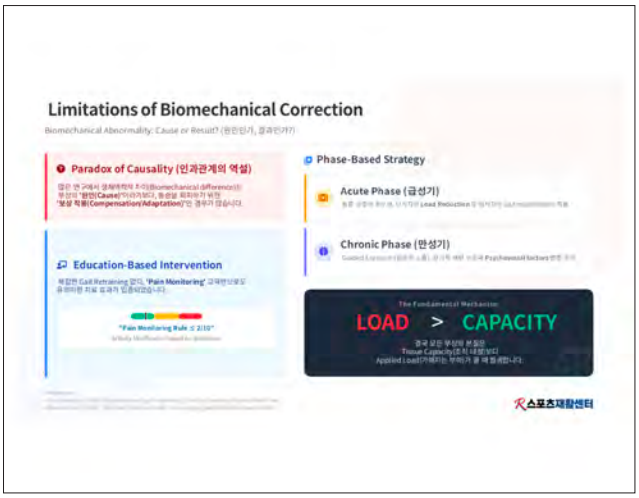

PFPS Correction Strategies
Gait Retraining
1. Increase Cadence (+7.5~10%)
2. Increase Knee Flexion at Landing
3. Reduce Vertical Oscillation
4. Softer Running
Supplementary Strategies
5. Environmental Modification
6. Strengthening

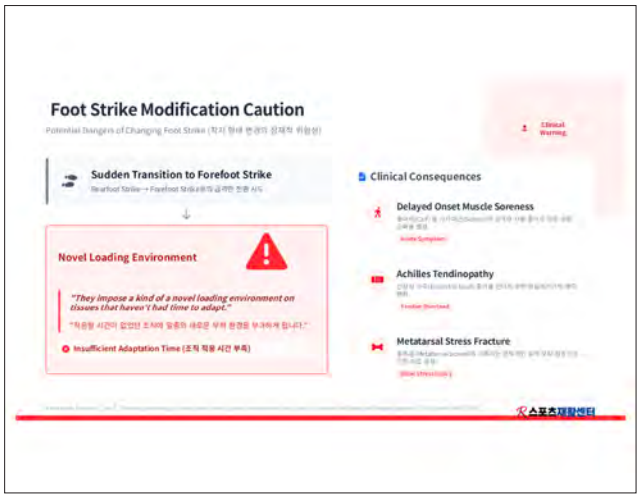

Gluteal Muscle Activity & PFPS
EMG Onset Time (Meta-Analysis)
Biomechanial Chain of Reaction
Delayed EMG Onset
Poor Hip Control
Dynamic Valgus
Increased PFJ Stress


Gluteus Medius Pre-activation
Muscle Activation Timing
Key Mechanism
Increase Step Rate (+10%)
Increased Pre-activation
Kinematic Control
Reduced PFJ Stress
Preparatory Stabilization (준비된 안정화)


Step Rate Impact on PFJ Pressure
Peak PFJ Contact Pressure & Area
Muscle-Tendon Forces
Net Cartilage Pressure

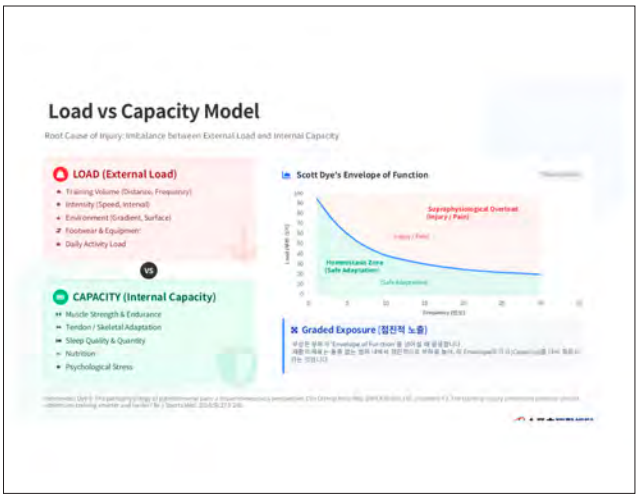

Step Rate & Energy Absorption
Relative Energy Absorption by Joint
Hip
Knee
Ankle
Ankle Relative Contribution
Knee Loading Reduction

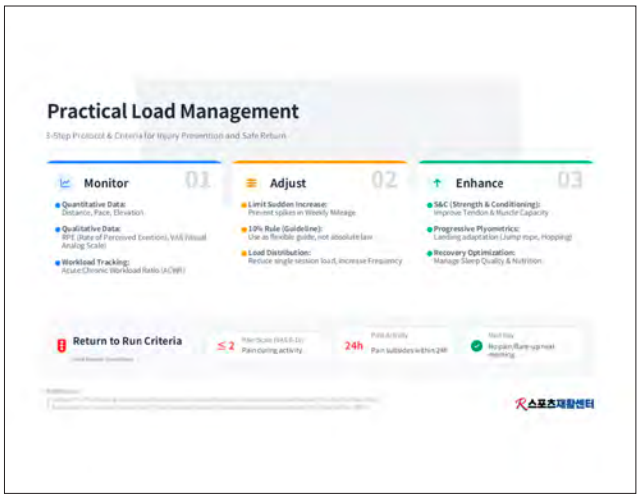

Limitations of Biomechanical Correction
Paradox of Causality (인과관계의 역설)
Phase-Based Strategy
Acute Phase (급성기)
Chronic Phase (만성기)
Education-Based Intervention
LOAD > CAPACITY


Foot Strike Modification Caution
Sudden Transition to Forefoot Strike
Novel Loading Environment
Clinical Consequences
Delayed Onset Muscle Soreness
Achilles Tendinopathy
Metatarsal Stress Fracture


Proximal-Focused Approach
"One of the easier ways to change that foot strike was to increase flexion. So (encouraging) a slightly higher knee gait if you like."
Proximal Intervention
Increase Knee Flexion
Distal Adaptation
Natural Change in Foot Strike
Directly changing foot strike pattern
Indirect change via knee/hip modification


Training Error Evidence
It was NOT possible to identify which training errors are related to running related injuries.
Rasmus et al. (2017)
Multifactorial Nature
Individualization
Clinical Takeaway


Load vs Capacity Model
LOAD (External Load)
CAPACITY (Internal Capacity)
Scott Dye's Envelope of Function
Graded Exposure (점진적 노출)


Practical Load Management
Monitor
Adjust
Enhance
Return to Run Criteria
스포츠재활센터


Conclusions & Clinical Messages
반복 충격과 누적 부하
(Cumulative Load)
거리 vs 속도 부상 구분
(Volume vs Pacing)
생체역학 교정의 한계
(Biomechanics ≠ Cause)
Load ≤ Capacity
균형 유지
스포츠재활센터


Contact
경청해 주셔서
감사합니다
스포츠재활센터

박은수

학력

이대목동병원 정형외과 전공의

서울아산병원 정형외과 족부족관절 임상강사

주요 경력

(전) 프로축구 K리그 충북청주fc 팀닥터

23-26, 핸드볼 H리그 주치의

22-25, KLPGA 골프 투어 주치의

14, 인천 아시안게임 주치의

현재 소속 및 직위

윈윈정형외과 대표 원장

대표논문

Jae SY, Franklin BA, Choi YH, Fernhall B. Metabolically healthy obesity and carotid intima-media thickness: effects of cardiorespiratory fitness. Mayo Clinic Proceedings. 2015 in press

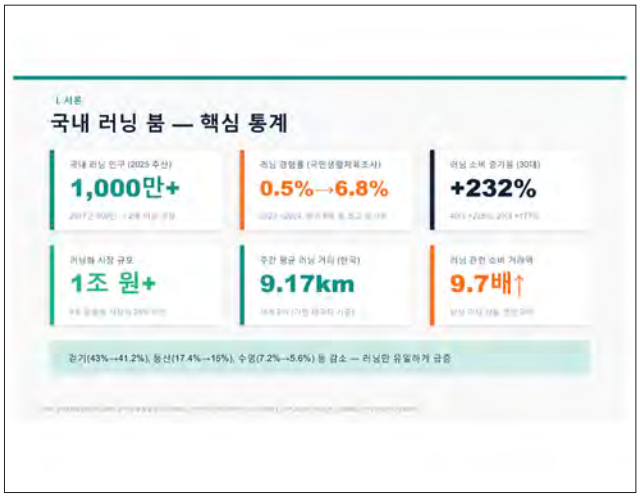
러닝 장비는 부상을 줄였는가? – 신발과 기술의 양면성
Has Running Equipment Reduced Injuries? – The Double-Edged Sword of Technology

윈윈정형외과
박은수

러닝 붐 시대, 스포츠의학의 역할은 무엇인가?
The Role of Sports Medicine in the Era of the Running Boom

진천선수촌
김찬혁









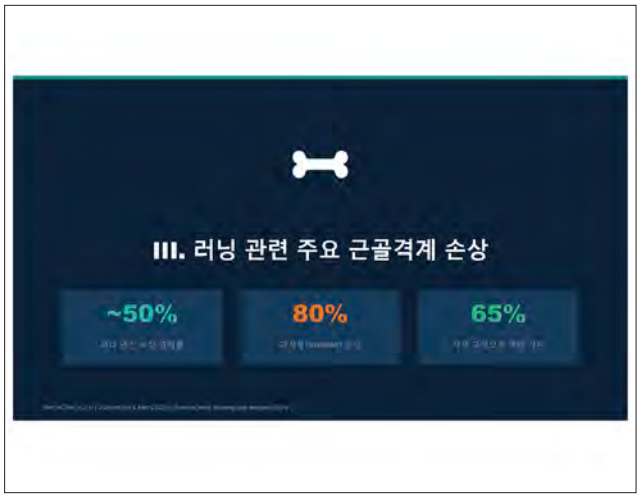

I. 서론
러닝의 건강 편익 — 왜 달리는가?
심혈관 건강
심장·혈관 기능 강화
혈압 관리, 심장질환 위험 감소
근골격계 건강
골밀도 유지 향상
근력 및 균형감각 개선
정신건강 증진
불안·우울 감소, 수면의 질 향상
러너스하이 (엔도르핀 분비)
사회적 연결
러닝크루·커뮤니티를 통한
사회적 유대감 형성
"Running adds life to our years, and it definitely adds years to life."


II. 배경
코로나 팬데믹 이후의 구조적 변화
팬데믹 발생
실내 체육시설 폐쇄
러닝 = 유일한 운동 옵션
전 세계 러닝 참여 15%↑
러닝 붐 시작
러닝화 매출 19% 급증
가상 레이스 시장 폭발
$59.1억 규모 형성
대면 대회 부활
오프라인 대회 폭발적 증가
마라톤 참가 신기록
러닝크루 문화 확산
러닝 문화 정착
국내 러닝 인구 1,000만
전 세대 확산
산업 생태계 성숙


II. 배경
MZ세대와 러닝크루 — 새로운 러닝 문화
글로벌 MZ세대 참여 현황
Z세대 마라톤 완주자 비율: 5% → 8% (2021→2024)
Strava 사용자 20%가 Z세대 여성
영국 Great Run 2024 참가자 중 53%가 첫 대회
여성 참가율 46% (YoY +2%p 증가)
사회적 연결이 운동 동기 1위 (Strava 조사)
프로 선수·인플루언서보다 친구·가족이 더 큰 동기
국내 러닝크루 현황
네이버 밴드 러닝 모임 2년간 +46%
당근 내 러닝 모임 2024.1 대비 4배+ 증가
전체 러닝 모임 40%가 "경험 제한 없음"
2030 러닝 관련 소비: 30대 +232%, 40대 +225%
20–40대 여성 러너 전체의 약 45%
마라톤 대회 연간 400개+ 전국 개최


II. 배경
러닝의 압도적 접근성 — 진입 장벽이 가장 낮은 운동
항목
러닝
골프
테니스
수영
초기 비용
20–30만 원
(러닝화)
200만 원+
(장갑·장비)
50–100만 원
(라켓·코트비)
월 10만 원+
(수영장 월회)
장소 제약
어디서나 가능
골프장 필수
코트 필요
(예약 경쟁)
수영장 필수
인원 제약
혼자~단체
2–4인
2–4인
혼자
학습 곡선
15–20분이면
시작 가능
수개월
레슨 필요
기본 기술
습득 필요
경험 학습
필요
핵심 시사점: 낮은 진입 장벽은 곧 '의학적 사전 준비 없이 시작하는 러너'가 대다수임을 의미 → 부상 위험 증가


II. 배경
참여자 특성의 변화 — 초보 러너의 시대
지표
과거
현재 (2024–2025)
국내 러닝 인구
2017년 약 500만 명
2025년 약 1,000만 명
러닝 경험률
2023년 0.5회
2024년 6.8% (+6.3%p)
주요 연령층
40–50대 중심인
20–40대 전 세대 확산
여성 참여 비율
30% 이하
약 45%
초보자 비율
낮음
약 55% (첫 대회 참가자)
스포츠의학적 시사점
• 초보 러너 53%: 사전 건강 평가와 부상 예방 교육의 필요성 대두
• 여성 러너 45%: 여성 특이적 손상 (RED-S, 여성선수삼주징)에 대한 인식 확대 필요


III. 러닝 관련 주요 근골격계 손상
~50%
80%
65%


III. 손상
주요 손상 유형 ① 무릎·대퇴 영역
손상
병태생리 / 특징
위험 요인
예방 전략
슬개대퇴통증후군 (Runner's Knee)
장경인대증후군 (ITBS)
햄스트링 손상


III. 손상
주요 손상 유형 ② 발·발목·경골 영역
손상
병태생리 / 특징
위험 요인
예방 전략
족저근막염
아킬레스건염
경골내측스트레스 증후군 (Shin Splints)
피로골절 (Stress Fracture)

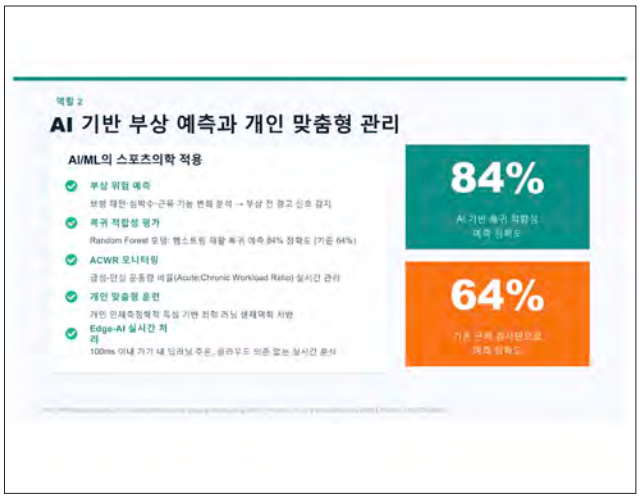

III. 손상
초보 러너의 손상 패턴 — 왜 더 취약한가?
핵심 메커니즘
심폐기능 적용 속도 •••••
근골격계 적응 ••
초보 러너 5대 위험 요인


IV. 러닝 붐 시대, 스포츠의학의 4가지 역할
사전예방의학적 접근
웨어러블·AI 모니터링
치료와 재활
교육과 예방 문화


역할 1
러닝 전 사전 건강 평가 (Pre-participation Screening)
근골격계 평가
심혈관계 평가
맞춤형 프로그램 설계


역할 1
생체역학 분석과 자세 교정 (Gait Analysis)
러닝 생체역학 분석 항목
핵심 교정 포인트


웨어러블 디바이스를 활용한 모니터링
Reactive (사후 치료) → Proactive (사전 예방) 패러다임 전환
스마트 인솔
IMU 센서 & 스마트워치
바이오센서
데이터 통합·분석


AI 기반 부상 예측과 개인 맞춤형 관리
AI/ML의 스포츠의학 적용
부상 위험 예측
복귀 적합성 평가
ACWR 모니터링
개인 맞춤형 훈련
Edge-AI 실시간 처리
84%
64%

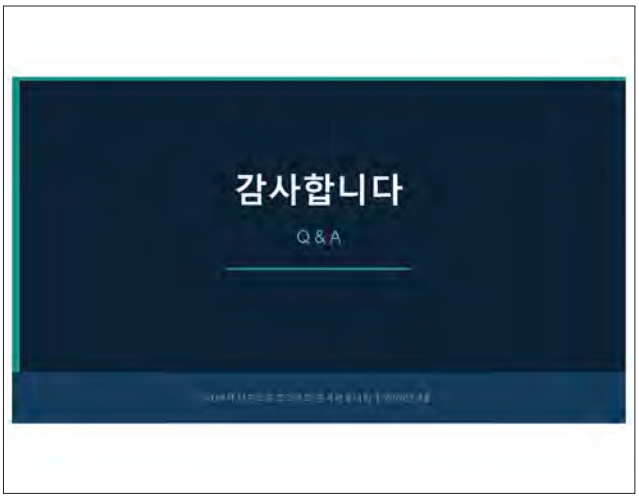

급성 손상 관리: RICE에서 PEACE & LOVE로
PEACE (급성기 0–3일)
LOVE (아급성기 3일 이후)
load
optimism
vascularisation
xercise


단계적 복귀 프로그램 (Return-to-Running Protocol)
통증 없는 보행
빠른 보행 / 파워워킹
Walk-Jog 인터벌
점진적 러닝 복귀
완전 복귀


교육과 예방 문화의 확산


런닝인구 1000만 시대의 미래 전망
엘리트 선수 (NTC)
일반인 러너 (1,000만)
패러다임 전환
디지털 헬스 융합
다학제적 협력


Take-Home Message
01 러닝 인구 1,000만 시대 — 스포츠의학의 대상은 더 이상 엘리트만이 아니다
02 초보 러너 비율 50% 이상 — 사전예방의학적 접근과 생체역학 분석이 핵심이다
03 웨어러블·AI 기술을 활용한 실시간 모니터링으로 '사후 치료'에서 '사전 예방'으로 전환해야 한다


감사합니다
Q & A

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

심포지엄 9: 에너지 밸런스를 넘어서: REDs에 관한 최첨단 통찰

Beyond Energy Balance: The Cutting Edge Insights on REDs (여성스포츠위원회 1)

좌장: 일산백병원 이언숙, 국립중앙의료원 전숙하



김리나

학력

한양 대학교 의과대학졸업

한양대학교 의과대학

고려대학교 안암병원 재활의학과 전공의

고려대학교 안암병원 재활의학과 임상 조교수

서울대학교 보건대학원 보건학 석사

현재 소속 및 직위

삼육서울병원 재활의학과 과장

여성운동선수 건강 패러다임의 확장 : Female Athlete Triad 에서 IOC 합의문까지
The evolution of REDs: Advancing woman's health from the Female Athletes Triad to the IOC consensus

삼육서울병원
김리나

Consensus statement

2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs)

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► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bjsports-2023-106994).

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Accepted 20 August 2023

ABSTRACT

Relative Energy Deficiency in Sport (REDs) was first introduced in 2014 by the International Olympic Committee's expert writing panel, identifying a syndrome of deleterious health and performance outcomes experienced by female and male athletes exposed to low energy availability (LEA; inadequate energy intake in relation to exercise energy expenditure). Since the 2018 REDs consensus, there have been >170 original research publications advancing the field of REDs science, including emerging data demonstrating the growing role of low carbohydrate availability, further evidence of the interplay between mental health and REDs and more data elucidating the impact of LEA in males. Our knowledge of REDs signs and symptoms has resulted in updated Health and Performance Conceptual Models and the development of a novel Physiological Model. This Physiological Model is designed to demonstrate the complexity of either problematic or adaptable LEA exposure, coupled with individual moderating factors, leading to changes in health and performance outcomes. Guidelines for safe and effective body composition assessment to help prevent REDs are also outlined. A new REDs Clinical Assessment Tool-Version 2 is introduced to facilitate the detection and clinical diagnosis of REDs based on accumulated severity and risk stratification, with associated training and competition recommendations. Prevention and treatment principles of REDs are presented to encourage best practices for sports organisations and clinicians. Finally, methodological best practices for REDs research are outlined to stimulate future high-quality research to address important knowledge gaps.

INTRODUCTION

> My body was just deteriorating because it was working harder, but with less food. It's a sign that everything was basically just shutting down. I'd completely lost control of it [body], yet still thought it was just something I had to go through, because the ultimate aim is a certain weight or look.[1]

Athletes are driven by strong internal and external pressure to achieve optimal performance. Many forms of performance pressure contribute to scenarios that either, intentionally or unintentionally, alter energy intake (EI) and exercise energy expenditure (EEE), resulting in low energy availability (LEA). The mathematical formula for energy availability (EA) that identifies the amount of energy that the body can contribute to functions associated with health, well-being and performance is well-established in sports science/medicine[3–4]:

$$\text{EA [Energy Availability]} = \frac{\text{(EI Energy Intake (kcal)} - \text{EEE (Exercise Energy Expenditure (kcal))}}{\text{FFM (Fat - Free Mass (kg) / day)}}$$

Scenarios commonly encountered in sport include extreme volumes of EEE, attempts to improve power-to-weight ratios, desire for excessive leanness and sport-specific physique alterations. All of these scenarios can lead to problematic LEA (see Definitions box 1), which can result in negative health and performance implications known as 'Relative Energy Deficiency in Sport' (REDs). REDs (altered from the original acronym 'RED-S' for improved comprehension and dissemination), was first introduced by the International Olympic Committee (IOC) in a consensus statement in 2014,[5] and was updated in 2018.[6] Since 2018, there have been considerable scientific advancements in the REDs research field including ~178 REDs and/or LEA original research publications featuring ~23 822 participants; (80% female), with ~62% of these studies implementing a cross-sectional design, ~14% as longitudinal observational and ~12% longitudinal intervention (see literature summary in online supplemental file 1). These scientific advances have improved our understanding of the underpinning physiology and psychology of REDs and the different clinical presentations between the sexes. There is a wide range in the reported estimated prevalence of LEA/REDs indicators in female (23%–79.5%[7–16]) and male (15%–70%[12–20]) athletes across a variety of sports due to the lack of a singular definitive diagnosis, mistaken use of LEA and REDs as interchangeable terms, lack of standardisation and accuracy of research methodologies (eg, inaccurate EA measurements), variation in physiological demands among the study populations and participant study volunteering biases.[21]

Compared with previous REDs consensus statements, this updated IOC REDs consensus is more

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To cite: Mountjoy M, Ackerman KE, Bailey DM, *et al*. *Br J Sports Med* 2024;**57**:1073–1098.

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Box 1 Definitions: Low Energy Availability

Energy availability
Energy availability is the dietary energy left over and available for optimum function of body systems after accounting for the energy expended from exercise. Energy availability is expressed as kcal/kg FFM/day, and is defined in the scientific literature in the form of a mathematical formula[2–4]:

***EA** [Energy Availability] =[**EI** [Dietary energy Intake (kcal)]-**EEE** [Exercise Energy Expenditure (kcal)]] / **FFM** [Fat-Free Mass (kg) / day]*

Low energy availability (LEA)
LEA is any mismatch between dietary energy intake and energy expended in exercise that leaves the body's total energy needs unmet, that is, there is inadequate energy to support the functions required by the body to maintain optimal health and performance.[6] LEA occurs as a continuum between scenarios in which effects are benign (*adaptable LEA*) and others in which there are substantial and potentially long-term impairments of health and performance (*problematic LEA*).

Adaptable LEA
Adaptable LEA is exposure to a reduction in energy availability that is associated with benign effects, including mild and quickly reversible changes in biomarkers of various body systems that signal an adaptive partitioning of energy and the plasticity of human physiology. In some cases, the scenario that underpins the reduction in energy availability (eg, monitored and mindful manipulation of body composition or scheduled period of intensified training or competition) might be associated with acute health or performance benefits (eg, increased relative VO_{2max}). Adaptable LEA is typically a short-term experience with minimal (or no) impact on long-term health, well-being or performance. Moderating factors may also alter the expression of outcomes.

Problematic LEA
Problematic LEA is exposure to LEA that is associated with greater and potentially persistent disruption of various body systems, often presenting with signs and/or symptoms, and represents a maladaptive response. The characteristics of problematic LEA exposure (eg, duration, magnitude, frequency) may vary according to the body system and the individual. They may be further affected by interaction with moderating factors that can amplify the disruption to health, well-being and performance.

Moderating factors
Characteristics of individual athletes, their environment or behaviour/activities that may amplify or attenuate the effect of LEA exposure on various body systems. Relevant moderating factors (eg, gender, age, genetics) vary according to the body system. They may offer protection or additional risk in the progression from LEA exposure to the expression of disturbances to health, well-being or performance.

Eating disorders
Mental illnesses clinically diagnosed by meeting defined criteria characterised by abnormal eating behaviours [eg, self-induced restricting food intake, preoccupation with body shape or weight, bingeing and purging (self-induced emesis, laxative use, excessive exercise, diuretic use)].[172]

Continued

Box 1 Continued

Disordered eating behaviours
Abnormal eating behaviours including restrictive eating, compulsive eating or irregular or inflexible eating patterns, excessive exercise beyond assigned training to compensate for dietary intake, and use of purgatives. The behaviours do not meet the clinical criteria for an eating disorder.

Relative Energy Deficiency in Sport (REDs)
A syndrome of impaired physiological and/or psychological functioning experienced by female and male athletes that is caused by exposure to problematic (prolonged and/or severe) LEA. The detrimental outcomes include, but are not limited to, decreases in energy metabolism, reproductive function, musculoskeletal health, immunity, glycogen synthesis and cardiovascular and haematological health, which can all individually and synergistically lead to impaired well-being, increased injury risk and decreased sports performance.[5]

robust in its methodology including (1) outlining criteria for consensus panel inclusion, thresholds for reaching consensus via voting statements, and the provision for dissent[22 23]; (2) being supported by a dedicated edition of related reviews and editorials providing detailed context to facilitate further understanding[21 24–30]; and (3) featuring a blend of science and knowledge translation (implementing an athlete-centric and coach-centric approach).

The primary target audience for this consensus statement includes clinicians and REDs research scientists, with secondary educational materials being developed for coaches and athletes to support the primary prevention of REDs. We have intentionally developed real-world content for clinicians in the athlete health and performance team involved in the prevention, diagnosis and treatment of REDs.[25 27 29] For REDs scientists, in addition to a summary of the underpinning science in the field, we have also provided suggestions for future research implementing recommended methodologies.[21] The outcomes of this consensus are focused on the developing to world-class level athlete (Tiers 2–5).[31]

The goals of this consensus statement are to (1) summarise the recent scientific advances in the field of REDs; (2) introduce a novel REDs Physiological Model template and validated REDs Clinical Assessment Tool-Version 2 (IOC REDs CAT2); and (3) provide practical, REDs-related clinical and methodological research guidelines to promote athlete health and well-being, along with safe optimisation of sport performance. This consensus is organised into five sections: (1) What is REDs?, (2) methodology and consensus results, (3) key scientific advances since the 2018 REDs consensus statement, (4) clinical applications and (5) research methodology guidelines.

What is REDs?

Life History Theory proposes that various biological processes related to growth, health, activity and reproduction compete for finite energy resources, with different priorities depending on the phase in the life cycle and other circumstances.[32–34] In sports science literature, EA to meet various biological functions is the amount of energy remaining of the EI after the energy demands of exercise are accounted for. Inadequate EI or an increased energy commitment to one biological process favours trade-offs that allocate energy away from other processes, especially growth, reproduction or maintenance.[32] In particular,

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such evolutionary selective pressures have favoured adaptations that allocate limited energy supplies during periods of LEA (eg, famines) to biological processes that support immediate survival, as well as long-term reproductive success.[32] Therefore, humans, like other animals, are adapted to cope with periods of LEA by downregulating biological processes that are temporarily unnecessary or reducible.[32] Some of these perturbations to body systems might be considered mild and/or transient, representing physiological plasticity[35] and could be termed *adaptable* LEA (see Definitions box 1).

However, although humans evolved to be physically active, they did not evolve to tolerate some modern elite training programs[36] or sports-related practices. This is especially the case in endurance sports (often >30 hours of training/week),[37] which can sometimes result in extreme EEE that exceeds the capacity of the human alimentary tract for sustained energy absorption.[38] Indeed, the spectrum of exposure to LEA can include scenarios (eg, significant duration, magnitude, frequency—see Definitions box 1), that in conjunction with moderating factors (eg, sex, age, health status), are associated with negative effects on various body systems. Such scenarios, termed *problematic* LEA manifest as impairments of health and well-being, as well as interruption to training (adaptation and enhancement of body systems via exposure to physiological stress) or competition (demonstration of optimal mental and physiological prowess).[39] In the real world, athletes experience exposure to LEA (purposefully or inadvertently) in various manners along the continuum from adaptable to problematic.[3 40] Indeed, under certain circumstances, some practices associated with LEA, such as body composition manipulation, periods of intensified training or competition workloads involving prodigious EEE, can be safely and effectively periodised into an athlete's annual plan (eg, the implementation is guided by experts, the athlete has the physical and psychological readiness, adequate recovery is included, and health is maintained).[41 42]

REDs is a clinically diagnosed, multifactorial syndrome characterised by the accumulation of the deleterious health and performance outcomes resulting from exposure to problematic LEA. Thus, given the significant scientific advances in the field, the updated 2023 definition of REDs is:

> a syndrome of impaired physiological and/or psychological functioning experienced by female and male athletes that is caused by exposure to problematic (prolonged and/or severe) low energy availability. The detrimental outcomes include, but are not limited to, decreases in energy metabolism, reproductive function, musculoskeletal health, immunity, glycogen synthesis and cardiovascular and haematological health, which can all individually and synergistically lead to impaired well-being, increased injury risk and decreased sports performance.

Methodology and consensus results

In addition to facilitating the synthesis of compiled information, consensus methodology also harnesses experts' insights to enable more validated recommendations to be made when the published evidence ranges from insufficient to adequate. The goal of consensus methods is to determine how much independent and diverse experts agree on nuanced and complex issues within a defined topic area while seeking to overcome some of the drawbacks associated with decision-making in groups or committees, which can be frequently dominated by one individual or coalitions representing vested interests.

This REDs consensus statement used the RAND-UCLA Appropriateness Method (RAM).[43] A diverse (ie, gender, geographic location, expertise) expert panel of authors was invited, consisting of sports medicine physicians, a sports endocrinologist, registered sports dietitians, sports physiologists, sports scientists, an athlete, a coach and a mental performance consultant. Authors were invited based on their expertise, as demonstrated by previous research, clinical and/or coaching experiences with REDs. From the entire group of authors, smaller working groups of content experts were tasked with preparing specific subtopics prior to the in-person consensus in the form of (1) a referenced summary of the existing scientific literature and (2) voting statements based on key novel and potentially controversial aspects identified in the literature review. These literature summaries and voting statements were compiled, then circulated for online confidential voting (Delphi method[44]). Answer categories were from strongly disagree, undecided, to strongly agree. We defined three levels of agreement based on which subsequent discussions were held:

1. Agreement: ≥80% of authors agreeing on the voting statement, without any author disagreeing.
2. Agreement with minority disagreement: ≥80% of authors agreeing on the voting statement, but with one or more authors disagreeing.
3. Disagreement: <80% of authors agreeing on the voting statement.

Statements without agreement were discussed at the subsequent meeting held at the Olympic House in Lausanne, Switzerland (September 2022). Authors were allowed to write a minority opinion in the event of disagreement with a statement when the consensus threshold was reached. The voting statements were revised after discussions and then subjected to a second round of confidential electronic voting at the end of the meeting (full details of voting statements, outcomes and actions are available via supplementary materials (online supplemental files 2–4)).

Consensus results

In the first round of online voting, we presented 135 evidence statements to the panel. Full agreement was reached for 76 of the statements. We have outlined our actions taken after in-person discussions in table 1. In the second round of confidential voting, 44 statements were presented to the authors. Of these, 24 were previous statements with disagreement that required a revote, and 20 were new statements. All voting statements reached an agreement or minority disagreement after two rounds of voting, providing a total of 144 statements of which 27 remained with a minority disagreement (ie, 80% agreement was reached, but one or more individuals disagreed with the statement).

Equity, diversity and inclusion statement

A diverse expert panel of authors consisted of sports medicine physicians, registered sports dietitians, athletes, coaches, sports physiologists, sports scientists and mental performance consultants. Authors were invited based on their expertise, as demonstrated by previous research, clinical and/or coaching experiences with REDs. In total, 10 females and 7 males from four continents participated.

Key scientific advances since the 2018 REDs consensus statement

There has been significant growth in the number of studies clearly showing that problematic LEA is the underlying aetiology of REDs. The new evidence on this topic provides a deeper fundamental understanding of how problematic versus adaptable LEA, along with its moderating factors, influences the health and performance of athletes (see Definitions box 1). The key

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Consensus statement

Table 1 Results of the online Delphi survey and subsequent actions taken

	Total	Agreement*	Minority disagreement†	Disagreement‡
Round 1 voting	**135**	**76**	**29**	**30**
Action taken				
Removed	11	–	2	9
Adjusted wording: revote	23	–	3	20
Adjusted wording: no revote	23	23	–	–
Revote	1	–	–	1
Added statements	20	–	–	–
Round 2 voting	**44**	**41**	**3**	
Overall outcome	**144**	**117**	**27**	

*Agreement: ≥ 80% agree without disagreement but potentially includes 'undecided' votes.
†Minority disagreement: ≥ 80% agree but with one or more disagreeing opinions.
‡Disagreement: <80% agreement.

emerging themes are (1) the additive impact of low carbohydrate availability (LCA) with LEA in the development of REDs; (2) the overlap of REDs and overtraining syndrome (OTS) symptomology; (3) the time-course of biomarker responses to problematic LEA in the development of REDs; (4) improved understanding of mental health associations of REDs; (5) advances in knowledge pertaining to REDs in male athletes and (6) para athletes.

The magnifying impact of LCA in the context of REDs

Most LEA intervention studies are also accompanied by a substantial reduction (25%–60%, depending on magnitude of LEA) in carbohydrate (CHO) ingestion, resulting in concurrent LCA.[45–48] In the real world, the magnitude of LCA is likely to be even greater considering the emphasis on protein intake during periods of calorie restriction.[49–51] Recently, several investigations have elucidated CHO's energy-independent or magnifying role in REDs-related health outcomes. There have been several short-term (≤6 days) investigations in male endurance athletes comparing the effects of high energy and high CHO availability, high energy with low CHO (<3 g CHO/kg BM/day) but high fat (LCHF), or low energy with low to moderate CHO availability diets on bone, immunity and iron biomarkers. These studies have reported increases in bone resorption biomarkers[52 53] with a concomitant impairment in biomarkers of bone formation,[53] as well as increased postexercise concentrations of interleukin-6 (IL-6) and hepcidin after LCA.[54] These findings suggest deleterious effects on bone, immunity and iron biomarkers as a result of LCA, sometimes in the absence of LEA. More recently, a 3-day intervention in young females also showed a 264% increase in hepcidin with a low energy, low CHO diet compared with only a 69% increase in hepcidin with isocaloric low energy but higher CHO diet.[55] Additionally, ~3.5 weeks of LCHF diet in elite endurance athletes resulted in impaired markers of bone remodelling both at rest as well as around exercise (up to 3 hours postexercise),[56] and elevated postexercise IL-6 concentrations compared with an isocaloric high CHO treatment.[57] Six studies since 2019 have shown an energy-independent and/or magnifying impact of LCA in the accelerated development of REDs outcomes.[52–57] Accordingly, LEA intervention studies need to also control and account for CHO intake and need to be of longer duration to determine long-term adaptation.

Symptomology overlap between REDs and OTS

REDs and OTS are syndromes involving the hypothalamic–pituitary–adrenal axis and have no single validated diagnostic biomarker; they feature a complex overlap of symptoms that hinge on a diagnosis utilising exclusion criteria.[37 58] Accordingly, a recent narrative review found that 18 of 21 identified OTS-based studies showed indications of LEA and LCA due to large increases in training while failing to compensate with increased EI, and thus may have demonstrated REDs outcomes rather than OTS.[37] It is important to note that LEA and/or LCA, although challenging to assess, should be *excluded* from an OTS diagnosis as LEA is the underlying aetiology for a REDs diagnosis.[37 59]

Time-course of LEA resulting in REDs

Although acute mild periods of LEA do not always lead to adverse outcomes, problematic LEA exposure leads to REDs. Our scientific understanding of the time-course of LEA leading to validated physiological and psychological signs/symptoms are still emerging, largely due to difficulties in accurately assessing and controlling for EA in prospective research.[21] Emerging definitions highlight short-term LEA as a few days to weeks, medium-term as weeks to months and long-term as months to years.[37 60] However, time-course cut-offs require further scientific validation, may differ between males and females and change with the severity and duration of LEA dose. Still, some signs/symptoms and REDs outcomes that appear to present temporally to various exposure periods of LEA have emerged. Importantly, some short-term signs or symptoms during the acute assessment may only represent a snapshot of a current LEA state and require the exclusion of other potential aetiologies (differential diagnoses). Such signs or symptoms do not always reflect a problematic LEA exposure leading to REDs.

Mental health outcomes of REDs

The sports community has prioritised the mental health of elite-level athletes as evidenced by a sharp rise in consensus statements[60–62] and prevalence studies[63–65] on this theme. A parallel focus has been the increased awareness of the risk factors for and the consequences of REDs, where psychological factors contributing to LEA and mental health consequences have been highlighted,[5] although less well understood.[6 35 66] Recent qualitative studies[1 67] involving mainly subelite endurance athletes provide support for this premise, reporting that LEA from intentional (eg, weight regulation) or unintentional (eg, failing to consciously increase EI with increased EEE) origins can be associated with short-term positive results such as performance improvements or social approval from the coach and the sports culture.[1] These short-term 'positive' outcomes make it more challenging for athletes to recognise the longer-term potential health and performance implications of exposure to problematic LEA.

Disordered eating (DE) behaviours, eating disorders (EDs) and/or REDs are common among certain athlete cohorts.[68] LEA and

DE behaviours, which exist along the spectrum between optimised nutrition and clinical EDs, may occur in isolation or together.[68] A prior history of DE behaviours or an ED might perpetuate a continued under-fuelling of energy[1] and must therefore be considered an important risk factor for developing REDs. DE behaviours and EDs may be exacerbated by social media influence, societal pressures, the athlete's training/coaching entourage, a belief that a specific physique/weight/appearance will improve performance and/or overall body dissatisfaction.[69] Given the potentially serious outcomes of DE behaviours and EDs, prevention, early identification, and timely interventions should be prioritised.[60 70]

Psychological indicators associated with problematic LEA and REDs are mood disturbances/fluctuations,[8 71 72] cognitive dietary restraint,[73] drive for thinness,[74 75] reduced sleep quality[30 76] and perfectionistic tendencies.[77] Depressive symptoms and affective disorders,[8 78 79] subjectively reported reduced well-being,[73] primary or secondary exercise dependence/addiction,[80 81] anxiety related to injury and/or recovery, sport-specific issues such as difficulty coping with weight requirements[67 76] and the development of EDs[1 82] are additional adverse mental health outcomes associated with problematic LEA and REDs. However, we must recognise that the picture is still unclear regarding the dynamics of mental health and DE behaviours according to sex and level of competition,[83] as well as in athletes with physical disabilities.[84] Furthermore, studies are required to (1) ascertain why many athletes experience few or no negative mental health consequences in the early stages of problematic LEA exposure[20 72 85] and (2) to better understand the reciprocal function of the different psychological variables.[86 87] As perceived stress appears to be common for many mental health concerns related to LEA and REDs, a heightened focus should be placed on developing psychologically safe environments surrounding athletes. Details on creating safe sport environments are outlined in the IOC consensus statement on mental health in elite athletes.[60]

REDs in male athletes

Although the 2014 IOC REDs consensus statement[3] and the 2018 update paper[6] alluded to the impact of LEA and REDs in male athletes, the available research on males at the time was scant. Since then, although the research community has emphasised the need for studies in men, currently only 20% of original studies from 2018 to 2022 include male athletes as subjects (see literature search summary in online supplemental file 1).

While a universal cut-off of 30 kcal/kg FFM/day as a threshold of LEA leading to some REDs outcomes in females is debated,[88] such a cut-off or range at which males experience REDs-related symptoms is even less understood,[89] but appears to be lower (eg, ~9to 25 kcal/kg FFM/day).[17 46 72 90 91] Indeed, there is evidence that most males can sustain a lower EA before physiological and psychological disturbances manifest. Nevertheless, problematic LEA can occur in male athletes and is associated with negative effects on the hypothalamic–pituitary–gonadal (HPG) axis and associated hormones[72 92–100]; changes in metabolic hormones[46 101–103]; impairments to immune function[104]; detriments to bone health[105]; as well as negative performance outcomes[18 90 104 106] and decreased lean body mass accrual.[107] Although changes are comparable to those REDs outcomes found in female athletes, the magnitude of the effects on some physiological parameters and the threshold at which these effects manifest appear to be variable between the sexes. Two emerging potential indicators of REDs in males are the presence of low libido and decreased morning erections, which have been identified as physiological consequences of LEA.[108–111]

REDs in para athletes

The estimated prevalence of REDs in para athletes is unknown; however, there are concerns that para athletes may be at even higher risk of problematic LEA than able-bodied athletes.[112] Among US para athletes preparing for Paralympic Games, 62% attempted to alter weight or body composition to enhance performance, 32% had elevated scores on the Eating Disorder Examination Questionnaire (EDE-Q) pathological behaviour subscale scores and 44% of the female athletes reported menstrual dysfunction.[113] Another study of EA estimates in wheelchair athletes reported that nearly the entire cohort fulfilled criteria of LEA across at least one 24-hour period during the week-long study.[114] Whether negative body image, risk of LEA and/or DE behaviours and EDs are related to their disability, athletic status, competitive pressure, training environment or a combination of factors remains to be elucidated.

Problematic LEA can lead to impaired bone health and bone-related injury secondary to factors such as altered skeletal loading experienced by para athletes (ie, the lack of loading stimulus experienced by wheelchair athletes and/or low-impact sports). Furthermore, in unilateral amputees, the affected limb may exhibit reduced bone mineral density (BMD).[115] Additionally, the presence of central neurological injury may result in alterations of the HPG axis and baseline menstrual function, regardless of energy status.[116 117] The risk of bone stress injury (BSI) is of particular concern in athletes with spinal cord injury who experience a substantial loss of BMD immediately postinjury and hence have a high incidence of low BMD for age and/or osteoporosis.[118] Dual-energy X-ray absorptiometry (DXA) is the most well-accepted tool for the measurement of BMD, but there are limitations in using standard population comparison reporting (eg, Z-scores); normative, reference datasets are determined from measurements in able-bodied populations and stratified by age-matched, sex-matched and limited race/ethnicity-matched categories to determine diagnostic cut-offs for 'low BMD for age' and 'osteoporosis'.[119 120] Therefore, there is a need for research in a wide variety of para athletes to develop BMD assessment techniques and reference ranges appropriate for the para athlete population.[112]

REDs Conceptual Models

The REDs Conceptual Models were developed to raise awareness of the athletic, coach, sports science and sports medicine communities to this syndrome. Figure 1 (REDs Health Model) and figure 2 (REDs Performance Model) are conceptual models that demonstrate the range of body systems for which there is theoretical, empirical, and/or clinical evidence of impairments that manifest in different ways. Undoubtedly, these outcomes occur over different timeframes and with different severity and significance to the individual athlete due to various moderating factors.[24]

Unlike earlier REDs models,[1 6] LEA is placed at the centre of the hub to note its role as an exposure variable. Graded arrows illustrate a continuum from adaptable LEA to problematic LEA exposure, with the former representing benign physiological adaptations to energy fluctuations (ie, physiological plasticity),[44] while the outer region of the hub notes the range of health and performance concerns which can be associated with the latter. A spectrum of energy mismatches, with differing severity of consequences, was part of the original concept of EA.[24] However, the updated model uses qualitative terms (adaptable, problematic) as an alternative to the previous focus on quantitative assessments with universally applied thresholds of concern. The most well-documented sequelae of problematic LEA are impairments

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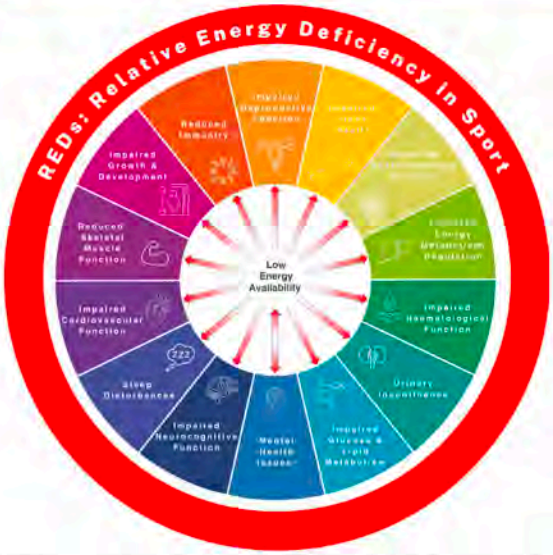


Figure 1 REDs Health Conceptual Model. The effects of LEA exist on a continuum. While some exposure to LEA is mild and transient termed adaptable LEA (arrow depicted in white), problematic LEA is associated with a variety of adverse REDs outcomes (arrow depicted in red). *Mental Health Issues can either precede REDs or be the result of REDs. LEA, low energy availability; REDs, Relative Energy Deficiency in Sport.

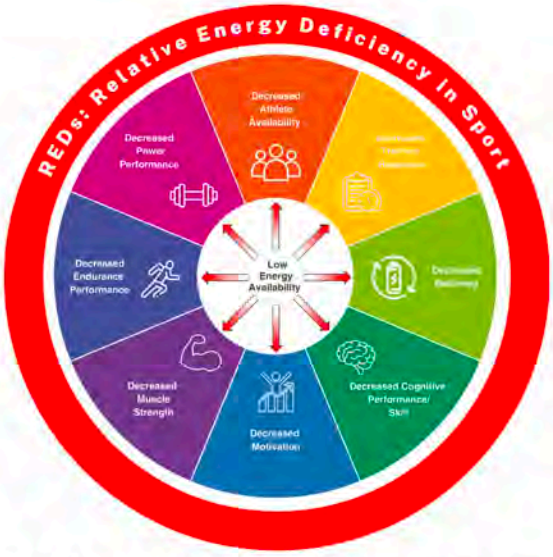


Figure 2 REDs Performance Conceptual Model. The effects of LEA exist on a continuum. While some exposure to LEA is mild and transient, termed adaptable LEA (arrow depicted in white), problematic LEA is associated with a variety of adverse REDs performance outcomes (arrow depicted in red). LEA, low energy availability; REDs, Relative Energy Deficiency in Sport.

of reproductive function and bone health in female and male athletes.[121–123] Tables 2 and 3 summarise these and many other conditions associated with LEA in athletes and other populations. Future updates will likely revise the range of recognised sequelae associated with REDs as we learn more about the effects of energy allocation and potential prioritisation of various body systems.

It is important to note that the REDs Health and Performance Conceptual Models are not separate entities; they involve considerable overlap. Indeed, presenting this information in two wheels simply offers different audiences an appreciation of the issues of greatest relevance to them. Each sign or symptom within the REDs Conceptual Models can occur due to aetiologies other than problematic LEA (tables 2 and 3). Therefore, the exclusion of primary aetiologies (differential diagnoses) should occur when diagnosing REDs (see Clinical Assessment Tool section below).

REDs Physiological Model

Experts in the field have long realised that applying LEA exposure (ie, severity, duration, frequency) on subsequent REDs short, medium and long-term outcomes is complex and dependent on many moderating factors. Accordingly, and novel to this 2023 consensus update, a more researched and clinically based unifying physiological model has been developed. To progress the REDs scientific field forward, we need integrated dynamic physiological models that can help explain the biological complexity and interaction within and between various body systems, as well as the inconsistencies in the manifestation of REDs signs and symptoms resulting from problematic LEA. Ideally, unique physiological models can be developed for each body system within the Health Conceptual Models (see figure 1) before being integrated to acknowledge substantial physiological 'cross-talk' among systems.

Step 1 of the REDs Physiological Model for each body system (figure 3) is to identify the range of specific health and performance impairments that might occur from LEA exposure, along with details of the criterion tests and metrics that best assess the presence of such disturbances. ***Step 2*** is to focus on characteristics of an athlete's LEA exposure (see figure 3 for examples) that might create a higher risk of it being problematic; for example, the duration, magnitude or origin of the LEA mismatch (see figure 3 for examples). ***Step 3*** is to consider moderating factors in an individual athlete's makeup, behaviours or environment that may either exacerbate or protect against various LEA-associated health and/or performance dysfunctions as they related to the specific body system. A systematic identification of such moderating factors is proposed (figure 3).

The development of a physiological model for each body system, underpinned by a 'systems biology mindset',[124] will enable a more nuanced assessment of the individual athlete and whether their specific combination of LEA exposure and secondary moderators is likely to lead to positive, neutral or negative health and/or performance outcomes.

Clinical applications

Assessment of EA

Seminal research[45 125] around EA in habitually sedentary females identified a continuum of zones ranging from low to high risk of harm (eg, high EA for mass gain and growth ≥45 kcal/kg FFM/day; adequate EA for weight maintenance and support of body function = ~45 kcal/kg FFM/day; reduced EA for body

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Table 2 Potential REDs health outcomes resulting from problematic LEA

Spoke	Examples of impairment	Populations with LEA (assessed directly or via surrogates) providing evidence of impairment	Examples of differential diagnoses (issues to be excluded)
Impaired reproductive function	***Females***	SF,[45 127 173–175] FA[176–179]	***Females***
	Alteration in LH concentrations or pulsatility	SF,[88] FA[168 180–184]	*Primary amenorrhoea:* constitutionally delayed puberty, various genetic syndromes, anatomic abnormalities
	Reduced oestrogen and progesterone	FA[178]	*Secondary amenorrhoea:* pregnancy, PCOS, pituitary mass (eg, prolactinoma), thyroid abnormalities
	Reduced testosterone	FA[185 186]	*Other menstrual dysfunction:* use of hormonal birth control methods, physiologic stress
	Primary amenorrhoea	SF,[88] FA[183 187 188]	***Males***
	Oligomenorrhoea/menstrual irregularities	FA[181–182 187 189 190]	Primary hypogonadism (gonadal disease), Hypogonadism (eg, hypothalamic/pituitary disease), toxic exposures, infection, psychosomatic neurological dysfunction
	Secondary amenorrhoea (FHA)	SF,[88 174] FA[187]	
	Luteal phase defects/deficiency	SF,[88] FA[187]	
	Anovulatory cycles		
	Males		
	Reduced testosterone	MA[18 90 98 102 191–197]	
	Sperm abnormalities	MA[194]	
	Erectile dysfunction	MA[81 108 111]	
	Females and males		
	Decreased libido	MA[108 111 198]	
Impaired bone health	Longitudinal loss of BMD/lack of expected bone accrual or maintenance (younger populations)	ANF,[195] FA,[196] MA[197]	*Low BMD:* genetic bone disorders (eg, osteogenesis imperfecta), hyperparathyroidism, poor micronutrient intake (eg, calcium and vitamin D), malabsorption disorders (eg, coeliac disease), malignancies (eg, leukaemia, lymphoma, metastasis), renal diseases, medications (eg, anabolic steroids)
	Lower BMD/low Z-score	FA[49 198–200] MA[18 49 200 201]	*Bone stress injury:*
	Impaired bone strength or microarchitecture	FA[202–204] MA[205]	External reasons (eg, training errors, surface, shoes) or internal issues (eg, body build, medical predispositions as above)
	Bone stress injuries		
	Change/differences in bone remodelling biomarkers	FA,[49 81 206–208] MA[49 81 210]	
		SF,[125] FA,[93 176 179 211] MA[53 212 213]	
Impaired GI function	Abdominal pain/cramps/bloating/alteration in bowel movements	FA,[8 81 169 214] MA[81]	GI diseases (eg, Coeliac disease, inflammatory bowel disease, *Helicobacter pylori*, gastro-oesophageal reflux, functional dyspepsia/constipation), medications (eg, antidepressants, iron pills, narcotics, laxative/cathartic use in EDs)
Impaired energy metabolism/ regulation	Subclinically or clinically low T3	SF,[127 185 215 216] FA,[49 183 170 188 188 199 217 218] MA[49 190]	Primary or central (secondary and tertiary) hypothyroidism, medications/supplements
	Low RMR/RMR ratio		
	Reduced leptin	FA[192 194 196 213–177] MA[197 199 222]	
		SF,[45 169] FA,[81 170 179 188 217] MA[46 224]	
		SF,[127 175] FA,[178 179 184 222 225] MA[86 102]	
	Increased cortisol		*Increased cortisol:* physiologic stress, Cushing disease, steroid use
Impaired haematological status	Low iron status	FA[226]	Acute or chronic blood loss (eg, menstrual cycle, GI bleeding), RBC destruction (eg, haemolysis, haemoglobinopathy, splenomegaly), poor micronutrient intake (eg, iron, vitamin B_{12}, folate), bone marrow diseases
	Increased hepcidin concentrations/response	SF,[55] MA[171 221]	
	Reduced iron absorption	MA[227]	
	Lower haemoglobin concentration/mass	FA,[228] MA[73]	
	Reduced response to altitude training	MA[229]	
Urinary incontinence	Urinary incontinence	FA[230–232]	Persistent urinary incontinence: trauma (eg, childbirth, surgery, radiation), anatomical abnormalities, neurological diseases Temporary urinary incontinence: pregnancy, urinary tract infection, constipation, certain foods and drugs
Impaired glucose and lipid metabolism	Reduced fasting/24-hour glucose	SF,[127] FA,[184 214 219] MA[233]	Impaired glucose metabolism: insulinoma, critical illness, medications, adrenal insufficiency Impaired lipid metabolism: familial hyperlipidaemia
	Reduced fasting/24-hour insulin	SF,[127] FA,[47] MA[46 102 233 234]	
	Elevated total cholesterol/LDL cholesterol	FA,[181 235 236] MA[72 192 199]	
Mental health issues	Depression	FA,[8 78 79] MA[79]	Primary psychologic/mood disorders
	Exercise dependence/addiction	FA,[81 237] MA[80 81]	
	DE behaviours/EDs	FA,[81 182 219] MA[80 81]	
Impaired neurocognitive function	Reduced/impaired memory	FA,[238] ANF[239]	Dementia (eg, Alzheimer's disease), vitamin deficiencies, infections, malignancies, ADHD, substance use disorder, primary psychologic/mood disorders, traumatic brain injury
	Reduced/impaired decision-making	ANF[240]	
	Reduced/impaired spatial awareness	FA[241]	
	Poor planning/cognitive flexibility	ANF[240]	
	Reduced executive function	FA[238]	

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Table 2 Continued

Spoke	Examples of impairment	Populations with LEA (assessed directly or via surrogates) providing evidence of impairment	Examples of differential diagnoses (issues to be excluded)
Sleep disturbances	Sleep disturbances (self-reported)	FA,[76] MA[70]	Primary psychologic/mood disorders, shift-work, obstructive sleep apnoea, chronic pain/injury, nocturia, medications/substance use, restless legs syndrome
Impaired cardiovascular function	ECG abnormalities (eg, sinus bradycardia, QT prolongation and QT dispersion)	FA,[139 242] MA,[72 244] ANM,[245] ANF[240 241]	*Bradycardia:* Genetic, ultra-endurance training, hypothyroidism, medications (eg, beta-blockers), toxic exposures, electroconductive disorders, electrolyte abnormalities
	Haemodynamic abnormalities (eg, hypotension and orthostatic hypotension, syncope)	FA,[240 248] ANF,[249] MA[244]	
	Impaired endothelial function/reduced blood flow	FA,[221 235 243 250–254] MA[255]	
	Cardiac abnormalities (eg, MVP, decreased left ventricular mass, decreased left ventricular systolic function, myocardial fibrosis)	ANF,[256] ANM[245 256]	*Hypotension:* illness, medications, dehydration
Reduced skeletal muscle function	Reduced rate of muscle protein synthesis Reduced rates of muscle glycogen restoration	FA,[257–259] SM,[161] MA[257 258] FA,[261] MA[48 262]	Inadequate protein intake Inadequate CHO intake
Impaired growth and development	Reduced IGF-1 Increased GH/GH resistance Deviation from the expected growth curve	SF,[127 215] FA,[168 170] MA[191 234 263 264] SF,[127] FA,[175] MA[192 264] FA,[196] ANF,[265 266] ANM[267 268]	Constitutional delayed puberty, chronic diseases, GH deficiency, congenital or acquired hypogonadotropic hypogonadism, genetic defects, hyperprolactinaemia, long-term drug use (eg, anabolic steroids, opioids, glucocorticosteroids)
Reduced immunity	Increased infection/illness susceptibility Change in immune biomarkers	FA,[10 269–271] MA[10 269 270] FA,[272] MA[273]	Primary or acquired immune deficiency (eg, chemotherapy, viral infections) Intensive exercise without LEA

Each of these outcomes can occur in the absence of LEA, therefore the differential diagnosis should be considered in the assessment and diagnosis of REDs severity and/or risk.
Populations providing evidence types: SF: sedentary females; FA: female athletes; ANF: females with anorexia nervosa; MA: male athletes; SM: sedentary males; ANM: males with anorexia nervosa.
ADHD, attention-deficit/hyperactivity disorder; CHO, carbohydrate; ECG, electrocardiogram; EDs, eating disorders; FHA, functional hypothalamic amenorrhoea; GH, growth hormone; GI, gastrointestinal; IGF-1, insulin-like growth factor-1; LDL, low density lipoprotein; LEA, low energy availability; LH, luteinising hormone; MVP, mitral valve prolapse; OCD, obsessive compulsive disorder; PCOS, polycystic ovary syndrome; RMR, resting metabolic rate; T3, triiodothyronine.

mass/fat loss=30–45 kcal/kg FFM/day; and LEA causing health implications ≤30 kcal/kg FFM/day).[126] The concept of the LEA threshold (30 kcal/kg FFM/day), below which health problems occurred, was based on elegant but short-term laboratory studies that investigated stepwise changes in EA, perturbations of sex hormones[45 127 128] and changes in markers of bone turnover[125] in a small sample of sedentary females. Although this concept was intended as a guide, rather than a diagnostic end-point, more recent information gleaned from real-life clinical observations, as well as short-term studies,[88] theoretical constructs and methodological challenges in assessment, around the frailty of a single, universal threshold,[129] have identified large differences in the EA level associated with health and performance concerns between individuals, the sexes, and among different body systems. Therefore, although EA calculations may inform research interventions or observations, there are risks in setting a definitive clinical threshold of EA due to many moderating factors.

Unfortunately, the measurement of EA in free-living athletes is challenged by a high level of burden (eg, time, effort) to the participant and assessor. Also, protocols to undertake EA assessments or EA-based diet prescription will continue to be challenged by the errors associated with accurately measuring EI, EEE and other contributing components (eg, FFM, resting metabolic rate (RMR)),[40 49 129] but these can be better managed in the future by implementing a standardised approach. Protocols that achieve a harmonised time-course for assessment and the individual components of EA may assist in future LEA and REDs activities by standardising the errors and limitations of the assessment, and balancing the issues of time and resource burden, feasibility and measurement precision. Future use of standardised methodologies should assist in better assessment of EA, more nuanced interpretation of past and future data, and better replication or comparison of work in this area.

Body composition assessment and management

Body composition assessment and management are important for optimising health and athletic performance, particularly in weight-sensitive and leanness-demanding sports.[130] Athletes may experience internal and/or external pressure to attain an 'athletic look' (aesthetic), potentially leading to body dissatisfaction and LEA, and then to symptoms of REDs, DE behaviours or EDs.[76 131] This is of concern, especially for young athletes, due to potentially long-lasting negative physical and psychological outcomes. Thus, body composition assessment is recommended only for medical purposes under 18 years of age[26 132 133] (see figure 4). Exceptional circumstances may exist where body composition assessment may be justified for athletes <18 years. Still, such a decision warrants careful consideration and consensus among the athletes' health and performance team and requires guardian consent.

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Many sports have engrained cultures where coaches and members of the athlete health and performance team exert subtle to extreme pressure on athletes to regulate body weight and composition.[131 134] Unfortunately, many members of the athlete entourage appear to (1) lack the knowledge of safe regulation of body weight and composition and how it can be utilised to improve performance while maintaining health; (2) have ignorance of the suitability of various body composition methods and the possible negative health effects consequent to inappropriate assessment and (3) have inadequate communication skills, with lack of optimised protocols on how to manage and safely implement the data to promote health and performance without the added risk of developing REDs, DE behaviours or EDs. In some instances, erroneous and intensive body composition measurement could lead to allegations of harassment and abuse by athletes.[132 135] It is important, therefore, to identify valid and

Table 3 Potential REDs performance outcomes that can result from problematic LEA

Spoke	Examples of direct or indirect impairment	Athletic populations with LEA (assessed directly or via surrogates) providing evidence of impairment
Decreased athlete availability (illness and injury)	Increase in training days lost or modified due to illness or injury (eg, impaired preparation)	Tier 4* FA (n=85) and MA (n=47) Olympic athletes from 11 different sports[10] Tier 4 FA (n=55) and MA (n=26) Olympic athletes from 11 different sports[269] Tier 4 FA endurance athletes (n=45)[214] Tier 4 FA endurance athletes (n=13)[274] Tier 3 FA college athletes (n=116) from endurance, power and team sports[275] Unspecified Tier FA high-school athletes (n=163) from endurance, power and team sports[276] Unspecified Tier FA high-school athletes (n=249) from aesthetic, endurance and team sports[277] A mix of Tier 1–4 FA (n=838)[278] Tier 2 FA figure skaters (n=137)[279]
	Inability to compete at key competitions due to illness or injury	Tier 4 FA endurance athletes (n=13)[274] Unspecified Tier FA high school athletes (n=163) from endurance, power and team sports[276]
Decreased training response	Decreased rather than increased performance of treadmill protocol following 4 weeks intensified training plus 2 weeks recovery	Tier 2 club level FA endurance runners (n=16)[71]
	Reduced performance of 5 km on-water rowing following a period of intensified training	Tier 4 national level MA (n=5) and FA rowers (n=5)[215]
	Reduced swimming velocity in 400 m time trial after 12 weeks of training	Tier 3 junior national level FA swimmers (n=10)[168]
	Self-reported reduction in training response	Unspecified mixed tier FA (n=1000)[8]
	Decreased aerobic (4000 m time trial) and anaerobic (15 s) performance after 2 weeks intensified training including inadequate energy intake	Tier 3 MA road cyclists (n=13)[116]
Decreased recovery	Direct: self-reported failure to recover between training sessions	Tier 4 FA (n=8) and MA (n=4) lightweight rowers[70]
	Indirect: reduced glycogen synthesis	Tier 3 MA endurance runners (n=7)[69] Tier 1 MA (n=6) and FA (n=7) endurance athletes[151]
	Indirect: reduced muscle protein synthesis	Unspecified tier resistance-trained FA (n=7) and MA (n=8)[217]
	Indirect: reduced PCr recovery	Tier 2 FA (n=19) endurance athletes[280]
Decreased cognitive performance/skill	Reduced reaction time	Tier 4 FA endurance athletes (n=30)[194]
	Self-reported impaired judgement and decreased coordination and concentration	Unspecified tier FA (n=1000)[8]
Decreased motivation	Decreased well-being	Tier 3 MA endurance athletes (n=18)[40]
	Increase in total mood disturbance (eg, fatigue, vigour)	Tier 4 national level MA (n=5) and FA rowers (n=5)[279]
	Self-reported increase in irritability and depression	Unspecified tier FA (n=1000)[8]
	Emotional lability	Tier 2–4 Mix of sports FA (n=8)[69]
	Increased irritability	Tier 3 Endurance FA (n=10) and MA (n=2)[67]
	Increase in total mood disturbance and general stress	Tier 3 MA Road cyclists (n=13)[116]
	Self-reported decrease in mood, emotional self-regulation, concentration, social interaction, food anxiety	Tier 4 FA (n=8) and MA (n=4) lightweight rowers[70]
Decreased muscle strength	Decreased neuromuscular strength	er 4 FA endurance athletes (n=30)[194]
	Decreased explosive power (countermovement jump)	Tier 3 MA endurance athletes (n=18)[40]
	Decreased explosive power (countermovement jump, reactive jump)	Tier 2–3 MA bodybuilder (n=1)[281]
	Decreased concentric hamstring peak torque	Tier 2 junior elite FA cross country skiers (n=19)[282]
	Decreased isometric bench press	Tier 2–3 MA bodybuilder (n=1)[281]
	Decreased one rep max squat, bench press, deadlift	Tier 2–3 FA fitness competitors (n=27)[194]
	Decreased concentric and eccentric peak force	Tier 2–3 MA bodybuilder (n=1)[284] Tier 2–3 FA physique athlete (n=1)[285]

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Table 3 Continued

Spoke	Examples of direct or indirect impairment	Athletic populations with LEA (assessed directly or via surrogates) providing evidence of impairment
Decreased endurance performance	Decreased performance of treadmill run protocol Reduced 5 km on-water rowing performance Decreased neuromuscular endurance Self-reported reduction in endurance performance	Tier 2 club level FA endurance runners (n=16)[ ] Tier 4 national level MA (n=5) and FA rowers (n=5)[75] Tier 4 FA endurance athletes (n=30)[ ] Unspecified Tier FA athletes (n=1000)[ ]
	Decreased $VO_{2\,max}$	Tier 3–4 FA endurance athletes (n=33)[ ] Tier 3 MA road cyclists (n=50)[ ] Tier 3 MA road cyclists (n=13)[ ]
	Apparent underperformance in 60 min functional power threshold vs training load Decreased performance of 4000 m time trial Self-reported decrease in rowing performance	Tier 4 FA (n=8) and M (n=4) lightweight rowers[ ]
Decreased power performance	Reduced velocity during 400 m swim time trial Decreased anaerobic (Wingate) performance Decreased number of throws in a Judo Specific Fitness Test Decreased performance of 15 s cycling sprint	Tier 3 junior national level FA swimmers (n=10)[ ] Tier 2–3 MA bodybuilder (n=1)[ ] Tier 2 MA second and third Dan black belt Judo athletes (n=11)[ ] Tier 3 MA road cyclists (n=13)[ ]

Each outcome can occur in the absence of LEA; therefore a differential diagnosis should always be considered in the assessment of REDs severity and/or risk.
*Tiering system according to McKay *et al*.[ ]
FA, female athlete; MA, male athlete; PCr, phosphorylated creatine; VO_{2} max, maximal oxygen consumption.

reliable body composition assessment methods and develop clear guidelines on how to interpret, manage, and communicate safely to athletic populations.[132]

Choosing an appropriate body composition assessment method involves consideration of its accuracy, repeatability, utility and cost. Some easy-to-use methods are 'doubly indirect', relying on regression equations to derive a body fat per cent; they do not provide valid data, use spurious assumptions and/or are influenced greatly by athlete presentation (eg, hydration levels).[136] Conversely, with operator training and sampling several sites, reliable assessments of subcutaneous adipose tissue thicknesses can be obtained via skinfolds (compressed and skin included) and brightness-mode (B-mode) ultrasound (uncompressed) method demonstrating good accuracy and sensitivity, especially for lean individuals.[137] Though costlier, DXA is a reliable method for assessing BMD and estimating fat and lean masses, provided standard test protocols are used.[138–140] In summary, using skinfolds, DXA, and B-mode ultrasound are the proposed body composition assessment methods available at the time of publication. For para athletes, adjustments of the assessment protocol and analysis of results may be needed. If that is impossible, the assessment should not proceed.

To minimise the risk of problematic LEA and DE behaviours, assessment of body mass and body composition is best conducted

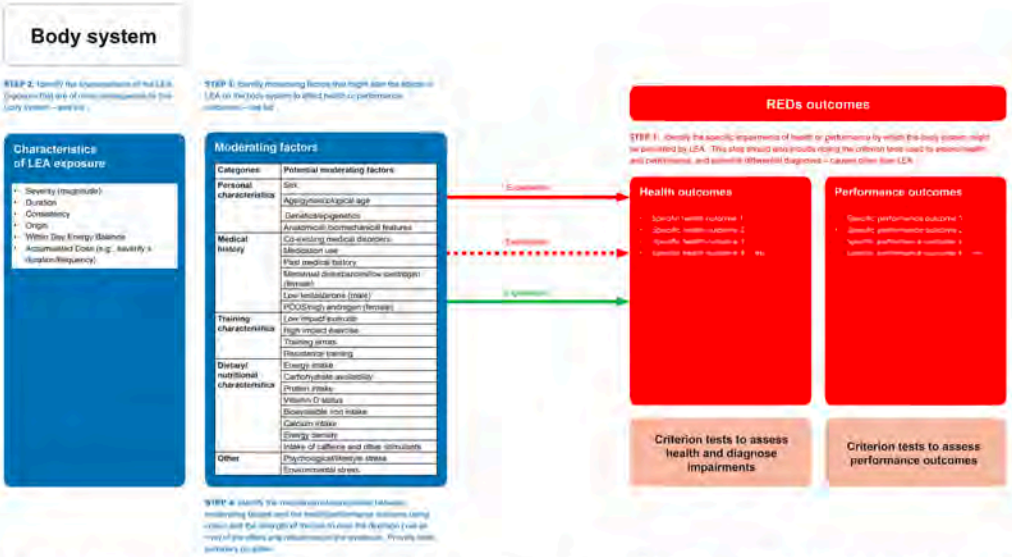


Figure 3 Integrated template of a clinical Physiological Model to show how problematic LEA 'exposure', with various associated moderating factors, can lead to various REDs 'outcomes', as represented by body system/health dysfunction(s) and potential performance impairment(s). This template outlines four steps to adapt and update the model as the future science of LEA/REDs evolves. Examples of moderating factors are also provided (step 3). LEA, low energy availability; REDs, Relative Energy Deficiency in Sport.

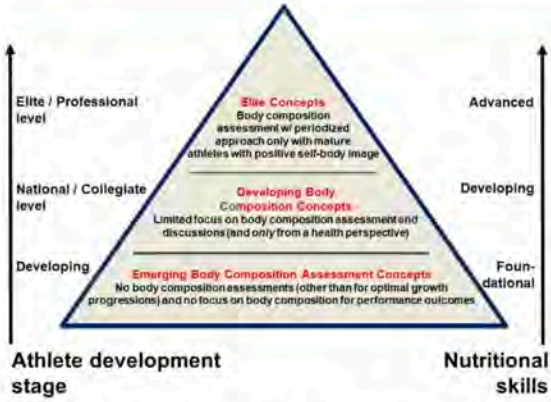


Figure 4 A conceptual framework on the implementation of body composition assessments (eg, height, weight, anthropometrics, skinfolds) within the context of athlete stage of development and their nutritional preparation skills[132] (reprinted with permission from BJSM).

by the athlete health and performance team who are trained in the specific methods and are competent to support the athlete and coach in making informed 'health first–performance second' decisions relating to body composition manipulation.[26 132] This should include prescreening to assess body image concerns and problematic eating behaviours, as well as implementing appropriate dietary interventions and subsequent athlete monitoring. Finally, body composition data are considered health data and must be kept confidential with appropriate levels of data protection. Accordingly, each body composition assessment and outcome report requires athlete informed consent and should only be shared with those the athlete authorises to be privy to the results.[68]

IOC REDs Clinical Assessment Tool-Version 2 (IOC REDs CAT2)

Significant scientific progress in REDs severity and risk assessment has been made since the original IOC REDs Clinical Assessment Tool (CAT) was published in 2015.[141] Because problematic LEA is the underlying aetiology for the health and performance outcomes of REDs, various LEA indicators (signs and symptoms) have emerged as the current best practice for clinical assessment and research purposes. These indicators underpin the new IOC REDs CAT2[25] (figures 5 and 6, and tables 4 and 5), which has undergone internal expert voting statement validation (see online supplemental files 2–4) and external REDs expert clinical cross-agreement validation.[25]

The IOC REDs CAT2 consists of a three-step process (figure 5): *Step 1*: implementation of population-specific validated REDs Screening Questionnaire(s) and/or clinical interviews, which are less sensitive and objective but inexpensive and easy to implement for the initial identification of athletes at risk; *Step 2*: implementation of the IOC REDs CAT2 Severity/Risk Assessment (tables 4 and 5) and Stratification with Sport Participation Guidelines (figure 6). These tools are based on accumulating various primary and secondary risk indicators (eg, biomarkers, BMD, injury history (tables 4 and 5), resulting in the stratification of an athlete's severity and risk as either green, yellow, orange or red light; and *Step 3*: an expert physician diagnosis including a treatment plan ideally integrating a collaborative multidisciplinary team (see Definitions box 2).

The IOC REDs CAT2[25] introduces a four-colour traffic-light severity/risk categorisation, in contrast to the three-colour stratification in the 2015 RED-S CAT,[141] due to the appreciation that the 2015 yellow zone had an extensive clinical severity/risk range of very low (a few minor symptoms) to very high (a few indicators away from removal from sport). Furthermore, each REDs traffic-light outcome is associated with varying severity/risk and sport participation recommendations (figure 6), ranging from full participation in training and competition (green) to continued monitoring (yellow) to intensive medical interventions and monitoring (orange) all the way to full medical support coupled with consideration for removal from competition and training (red). The IOC REDs CAT2 also provides a more concrete scientific framework and, where scientifically supported, a scoring system identified for each indicator. It is important to note that despite diagnostic progress, there is no singular validated diagnostic method for REDs, as the syndrome has a complex mosaic of signs and symptoms, necessitating the exclusion of other potential aetiologies in the differential diagnosis for each REDs indicator. Over time, the IOC REDs CAT2 will be modified to reflect advances in scientific knowledge and feedback from widespread utilisation.

Prevention and treatment of REDs

Primary and secondary prevention of REDs

Primary prevention includes tackling inadequate awareness and knowledge of the health and performance sequelae of REDs and sports nutrition among athletes[113 142–144] and their entourage (eg, coaches,[145–147] parents, athlete health and performance



Figure 5 The IOC REDs CAT2 three-step protocol including: Step (1) screening; Step (2) severity and risk assessment and stratification; and Step (3) clinical diagnosis and treatment. CAT, Clinical Assessment Tool; IOC, International Olympic Committee; REDs: Relative Energy Deficiency in Sport.

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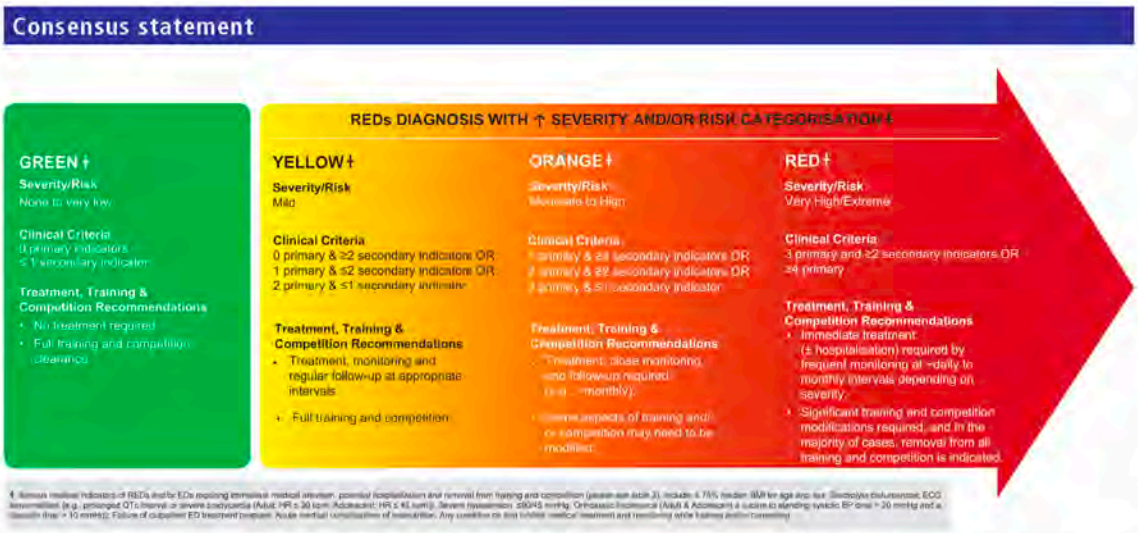


Figure 6 IOC REDs CAT2 Severity/Risk stratification with sport participation guidelines implementing the associated IOC REDs Severity/Risk Assessment tool (see table 4), with varying clinical management recommendations. Please see online supplemental file 5 for the IOC REDs CAT2 scoring tool. *Disclaimer*: these guidelines are not to be used in isolation and are not to be solely used for diagnosis. Furthermore, these guidelines are less reliable when it is impossible to assess all indicators in table 4. These guidelines are not a substitute for professional clinical diagnosis, advice and/or treatment from a team of REDs health and performance experts led by a physician. along with the evaluation of health status presented here, Severity/Risk stratification and sport participation decisions need to be made in the context of various decision modifiers, such as performance level of the athlete, sport type, participation risk, conflict of interest, athlete/coach pressures, timing and season.[285]
bpm, beats per minute; BMI, body mass index; bp, blood pressure; ECG, electrocardiogram; EDs, eating disorders; HR, heart rate; REDs, Relative Energy Deficiency in Sport.

team).[142 148 149] For example, less than half of coaches and physicians surveyed were able to identify the three components of the female athlete triad[147 148 150 151]; other studies reported similar knowledge gaps among physiotherapists and athletic trainers.[142 145] Short-term education programmes, using various delivery methods and focusing on factors associated with EDs, DE behaviours, and REDs have been shown to improve nutritional knowledge and reduce signs of dieting and body image concerns in female and male athletes.[70 152–158] Furthermore, early identification of symptoms using screening instruments, individual health interviews and objective assessment of REDs biomarkers may be useful as secondary prevention.[25] However, the REDs education and behaviour modification research field is underdeveloped, and specific REDs education programmes targeting athletes and other key personnel require further exploration and validation.[27]

Treatment (tertiary prevention) principles of REDs

Clinical treatment of diagnosed REDs cases (risk stratified in the yellow, orange and red light) should prevent further long-term health and performance sequelae,[27] sometimes requiring adjuvant treatment of body system dysfunction(s) (eg, low BMD, GI dysfunction, depression (see figures 1 and 2)) while reversing problematic LEA and its various underpinning causes.[69] The primary approach to treating REDs should be a restoration of optimal EA via non-pharmacological approaches, including changes to diet and exercise to achieve sustained optimal EA with appropriate contributions of macronutrients and micronutrients.[159]

Studies of LEA exposure have identified a somewhat more prominent effect of poor EI, rather than excessive EEE, in causing most of the physiological perturbations.[127 160] Long-term, well-controlled dietary and/or exercise intervention studies of REDs are needed, but numerous practical and methodological challenges exist. Indeed, in the one intention-to-treat 12-month, randomised controlled clinical trial that implemented dietary changes to increase EI in exercising females with REDs-related biomarkers, there was a high drop-out rate (57%), and improvement in some (eg, menstrual function resumption in select participants),[161] but not all symptoms (eg, inability to retard bone loss).[162] Such findings may indicate that optimal dietary interventions are not yet identified, dietary changes are difficult to accept or implement, various REDs sequelae improve at different rates, the dose of LEA may influence time to recovery, or a combination of these and other factors.

There are some useful pharmacological and psychological approaches emerging to treat clinical issues associated with REDs.[27] One example is 17β-oestradiol transdermal patch continuously with cyclic oral micronised progesterone administration, which demonstrated increased BMD Z-scores at the spine (2.75%), femoral neck (5.25%) and total hip (1.85%) at the end of a 12-month intervention in oligo-amenorrhoeic endurance athletes; those randomised to combined oral contraceptive pills (ethinyl oestradiol and desogestrel) or no treatment had inferior BMD results.[163]

A comprehensive team approach of the athlete health and performance team, including sports medicine, nutrition, psychology and sports science personnel, together with coach and family engagement is recommended. The team approach is especially important in athletes with severe REDs stemming from DE behaviours or EDs.[27 68 164] Treatment goals should ensure safe sport participation while undergoing long-term treatment and monitoring, including risk stratification to assess the safety of continued sports participation.

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Table 4 IOC REDs CAT2 Severity/Risk Assessment tool that implements primary, secondary and potential indicators into a traffic-light criterion outlined in figure 6

REDs indicator	References
Severe primary indicators (count as 2 primary indicators)	
Primary amenorrhoea (*females*: primary amenorrhoea is indicated when there has been a failure to menstruate by age 15 in the presence of normal secondary sexual development (two SD above the mean of 13 years), or within 5 years after breast development if that occurs before age 10); or prolonged secondary amenorrhoea (absence of 12 or more consecutive menstrual cycles) due to FHA	6 141 286–288
Clinically low free or total testosterone (*males*: below the reference range)	49 92 121 289–291
Primary indicators	
Secondary amenorrhoea (*females*: absence of 3–11 consecutive menstrual cycles) caused by FHA	6 141 286 289
Subclinically low total or free testosterone (*males*: within the lowest 25% (quartile) of the reference range)	49 92 95 121 289–291
Subclinically or clinically low total or free T3 (within or below the lowest 25% (quartile) of the reference range)	49 289 290
History of ≥1 high-risk (femoral neck, sacrum, pelvis) or ≥2 low-risk BSI (all other BSI locations) within the previous 2 years or absence of ≥6 months from training due to BSI in the previous 2 years	100 286 292
Pre-menopausal females and males <50 years old: BMD Z-score* <−1 at the lumbar spine, total hip or femoral neck; or decrease in BMD Z-score from prior testing *Children/adolescents*: BMD Z-score* <−1 at the lumbar spine or TBLH or decrease in BMD Z-score from prior testing (can occur from bone loss or inadequate bone accrual)	119 120 123 288
A negative deviation of a paediatric or adolescent athlete's previous growth trajectory (height and/or weight)	294 295
An elevated score for the EDE-Q global (>2.30 in females; >1.68 in males) and/or clinically diagnosed DSM-5-TR-defined Eating Disorder (*only one primary indicator for either or both outcomes*)	68 80 276 286–288
Secondary indicators	
Oligomenorrhoea caused by FHA (>35 days between periods for a maximum of 8 periods/year)	6 141 286 289
History of 1 low-risk BSI (see high vs low-risk definition above) within the previous 2 years *and* absence of <6 months from training due to BSI in the previous 2 years	100 286 292
Elevated total or LDL cholesterol (above reference range)	191 285 288
Clinically diagnosed depression and/or anxiety (*only one secondary indicator for either or both outcomes*)	296 300 301
Potential indicators (not scored, emerging)††	
Subclinically or clinically low IGF-1 (within or below the lowest 25% (quartile) of the reference range)	11 100 298
Clinically low blood glucose (below the reference range)	11 103
Clinically low blood insulin (below the reference range)	45 179 290
Chronically poor or sudden decline in iron studies (eg, ferritin, iron, transferrin) and/or haemoglobin	169 300–304
Lack of ovulation (via urinary ovulation detection)	287 305–307
Elevated resting AM or 24-hour urine cortisol (above the reference range or significant change for an individual)	45 127 179 290
Urinary incontinence (*females*)	290 308 309
GI or liver dysfunction/adverse GI symptoms at rest and during exercise	9 214 310
Reduced or low RMR <90 kcal/kg FFM/day or RMR ratio <0.90	9 219 311 312
Reduced or low libido/sex drive (especially in males) and decreased morning erections	108–111
Symptomatic orthostatic hypotension	294 313 314
Bradycardia (HR <40 in adult athletes; HR <50 in adolescent athletes)	198 295 315
Low systolic or diastolic BP (<90/60 mm Hg)	315 316
Sleep disturbances	307 317
Psychological symptoms (eg, increased stress, anxiety, mood changes, body dissatisfaction and/or body dysmorphia)	9 68 296–300 301 318
Exercise dependence/addiction	68 80 319 320
Low BMI	258 294 295

Continued

Table 4 Continued

REDs indicator	References
Every indicator above requires consideration of a non-LEA-mediated differential diagnosis. All indicators apply to females and males unless indicated. Menstrual cycle status and endogenous sex hormone levels cannot be accurately assessed in athletes who are taking sex hormone-altering medications (eg, hormone-based contraceptives), and thyroid hormone status indicators cannot be accurately assessed in athletes who are taking thyroid medications. All laboratory values should be interpreted in the context of age-appropriate and sex-appropriate and laboratory-specific reference ranges. Most REDs data and associated thresholds have been established in premenopausal/andropausal adults unless indicated. *Disclaimer*: this tool should not be used in isolation nor solely for diagnosis, as every indicator requires clinical consideration of a non-LEA-mediated differential diagnosis. Furthermore, the tool is less reliable in situations where it is impossible to assess all indicators (eg, menstrual cycle status in females who are using hormonal contraception). This tool is not a substitute for professional clinical diagnosis, advice and/or treatment from a physician-led team of REDs health and performance experts Adolescent refers to <18 years of age. *BMD assessed via DXA within ≤6 months. In some situations, using a Z-score from another skeletal site may be warranted (eg, distal 1/3 radius when other sites cannot be measured or including proximal femoral measurements in some older (>15 years) adolescents for whom longitudinal BMD monitoring into adulthood is indicated).[119 321] A true BMD decrease (from prior testing) is ideally assessed in comparison to the individual facilities DXA's LSC based on the facilities calculated coefficient of variation (%CV). As established by ISCD, at the very least, LSC should be 5.3%, 5.0% and 6.9% for the spine, hip and femoral neck to detect a clinical change.[120 321] †Potential indicators are purposefully vague in quantification, pending further research to quantify parameters and cut-offs more accurately. BMD, bone mineral density; BMI, body mass index; BP, blood pressure; BSI, bone stress injuries; DSM-5-TR, Diagnostic and Statistical Manual of Mental Disorders, fifth edition, text revision; DXA, dual-energy X-ray absorptiometry; EDE-Q, Eating Disorder Examination Questionnaire; FFM, fat-free mass; FHA, functional hypothalamic amenorrhoea; GI, gastrointestinal; HR, heart rate; IGF-1, insulin-like growth factor 1; ISCD, International Society for Clinical Densitometry; LDL, low-density lipoprotein; LSC, least significant change; RMR, resting metabolic rate; T3, triiodothyronine; T, testosterone; TBLH, total body less head.	

REDs research methodology guidelines

Although the seminal REDs research implemented randomised clinical trials with strict laboratory-controlled EA interventions in habitually sedentary females,[45 125 127 160 163] most of the research since has involved cross-sectional study designs investigating the prevalence of various LEA indicators (indirectly via questionnaires or directly via indicators).[8 11 21 49 78 166 167] While results have confirmed the aetiology of REDs is problematic LEA, findings also show significant individualised responses concerning the type, prevalence and severity of the impairments of various body systems associated with this exposure,[8 11 49 78 166 167] as well as a lack

Table 5 Serious medical indicators of REDs and/or EDS requiring immediate medical attention, potential hospitalisation and removal from training and competition (adapted from ED clinical management recommendations, paediatric and adult ED papers and athlete cardiovascular health consensus papers.[294 295 313 315 316 322 323] *Disclaimer: this list should not be used in isolation and should be based on a thorough clinical assessment that considers the severity of the athlete's physical and mental health.*

Serious medical indicators
► ≤75% median BMI for age and sex
► Electrolyte disturbances (eg, hypokalaemia, hyponatraemia, hypophosphataemia)
► ECG abnormalities (eg, prolonged QTc interval or severe bradycardia (adult: HR≤30 bpm; adolescent: HR≤45 bpm))
► Severe hypotension: ≤90/45 mm Hg
► Orthostatic intolerance (adult and adolescent: a supine to standing systolic BP drop>20 mm Hg and a diastolic drop>10 mm Hg)
► Failure of outpatient ED treatment programme
► Acute medical complications of malnutrition (eg, syncope, seizures, cardiac failure, pancreatitis)
► Any condition that inhibits medical treatment and monitoring while training and/or competing

BMI, body mass index; BPM, beats per minute; ECG, electrocardiogram; ED, eating disorder; HR, heart rate; QTc, corrected QT.

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Box 2 Definitions - IOC REDs-Clinical Assessment Tool-2 (IOC REDs CAT2)

REDs CAT primary indicators
Outcome parameters most consistently resulting from problematic LEA leading to REDs signs and/or symptoms identified in the scientific literature and/or with the greatest measurement validity (ie, sensitivity, specificity) and/or indicative of increased severity and risk of REDs. Accordingly, these indicators hold the most evidence and impact in the overall IOC REDs CAT2 Severity/Risk Assessment and Stratification Tool.

REDs CAT secondary indicators
Outcome parameters with some scientific evidence, resulting from problematic LEA leading to REDs signs and/or symptoms identified in the scientific literature and/or with lower measurement validity (ie, sensitivity, specificity) and/or have shown less severity and risk of REDs. Accordingly, these indicators hold a secondary level of evidence and impact in the overall IOC REDs CAT2 Severity/Risk Assessment and Stratification Tool.

REDs CAT potential indicators
Emerging outcome parameters lacking robust scientific evidence but may possibly be linked to problematic LEA leading to REDs signs and/or symptoms. These parameters generally demonstrate many of the following:
⇒ poor and/or inconsistent evidence
⇒ lack of existing validated screening tool, including a lack of validated cut-offs or thresholds in athletes
⇒ poor measurement validity (ie, sensitivity, specificity or high variability)
⇒ high cost and/or poor global availability
Accordingly, these indicators are listed as supportive in the Severity/Risk Assessment of REDs but are not directly involved in the IOC REDs CAT2 Severity/Risk Assessment and Stratification Tool. Potential indicators may move up to secondary or primary designation or off any list, pending more research validity and/or improved availability and/or cost.

REDs symptoms
Any REDs primary, secondary or potential indicator parameter(s) that an athlete directly reports or experiences (eg, pain from a BSI, amenorrhoea, depression, hunger, low libido, performance and training plateaus or declines) in the IOC REDs CAT2 Severity/Risk Assessment and Stratification Tool.

REDs signs
Any REDs primary, secondary or potential indicator parameter(s) that a clinician identifies on the IOC REDs CAT2 Severity/Risk Assessment Tool. A REDs sign may also be a significant individual change in a primary, secondary or potential indicator from the athlete's baseline within the context of REDs, with or without athlete symptoms (eg, a significant change in sex hormones, resting metabolic rate, cholesterol). *Note*: some indicators can be both signs and symptoms (eg, amenorrhoea).

IOC REDs CAT2 Severity/Risk Assessment and Stratification with Sport Participation Guidelines
A clinical tool to assist with identifying the current severity and/or the future risk of REDs that is comprised of an accumulation of primary and secondary indicators of REDs. The IOC REDs CAT2 Severity/Risk Stratification with Sport Participation Guidelines identifies the severity and/or risk of REDs for a given athlete

Continued

Box 2 Continued

along a spectrum characterised by a traffic light continuum from healthy (green) to mild (yellow), to moderate (orange), to severe (red), and provides sport participation guidelines for each level.

REDs diagnosis
A diagnosis of REDs results from the clinical assessment by a physician with expertise in REDs, using information collected from a multidisciplinary team (eg, sports medicine physician, sports dietitian, sports physiologist, sports psychologist/psychiatrist), which ideally includes: (1) appropriately validated questionnaires and/or clinical interview; (2) physical assessment; and (3) laboratory and imaging data as indicated in the IOC REDs Severity/Risk Assessment and Stratification Tool. A REDs diagnosis is predicated on excluding other aetiologies in the differential diagnosis for each REDs indicator and ranges from yellow to orange to red severity/risk.

of a universal EA threshold below which problems are observed.[88] Cross-sectional studies are useful for clinical REDs assessment and prevalence, but an analysis of this literature reveals multiple limitations (eg, lack of a classification of subject calibre/training status; lack of a standardisation of recruitment and assessment protocols; poor characterisation of menstrual status and hormonal contraceptive use; varied use of indicators of physiological, hormonal and performance status; and poor or non-existent assessment of EA). It is noted that there are few prospective or cohort studies in which groups of athletes with and without signs of LEA have been monitored longitudinally to note changes in health and performance.[168 169] Finally, there is also a need for controlled intervention studies in which EA manipulations are implemented with rigorous designs and careful assessment of the dose–response, time-course and variability in the development of perturbations to body systems and functional impairments.[46–48 53 54 170 171] By the triangulation of data from these various approaches (cross-sectional/longitudinal/interventional studies), the complexity of the relationship between LEA and REDs can be realised. It is recommended that future REDs research be conducted using standardised methodology to provide more accurate insights and to facilitate cross-study comparisons.[21]

Table 6 summarises methods that are considered to be preferred techniques for assessing health and performance outcomes associated with REDs, as well as others that do not reach that criterion but are commonly used *and* considered acceptable in terms of validity (ie, variability and precision) and feasibility (eg, availability, cost). Some tests have standards and diagnostic criteria for what is considered 'normal' versus 'impaired'. Meanwhile, the assessment of other features provides quantitative data that can be compared over time or between individuals and interpreted with consideration of the known precision/errors of measurement.

CONCLUSION

As evidenced by this consensus statement, there have been numerous scientific advances in the field of REDs since the publication of the 2018 IOC consensus update statement[6]: from new scientific concepts around our understanding of the evolution of various REDs signs and symptoms to the development of a Physiological Model depicting the nuanced complexity of how LEA exposure (either problematic or adaptable), with associated moderating factors, leading to changes in health and/or

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Table 6 Methods (preferred, used and recommended, and potential) for studying various health and performance outcomes of REDs

Health outcome	Methods and notes
Impaired reproductive function	*Preferred* ► Overnight sampling of LH and FSH[324] ► Menstruating females: phase-based hormonal approach using urinary ovulation kits (testing mid-cycle LH surge) and blood sampling[297] ► Postpubertal males: morning total and free testosterone level[325 326] *Used and recommended* ► Females: self-reported menstrual history, urinary ovulation testing,[297 327] LEAF-Q[171] ► Males: self-reported libido/morning erection (eg, LEAM-Q[328] or ADAM-Q[111 329])
Impaired bone health	*Preferred* ► DXA[133 330] – Using age-appropriate and medically appropriate body-site scanning[330] – Using age-appropriate, sex-appropriate and activity-appropriate interpretation (eg, Z-score vs T-score) *Used and recommended* ► Bone stress injury and fracture history *Potential* ► HRpQCT
Impaired gastrointestinal function	*Preferred* ► Oesophageal motility: oesophageal manometry, barium swallow ► GERD: upper endoscopy ► Gastric motility: electrogastrography[149 332] ► Gastroparesis: gastric emptying study ► Pancreatitis: ≥2 of: (a) lipase >3× upper limit of normal; (b) imaging findings consistent with pancreatitis; (c) characteristic epigastric pain ► Intestinal transit: radiopaque marker study,[202] orocaecal transit time test[334 335] ► SMA syndrome: upper GI oral contrasted study, MRI or CT[330–338] *Used and recommended* ► GERD: many questionnaires,[339] including GerdQ[340] ► Constipation: Wexner Constipation Score,[341] Bristol Stool Scale[342] ► Diarrhoea: Bristol Stool Scale[342] ► Irritable bowel syndrome: Rome IV Criteria[343] **Elevated transaminases**[344 345] ► Defecatory disorders, faecal incontinence[346]: Faecal Incontinence Questionnaire,[9 347] Faecal Incontinence Severity Index (FISI),[348] Altomare's Obstructed Defecation Scale (ODS) score[349] ► Multiple GI symptoms: Rome II questionnaire[350] ► GI symptoms during exercise[331 332] ► LEAF-Q GI subsection score ≥2 indicative of LEA[219 351] ► Athlete-specific GI symptom inventory[259] ► Feeding challenge during exercise[254 255] *Potential* ► Intestinal transit: wireless motility capsule ► Gut bacterial profile ► Faecal or plasma short-chain fatty acid concentration
Impaired energy metabolism/regulation	*Preferred* ► Thyroid function tests: TSH, free T4, total and free T3[165] ► Leptin: overnight sampling[164] ► Cortisol: overnight sampling,[179] 24-hour urinary free cortisol[157] ► Laboratory/expert-controlled measurements/estimates of all compartmentalised energetic intakes and total daily expenditures (exercise, non-exercise activity, basal metabolic rate, thermic effect of food)[338] *Used and recommended* ► Cortisol: morning serum cortisol, late-night salivary cortisol[157] ► RMR: indirect calorimetry,[338] room calorimetry[211]
Impaired haematological status	*Preferred* ► CBC with differential ► Iron studies (iron, ferritin, transferrin, total iron binding capacity) with age-appropriate, sex-appropriate and laboratory-appropriate cut-offs ► Carbon monoxide haemoglobin mass measurement[167 181] *Used and recommended* ► Self-reported history of iron deficiency or anaemia *Potential* ► App-based self-assessment[352]
Urinary incontinence	*Preferred* ► Stress urinary incontinence: bladder stress test[353] ► International Consultation on Incontinence-Urinary Incontinence Short-Form (ICIQ-UI-SF)[350 351] ► 3 Incontinence Questionnaire (3IQ)[354] *Potential* ► Pelvic Floor Dysfunction-ScrEeNing Tool IN fEmale athLetes (PFD-SENTINEL)[355]
Impaired glucose and lipid metabolism	*Preferred* ► Fasting blood glucose (serial measures)[356] ► Fasting insulin[356] ► Lipid panel: HDL, LDL, total cholesterol, triglycerides[200] *Used and recommended* ► Continuous glucose monitor[357]
Mental health issues	*Preferred* ► Clinical interview with psychiatrist or psychologist, DSM-5-TR[358] *Used and recommended* ► Depression: PHQ,[359] Centre for Epidemiological Studies Depression Scale,[360] Beck Depression Inventory[361] ► Generalised anxiety: GAD-7,[164 237] DASS-21[29 205 212 274] ► Stress: Perceived Stress Scale[275] ► Brunel Mood Scale[276] ► Profile of Mood States[277 278] ► Eating disorders: EDE-Q,[279–281] BEDA-Q,[282] Eating Disorder Inventory,[283] self-report
Impaired neurocognitive function	*Preferred* ► Clinical neuropsychological assessment *Used and recommended* ► Multiple domains: CogState assessment battery[284] ► Planning/cognitive flexibility: Wisconsin Card Sorting Test[362] ► Attention: Stroop Colour and Word Test[285–287] ► Decision making: Iowa Gambling Test[288 289] ► Verbal memory: California Verbal Learning Test-II[290] ► Executive function: Delis-Kaplan Executive Function System Color-Word Interference Test,[236] BRIEF-A[291]

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Table 6 Continued

Health outcome	Methods and notes
Sleep disturbances	*Preferred* ► Polysomnography[390] *Used and recommended*[392] ► Research-grade actigraphy ► Sleep diaries ► Numerous questionnaires, including Athlete Sleep Screening Questionnaire (ASSQ),[393] Athlete Sleep Behaviour Questionnaire (ASBQ),[394] Epworth Sleepiness Scale,[395] Pittsburgh Sleep Quality Index,[10 396] Insomnia Severity Index[144 397] *Potential* ► Sport wearables[398]
Impaired cardiovascular function	*Preferred* ► Conduction, rhythm abnormalities: ECG[212] ► Rate abnormalities: cardiac telemetry, Holter monitor ► Haemodynamics: sphygmomanometery, orthostatic sphygmomanometery (≥20 mm Hg drop in systolic pressure ≥10 mm Hg drop in diastolic pressure on standing from supine)[213 399] ► Autonomic function: heart rate variability by Holter monitor,[400 401] baroreflex sensitivity testing,[402] bedside tests (eg, Valsalva, tilt testing) ► Structural abnormalities: transthoracic echocardiogram[213] ► Endothelial dysfunction: brachial artery flow-mediated dilatation[213 403] *Used and recommended* ► Heart rate: chest-mounted electrode-containing heart rate strap[404 405] ► Haemodynamics: self-reported episodes of orthostatic (pre-) syncope *Potential* ► Sport wearables[398 406]
Reduced skeletal muscle function	*Preferred* ► Muscle protein synthesis: isotopic amino acid labelling,[407] deuterated water ingestion[408 409] ► Muscle glycogen content: histochemical analysis of biopsy-derived muscle samples,[410] ^{13}C-magnetic resonance spectroscopy[410 411] *Used and recommended* ► None—exclude assessment if unable to directly measure as above
Impaired growth and development	*Preferred* ► Paediatric patients: clinical assessment with growth charts – Deviation from baseline growth trajectory, defined as a dynamic change with time (vs a single measurement) – Decrease in growth Z-score by >1[284 412] ► Growth hormone: overnight sampling[413] ► IGF-1: serum levels, IGFBP-3 levels[414] *Used and recommended* ► Paediatric patients: delayed markers of puberty (thelarche, menarche, spermarche)
Reduced immunity	*Preferred* ► To be determined *Used and recommended* ► Self-reported illness frequency[107 113 415] *Potential* ► CBC, with differential, immunoglobulin G glycome, leucocyte transcriptome and cytokine profile[272]
Performance outcome	**Methods and notes**
Decreased athlete availability	*Preferred* ► Self-reported days of training/competition lost or modified due to illness or injury[10 224 416]
Decreased training response	*Preferred* ► Longitudinal tracking of valid performance-related metric specific to athlete/sport (eg, sport-related time trial)[169 417 418] *Used and recommended* ► Self-reported plateauing of ability/performance despite training progression[419] ► Exercise lactate profile[420 421] ► Lactate: RPE ratio[422 423] ► Catecholamine concentrations[424]
Decreased recovery	*Preferred* ► To be determined *Used and recommended* ► Lab-based studies: – Creatine phosphate system: ^{31}P magnetic resonance spectroscopy[425] – Exercise-induced muscle damage: muscle biopsy[426] ► Field-based studies: – Questionnaires: Recovery-Stress Questionnaire (REST-Q),[10 427] self-reported perceptions of recovery, Profile of Moods State (POMS),[277] Hooper-MacKinnon Questionnaire[428] – Creatine kinase (total, muscle)[429] ► Athlete's subjective report of readiness[430] *Potential* ► Wearable/commercialised recovery/readiness algorithms[431]
Decreased cognitive performance/skill	*Preferred* ► Skill: sport-specific measures (eg, Loughborough Soccer Passing Test)[427 431] *Used and recommended* ► Reaction time: consider sport-specific tests[424] ► Spatial awareness: mental rotation test[431]
Decreased drive/motivation	*Preferred* ► To be determined *Used and recommended* ► Motivation: Behavioural Regulation in Sport Questionnaire (BRSQ),[425] Psychological Need States in Sport-Scale (PNSS-S)[426] ► Athlete Burnout Questionnaire (ABQ)[432] ► Maslach Burnout Inventory[428]
Decreased muscle strength	*Preferred* ► Longitudinal tracking of valid performance-related metric specific to athlete/sport (eg, sport-related strength test, such as snatch or clean and jerk for weightlifting, or throw distance for shot put)[433] *Used and recommended* ► Isokinetic dynamometry[440 441] ► One repetition maximum, specific movement (eg, bench press)[442 443]

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Table 6 Continued

Performance outcome	Methods and notes
Decreased endurance performance	*Preferred* ► Longitudinal tracking of valid performance-related metric specific to athlete/sport (eg, sport-related time-trial)[68 417 419] *Used and recommended* ► Laboratory-based VO_2 max testing (via indirect calorimetry)[444] ► Laboratory-based lactate threshold testing[445] ► Multistage shuttle run[446 447] ► Cycling ramp test[448]
Decreased power performance	*Preferred* ► Wingate test[440] *Used and recommended* ► Counter-movement jump[71] ► Standing broad jump[433 451] ► Bosco test[452 453]

*While various methods have been used clinically and in research settings, many have not been validated or used in athletes or specifically used to assess the effects of REDs. Therefore, this table proposes methods that have been used for outcomes of interest and that the authors recommend to date.
ADAM-Q, Androgen Deficiency in Ageing Males Questionnaire; BEDA-Q, Brief Eating Disorder in Athletes Questionnaire; BRIEF-A, Behaviour Rating Inventory of Executive Function–Adult Version; CBC, complete blood count; DASS-21, Depression Anxiety Stress Scale-21; DSM-5 TR, Diagnostic and Statistical Manual of Mental Disorders– fifth edition, text revision; DXA, dual-energy X-ray absorptiometry; EDE-Q, Eating Disorder Examination Questionnaire; FSH, follicle stimulating hormone; GAD-7, General Anxiety Disorder-7; GERD, Gastro-oesophageal reflux disease; GerdQ, Gastro-oesophageal Reflux Disease Questionnaire; GI, gastrointestinal; HDL, high-density lipoprotein; HRpQCT, high-resolution peripheral quantitative computed tomography; IGF-1, insulin-like growth factor 1; IGFBP-3, insulin-like growth binding protein-3; LDL, low-density lipoprotein; LEA, low energy availability; LEAF-Q, Low Energy Availability in Females Questionnaire; LH, luteinising hormone; PHQ, Patient Health Questionnaire; RMR, Resting Metabolic Rate; RPE, rating of perceived exertion; SMA, superior mesenteric artery; T3, triiodothyronine; T4, thyroxine; TSH, thyroid stimulating hormone; VO_2 max, Maximal oxygen consumption.

performance outcomes in individual athletes. Our understanding of the outcomes of problematic LEA exposure causing REDs on athlete mental health and in male athletes has also been further refined.

In addition to the scientific advances, we have presented a summary of practical clinical guidelines for assessing LEA and for safe body composition measurement. We have also reviewed the scientific literature on the prevention and treatment of REDs and introduced an updated, validated IOC REDs CAT2 to aid in diagnosis and Severity/Risk Assessment. Finally, by providing standardised guidelines for research methodology, we look forward to high-quality REDs research outcomes in the future. Most importantly, our work aims to stimulate action by sports organisations, sports scientists, and the athlete health and performance team to protect the health and well-being of the many athletes at risk for developing this syndrome.

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Correction notice This article has been corrected since it published. Figure 6 has been updated in the online version only and not in print.

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Acknowledgements The authors would like to thank the International Olympic Committee for prioritising and supporting athlete health, Bryan Holtzman, Margot Rodgers and Grace Saville for citation and editorial assistance and Joe DeLeo for graphic support.

Contributors All authors were involved in the conception, drafting, voting, in-person discussion, revising and approval of the final manuscript prior to submission. MM was responsible for leading the consensus project and for coordinating the consensus statement manuscript. AUJ represented the athlete's voice, and DMB represented the coach's voice. RB, IJE and LE represented the International Olympic Committee's Medical and Scientific Department.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests MM is a Deputy Editor of the BJSM and a member of the BJSM IPHP Editorial Board. KEA is a Deputy Editor of the BJSM and an Associate Editor of the BJSM IPHP. EV is an Associate Editor of the BJSM, an Associate Editor of the BJSM IPHP and Editor in Chief of BMJ Open Sports and Exercise Medicine. RB is the IOC Medical and Scientific Director. LE is the IOC Head of Science Activities and an Editor of BJSM IPHP. IJE is an IOC member and the Chair of the IOC Medical and Scientific Commission.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

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Br J Sports Med: first published as 10.1136/bjsports-2023-106994 on 26 September 2023. Downloaded from http://bjsm.bmj.com/ on February 18, 2026 by guest. Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

Correction

Correction: *2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs)*

Mountjoy M, Ackerman KE, Bailey DM, et al. 2023 International Olympic Committee's (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs). *Br J Sports Med* 2023;57:1073–1097

Figure 6 and online supplementary file 5 have been updated. This has been updated in the online version only and not in print.

doi:10.1136/bjsports-2023–106994

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Br J Sports Med 2024;**58**:e4. doi:10.1136/bjsports-2023-106994corr1

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주요경력

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대표논문

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대한민국 여성 엘리트 선수의 에너지 가용성: 현황 진단과 체계적 관리 전략
Energy Availability in Korean Female Elite Sports: Current Status and Systematic Management Strategies

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저 에너지 가용성(Low Energy Availability, LEA)은 운동으로 소비한 에너지를 제외하고도 생리적 기능, 회복, 적응, 건강 유지를 위해 필요한 에너지가 충분히 확보되지 못한 상태를 의미한다. 최근 스포츠의학 분야에서는 LEA를 단순한 영양 섭취 부족의 문제가 아니라, 선수의 건강과 경기력 전반에 영향을 미치는 핵심 병태생리로 이해하고 있다. 특히 2023년 국제올림픽위원회(IOC) REDs 합의문은 Relative Energy Deficiency in Sport (REDs)를 여성과 남성 모두에서 발생할 수 있는 증후군으로 재정의하면서, LEA가 생리적 기능뿐 아니라 심리적 기능에도 영향을 미친다고 제시하였다. 또한 2018년 이후 170편 이상의 새로운 연구가 축적되면서 저탄수화물 가용성, 정신건강, 남성 선수의 LEA 영향 등에 대한 근거가 확대되었고, 이에 따라 새로운 REDs Clinical Assessment Tool Version 2 (CAT2)가 제안되었다.

이와 같은 국제적 논의는 여성 엘리트 선수의 LEA를 보다 입체적으로 평가하고 관리해야 할 필요성을 분명히 보여준다. 2025년 Female Athlete Triad Coalition 업데이트는 여성선수 건강을 이해하는 핵심 축으로 여전히 에너지 상태, 생식 기능, 골 건강의 상호작용을 강조하면서도, 청소년과 성인 선수를 포함한 실제 임상 현장에서는 선별, 진단, 치료, 복귀 판단을 더욱 체계화해야 한다고 제언하였다. 다시 말해, 여성선수의 LEA는 월경 이상이나 골밀도 저하가 나타난 이후에 확인하는 문제가 아니라, 그 이전 단계에서 조기에 탐지하고 개입해야 하는 문제로 접근할 필요가 있다.

본 발표는 이러한 문제의식 위에서, 대한민국 여성 엘리트 선수 62명을 대상으로 수행된 실태조사 결과를 토대로 대한민국 여성 엘리트 선수의 LEA 현황과 관리 방향을 논의하고자 한다. 본 조사에서는 K-LEAF-Q를 적용하였으며, 방법론에 따라 총점 8점 이상을 LEA 위험 기준으로 해석하였다. 그 결과 여성 국가대표 선수의 LEA 유병률은 43.5%로 나타났고, 종목별로는 리듬체조 100%, 펜싱 50%, 유도 47%에서 높은 위험 분포가 확인되었다. 이는 LEA가 특정 심미 종목에 국한된 예외적 현상이 아니라, 국내 여성 엘리트 스포츠 전반에서 관리 체계가 필요한 수준의 문제임을 시사한다.

본 조사에서 특히 주목할 점은 LEA 위험군과 정상군 간에 신체조성, 기초대사량, 골밀도, 혈액 변인에서 뚜렷한 차이가 확인되지 않았다는 사실이다. 반면 심리·행동적 지표에서는 의미있는 차이가 관찰되었다. LEA 위험군은 정상군에 비해 수면의 질이 유의하

게 낮았으며, 식이태도 고위험군은 22.6%로 확인되었고 이들은 정상군보다 주말 탄수화물 섭취량이 유의하게 낮았을 뿐 아니라 근력도 낮게 나타났다. 이는 여성 엘리트 선수에서 LEA의 초기 신호가 반드시 체성분 변화나 혈액 검사 이상으로 먼저 나타나는 것이 아니라, 회복의 질 저하와 탄수화물 가용성 저하, 그리고 제한적 식이태도와 같은 행동적·기능적 영역에서 더 먼저 포착될 수 있음을 보여준다.

이러한 결과는 최근 국제 연구동향과도 일치한다. IOC관련 서브그룹의 정신건강 리뷰는 문제성 LEA와 연관된 초기 심리 지표로 기분 변화, 피로, 심리적 갈등을 제시하였고, 보다 심화된 결과로는 웰빙 저하, 불안, 우울 증상, 섭식 장애를 제안하였다. 또한 REDs 예방에 관한 최신 고찰은 교육, 조기선별, 다학적 치료를 각각 1차, 2차, 3차 예방의 핵심 축으로 제시하면서, 자기보고식 설문, 개별 면담, 객관적 마커 평가를 함께 활용할 것을 권고하였다. 아울러 최근 CAT2 실제 적용 연구에서는 200명이상 엘리트 선수 집단에서 REDs 중증도가 높을수록 무월경, 골 스트레스 손상, 낮은 T3, 낮은 성호르몬, 낮은 골밀도와 연관되었고, 향후 골 스트레스 손상 위험도 증가하는 것으로 보고되었다. 이는 LEA 또는 REDs를 단일 수치나 단일 검사로 판별하기보다, 다지표 통합 평가로 접근해야 함을 뒷받침한다.

영양학적 측면에서도 최근 연구는 총 열량뿐 아니라 탄수화물 가용성의 중요성을 강조한다. 2023년 여성 지구력 선수를 대상으로 한 리뷰연구에서 낮은 탄수화물 가용성(Low Carbohydrate Availability, LCA)이 여성 선수에서 흔하며, LEA를 악화시키거나 독립적으로 건강 및 경기력 저하에 기여할 가능성이 제시되었다. 이러한 관점은 이번 국내 자료에서 식이 태도 고위험군의 주말 탄수화물 섭취 부족이 관찰된 결과 와도 맞닿아 있다. 따라서 여성 엘리트 선수의 LEA 관리는 단순히 “적게 먹지 말자”는 수준을 넘어, 훈련 일정과 회복 요구에 맞춘 탄수화물 가용성 확보 전략으로 구체화될 필요가 있다.

종합하면, 대한민국 여성 선수의 LEA 관리 전략은 세 가지 원칙 위에서 재구성될 필요가 있다. 첫째, 조기 발견의 초점을 체중이나 체지방률보다 수면, 회복, 식이 태도, 월경 및 부상 이력과 같은 전구 신호에 두어야 한다. 둘째, K-LEAF-Q를 중심으로 하되, 식이 태도 평가, 수면 및 정신건강 문항, 필요 시 골 건강과 혈액 지표를 연계한 다층적 스크리닝 체계를 구축해야 한다. 셋째, 실제 개인은 스포츠의학, 영양, 심리, 컨디셔닝이 연계된 다학제 체계 안에서 이루어져야 하며, 교육과 상시 모니터링이 병행되어야 한다.

결론적으로, 여성 엘리트 선수의 LEA는 더 이상 특정 종목에 한정된 특수한 문제가 아니다. 국내 국가대표 여성 선수 자료에서 확인된 43.5%의 유병률은 현황 파악을 넘어 체계적 관리 체계의 구축이 시급함을 보여준다. 특히 이번 자료는 신체조성이나 혈액검사 이상보다 수면의 질 저하와 제한적 식이 태도, 낮은 탄수화물 가용성이 보다 민감한 초기 신호일 수 있음을 시사한다. 향후 여성 엘리트 선수의 건강 보호와 경기력 지속 가능성을 위해서는 LEAF-Q 기반 선별, 회복 및 심리 지표 모니터링, 탄수화물 가용성 중심의 영양 전략, 다학제적 개입이 통합된 한국형 LEA 관리 모델의 정립이 필요하다.

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The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

심포지엄 10: 여성 스포츠의 의학적 패러다임: FAIR 합의문에서 생활체육까지의 임상적 확장

The Medical Paradigm in Women's Sports: Clinical Expansion from the FAIR Consensus Statement to Recreational Sports (여성스포츠위원회 2)

좌장: 건국대병원 이선주, 상명대학교 김태경



박지환

학력

한국체육대학교 태권도학과 학사
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주요 경력

평창동계올림픽 여자컬링대표팀 선수트레이너
스포츠토토여자축구팀 선수트레이너
서울시청여자축구팀 선수트레이너
여자국가대표핸드볼팀 선수트레이너

현재 소속 및 직위

세종스포츠정형외과 도수물리치료센터 부실장

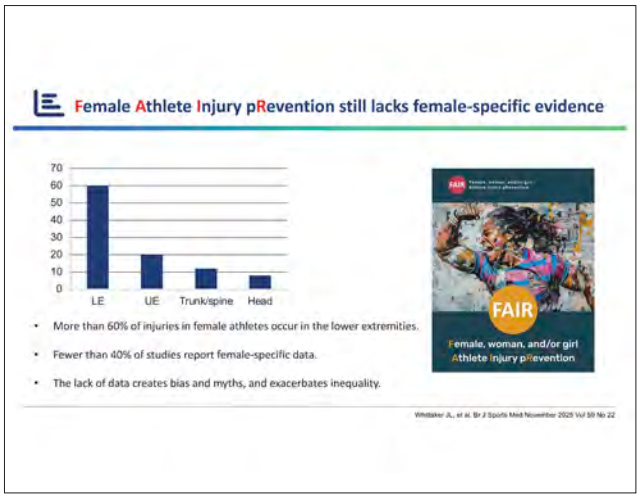
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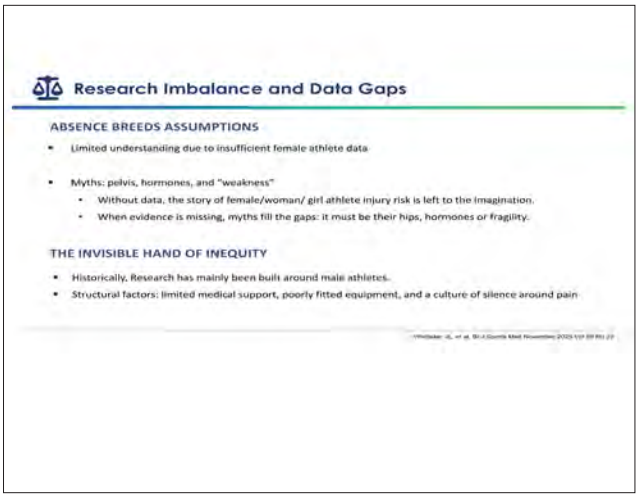
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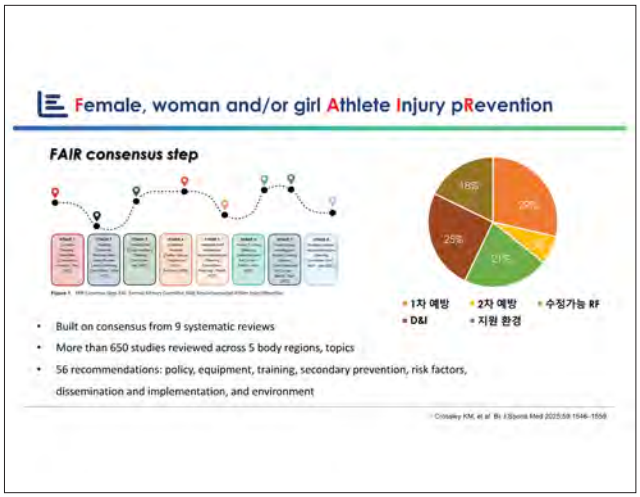
여성 운동선수 손상예방: FAIR consensus의 임상적 의미
Injury Prevention in Female Athletes: Clinical Implications of the FAIR Consensus

세종스포츠정형외과
박지환







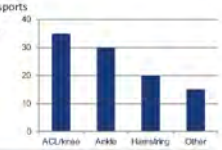


Systematic review

Prevention strategies for lower extremity injury: a systematic review and meta-analyses for the Female, woman and/or girl Athlete Injury pRevention (FAIR) consensus

Lower extremity injuries represent the greatest injury burden in female athletes

- More than 60% of injuries in female athletes involve the lower extremities
- Lower extremity injuries are the most common injury category in many sports
- associated with substantial medical costs, post-traumatic osteoarthritis, reduced function, lower physical activity, and poorer quality



Bullock GS, et al. Br J Sports Med 2025;59:1575–1586.

LE main injury prevention strategy : Neuromuscular training

Neuromuscular training showed the strongest evidence, especially for ACL and ankle injury prevention

- A programme including balance, strength, agility, and change-of-direction exercises
- Effective when performed for 10 minutes twice per week, progressing from bilateral to single-leg movements
- Associated with a 61% reduction in ACL injuries, a 39% reduction in ankle sprains, and a 19% reduction in overall lower extremity injuries

NMT should be a standard warm-up strategy in female sports settings

Bullock GS, et al. Br J Sports Med 2025;59:1575–1586.

Modifiable risk factors for lower-extremity injury

Effective prevention programmes do not necessarily identify single independent risk factors

- Individual strength variables were **not consistently identified as independent risk factors.**
- **Combination of strength, balance, agility, and movement retraining,** rather than from one variable alone.
- Possible that thresholds, **sport-specific effects, age-specific effects, and heterogeneity** across studies obscure true relationships.

Risk Factor	Association
High BMI	High injury risk(very low certainty evidence)
Strength measure	No association
Use of Artificial ruf	No association
Specific training duration	Unclear

Whitaker JL, et al. Br J Sports Med 2026;59:1499–1513.

Modifiable risk factors: Clinical implications and future direction



- ✓ Past research has focused mainly on physical factors such as body size, strength, movement, and biomechanics.
- ✓ **Psychosocial, environmental, and female-specific health factors** remain underexplored.
- ✓ A single screening test may be insufficient; **longitudinal monitoring** may provide better insight into injury risk.



Injury risk in female athletes should be understood beyond single screening variables

Whitaker JL, et al. Br J Sports Med 2026;59:1499–1513.

Prevention strategy for upper extremity injuries

Systematic review

OPEN ACCESS

Prevention strategies and modifiable risk factors for upper extremity injury: a systematic review and meta-analysis for the Female, woman and/or girl Athlete Injury pRevention (FAIR) consensus

- 55 studies; only 26% of participants were female
- 17 studies (31%) reported female-specific outcomes

→remains limited in female representation and reporting

- Only 5 prevention studies included female-specific data

: **ER strengthening, scapular control, posterior shoulder & upper back strengthening, and sport-specific drills.**

- **~51% reduction in injury rate** (very low-certainty evidence)
- Shoulder-specific exercise programmes showed the clearest preventive effect

Henning EE, et al. Br J Sports Med 2025;59:1587–1598.

UE : Risk Factor and clinical implications

Risk Factor	Association
Reduced shoulder strength	Higher injury risk
ROM	Unclear
High training load	Higher risk
Early sport specialisation	Higher risk

- **Shoulder strength and ROM were the most studied factors,** but findings were inconsistent.
- **Lower ER:IR ratio and lower isometric ER/IR strength** may be associated with injury risk, but the evidence is still very limited.
- Clinicians should not rely on a single value alone and should also **consider training load, recovery, season structure, and support environment.**

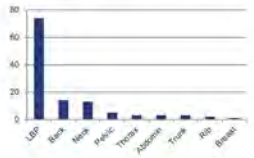
Henning EE, et al. Br J Sports Med 2025;59:1587–1598.

Spine and trunk : incidence

- A total of 105 studies were included, but only 23.6% of participants were female athletes.
- Only about 33% of studies reported female-specific results separately.
- Beyond low back pain to include breast, pelvic floor, and pregnancy-related issues.
- Exercise-based prevention showed unclear effects in female-specific data.

Systematic review

Prevention strategies and modifiable risk factors for spine, chest, abdominal and/or pelvic injury and pain: a systematic review and meta-analysis for the Female, woman and/or girl Athlete Injury pRevention (FAIR) consensus



Whittaker JL, et al. Br J Sports Med 2025;59:1515–1528

Prevention strategies and modifiable risk factors for spine, chest, Abdominal and/or pelvic injury and pain

- Exercise-based programmes showed unclear effects (very low-certainty evidence).
- No differences were found in body mass, BMI, weekly training hours, or spinal flexion.
- Hip mobility and strength showed unclear associations.
- Core stabilization and flexibility training may be considered, along with encouraging pain reporting.



Whittaker JL, et al. Br J Sports Med 2025;59:1515–1528

Clinical implication for spine, chest, Abdominal and/or pelvic injury and pain

- Psychosocial factors such as stress and culture should also be considered
- Regular monitoring of pain and function
- Consider pelvic floor training and counselling on menstrual and pregnancy-related issues
  - Menstrual, pregnancy, and postpartum experiences
  - Safe reporting culture for pelvic floor symptoms and breast pain
  - Female-specific equipment and support systems
  - Season structure, training environment, and access to care
  - These factors may be important for injury prevention, but remain understudied



Whittaker JL, et al. Br J Sports Med 2025;59:1515–1528

Prevention strategies and modifiable risk factors for concussion

- 108 studies: 67 prevention, 41 risk factor studies
- Only 37% of studies reported female-specific outcomes.
- Injury rates were higher in youth sports.
- **Headgear reduced concussion risk by 30–39%** in youth lacrosse and soccer (very low-certainty evidence).
- Protective eyewear showed no effect on concussion prevention.
- No difference was found between artificial turf and natural grass.



Systematic review

Prevention strategies and modifiable risk factors for concussion: a systematic review and meta-analysis for the Female, woman and girl/or Athlete Injury pRevention (FAIR) consensus

Dick LL, et al. Br J Sports Med 2025;59:1599–1616

Prevention strategies and modifiable risk factors for concussion

Risk Factor	Association
Neck strength/endurance	Inconsistent evidence
Playing surface	No difference
Training load	Unclear
Detection/reporting style	Observer effect



- Early recognition and protocol-based management
- **Possible benefit of neck strengthening and technique training**
- Consider female-specific factors in recovery and return-to-play



Dick LL, et al. Br J Sports Med 2025;59:1599–1616

Dissemination and implementation (D&I) of injury prevention interventions

Systematic review

OPEN ACCESS

Dissemination and implementation of injury prevention interventions: a scoping review for the Female, woman and/or girl Athlete Injury pRevention (FAIR) consensus

whether effective injury prevention strategies are actually known, adopted, delivered, and sustained in female athletes

- The focus was not only on efficacy, but on real-world use in sport settings.
- It asked whether effective strategies are actually known, adopted, and maintained over time.

The key question is not only what works, but what lasts in practice

Petersen BE, et al. Br J Sports Med 2025;59:1618–1632

Dissemination and implementation (D&I) of injury prevention interventions

Pre-implementation: positive attitudes, low programme awareness

- Athletes and coaches generally believed that injuries are preventable.
- However, awareness of specific programmes such as 11+ was 25-58%
- Female athletes acknowledged the need for injury prevention, but showed limited connection to specific programmes and wanted better access to expert guidance.





Patterson SE, et al. Br J Sports Med 2025;59:1616-1622.



Figure 5 Distribution of papers and D&I outcomes across the phases of the QUERI Implementation Roadmap (adapted from Kilbourne et al. 2019)*. *The text in blue is based on synthesised evidence of the included study findings. D&I, dissemination and implementation; IP, injury prevention; QUERI, Quality Enhancement Research Initiative.

Patterson SE, et al. Br J Sports Med 2025;59:1616-1622.

Dissemination and implementation (D&I) of injury prevention interventions

Implementation in practice

- PPE was adopted more easily than training-based interventions.
- Training programmes were often performed only 1–2 times per week, with low fidelity.
- In practice, doing prevention exercises correctly was harder than simply adopting them.

What makes programmes acceptable

- Major barriers were time, low sport specificity, and limited coaching resources.
- Programmes longer than 15 minutes showed lower acceptance.
- Better-accepted programmes were short, adaptable, sport-specific, and engaging.

Programmes | brief, flexible, and easy to integrate into routine practice.

The future question is not only what works,
but who delivers it, how well it is maintained, and why it breaks down

Patterson SE, et al. Br J Sports Med 2025;59:1616-1622.

A Road Map for FAIR Action Across the Sport Ecosystem



Figure 1 A roadmap for FAIR action across the sport ecosystem. FWG, female, woman and girl. (Whittaker JL, et al., 2025)

Roadmap summary:

Individual: Record and monitor female-specific data

Team/Interpersonal: Promote research participation and build trust

Organization/Community: Strengthen surveillance systems and publication standards

National/international level: Require inclusion of female athletes in research and invest in resources

Clinical Guidance and implementation Strategies

- ✓ **Lower extremity: Regular neuromuscular training and BMI monitoring**
- ✓ **Upper extremity: Strengthen shoulder strength and stability, and manage training load**
- ✓ **Spine/trunk: Core strengthening, postural correction, and pelvic floor health assessment**
- ✓ **Concussion: Recommend headgear, ensure early detection, and follow RTP protocols**
- ✓ **General: Balance training load and recovery, and address psychosocial factors**

What should change? — A roadmap for action

- ✓ Data are power: the experiences of **female athletes must be recorded and made visible.**
- ✓ Intersectional factors should be considered, **including Para sport, gender diversity, low- and middle-income countries, and youth/older athletes.**
- ✓ Improvements are needed across **environments, culture, and policy.**
- ✓ **Design exercise programmes** that can be performed **without specialized equipment.**
- ✓ **Use mobile apps and online resources** to support education and delivery.
- ✓ Life-stage factors such as **menstruation, pregnancy, postpartum, and menopause should be studied.**
- ✓ **Standardized surveillance and reporting systems** need to be established.

Take home message

- Research on female athletes remains limited, and data are power.
- Neuromuscular training is effective for lower extremity injuries, but evidence in other areas remains limited.
- Tailored programs are needed for the prevention of shoulder, spine, trunk, and concussion-related injuries.
- Dissemination and implementation strategies must consider adoption, sustainment, and cultural factors.
- A sustainable sport environment should be built through equity and inclusion.

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박병선

학력

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주요 경력

대한정형외과 스포츠의학회 제42회 춘계학술대회 우수구연상

현재 소속 및 직위

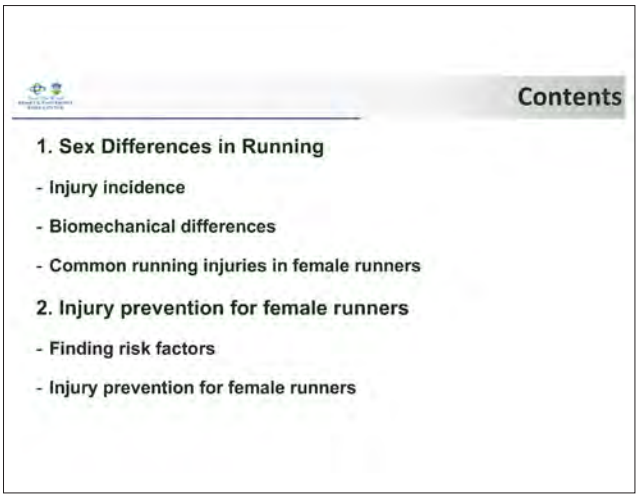
건국대학교병원 정형외과 스포츠의학센터, 건강운동관리사

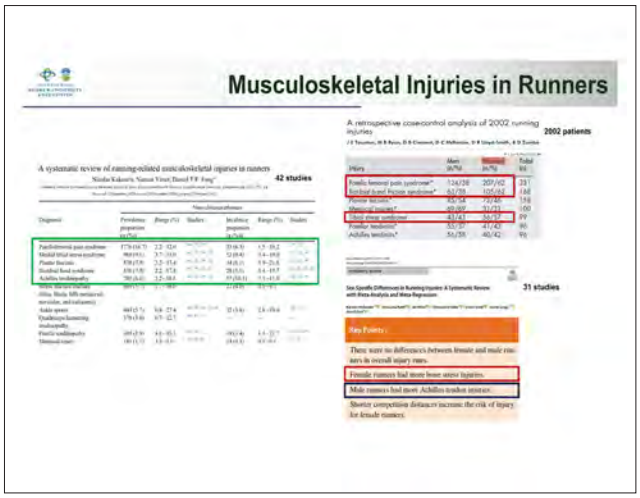
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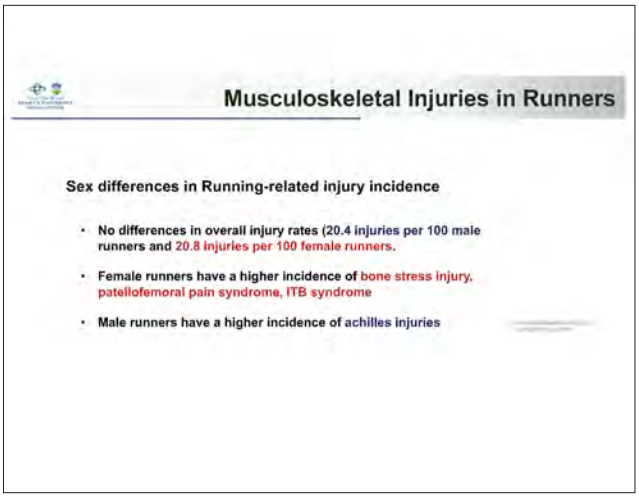
1. Effect of hand grip exercise on rotator cuff strength and shoulder function recovery after arthroscopic rotator cuff repair: Byeong Sun Park, Seung Ik Cho, Da Hui Jeong, Ji Seung Yoo, Dong Hwan Lee, Seok Won Chung. Clinics in Orthopedic Surgery. 2026
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3. Current Trends and Future Developments in Anterior Cruciate Ligament Reconstruction: Dhong Won Lee; Ji Nam Kim; Se Woong Kim; Seung Ik Cho; Na Yeon Kim; Byung Sun Park. Current Concepts Review. The Korean Journal of Sports Medicine. 2023

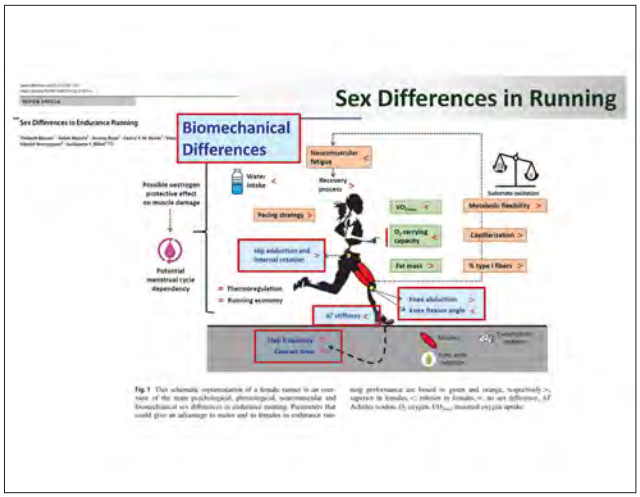
생활체육 여성 러너를 위한 부상 예방 전략
Injury Prevention Strategy for Female Recreational Runners

건국대학교병원
박병선









Biomechanical Differences in Running

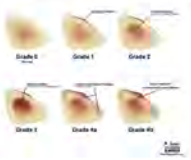


- In recreational runners, females exhibited significantly greater hip adduction and internal rotation during the stance phase of running compared to males
- The current results suggest that if the step width is identical, the subjects with greater knee abduction had smaller rearfoot eversion to compensate for greater hip adduction, which were more apparent in females.

Tibial Bone Stress Injuries

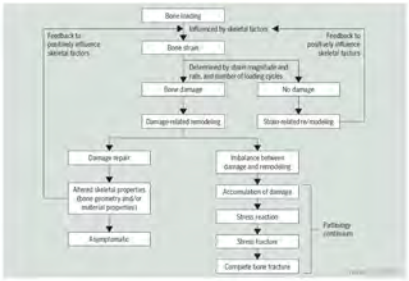


Fredericson classification system



- In runners, BSI (bone stress injury) come from the failure of bones to overcome the repetitive, submaximal forces from running
- It can range from a mild periosteal reaction (grade 1-2), to more severe presentations like bone bruising underneath the surface of the bone (grade 3), which can eventually lead to a full fracture (grade 4)

Tibial Bone Stress Injuries



Tibial Bone Stress Injuries

Incidence of bone stress injuries in different college sports



- Bone Stress Injuries Occur Twice as Often in Female than in Male Runners
- Gender (female), increased BMI, and excessively pronated foot were related to MTSS injury
- Biomechanical factors
  - Average vertical loading rates, peak hip adduction and rear foot eversion during running were increased in runners with a previous tibial stress fracture
- One possible explanation that has been discussed was the association of bone stress injuries with the female athlete triad (low energy availability, menstrual disturbance and low bone mineral density) to explain the higher risk for bone stress injuries in female runners

Iliotibial Band Syndrome

Lower extremity kinematics during running and hip abductor strength in iliotibial band syndrome: A systematic review and meta-analysis

Eric Fech [1], Richard A. Brindle [1], Michael B. Pohl [1]



- Greater hip adduction and knee internal rotation in healthy female runners compared to male runners may result in greater iliotibial band strain and place females at a greater risk for developing ITBS.
- Female runners with previous ITBS exhibited less isometric hip abductor strength

PFPS (Patellofemoral Pain Syndrome)





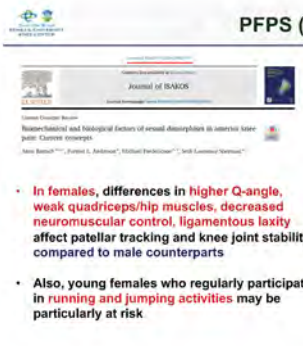
- Also known as anterior knee pain or runner's knee or chondromalacia patella
- Pain around the patella with squatting, stair climbing, prolonged sitting, or other functional activities loading the PF joint in a flexed position
- Mainly young women without any structural problems

PFPS (Patellofemoral Pain Syndrome)



- The higher incidence of PFPS in women is likely multifactorial, resulting from a combination of risk factors.
- Abnormal loading of the PF joint due to a combination of patellar maltracking, muscle imbalance or dynamic valgus knee

PFPS (Patellofemoral Pain Syndrome)



- In females, differences in higher Q-angle, weak quadriceps/hip muscles, decreased neuromuscular control, ligamentous laxity affect patellar tracking and knee joint stability compared to male counterparts
- Also, young females who regularly participate in running and jumping activities may be particularly at risk



PFPS (Patellofemoral Pain Syndrome)

- Impaired neuromuscular control, dynamic knee valgus



- In males, landing with decreased knee flexion and increased hip external rotation increase the risk of the development of PFP
- In females, landing with less hip abduction and increased knee internal rotation increase the risk of the development of PFP



- Females with anterior knee pain had increased peak knee valgus while running compared to matched controls

Risk factors for running injuries

- Risk factors for running are multi-factorial and consist of training load, biomechanical, anatomical and anthropometrical variables
- Biomechanical Findings
  - Healthy non-injured runners
    - Female runners demonstrate greater peak hip flexion, adduction, and internal rotation angles, and smaller knee flexion angles than male runners
  - Injury-specific
    - Female runners with PFPS demonstrate greater peak hip adduction
    - Female runners who develop ITBS are more likely to demonstrate greater peak hip adduction, knee internal rotation and lower hip abduction strength
    - Female runners who previously experienced a tibial bone stress injury demonstrate greater peak hip adduction and ankle eversion

Finding Risk Factors for Running Injuries

- Test for biomechanical movement

- Lateral Step-Down Test



TABLE 1 Scoring Criteria for the Lateral Step-Down Test

Criterion	Interpretation	Score
Arm strategy	• Removal of a hand off the waist	1
Trunk alignment	• Leaning in any direction	1
Pelvis plane	• Loss of horizontal plane	1
Knee position	• Tibia medially medial to second toe • Tibia laterally medial to medial border of foot	1 2
Steady stance	• Subject stopped down on opposite limb, or first returned from side-to-side	1

Score Classification
0-1: "good" quality of movement
2-3: "moderate" quality of movement
4↑: "poor" quality of movement

Finding Risk Factors for Running Injuries

- Test for biomechanical movement

- Y-Balance Test (YBT)



Limb Length: 85	R(cm)	L(cm)	Diff.(cm)
Anterior	44	46	2
Posteromedial	88	92	4
Posterolateral	86	86	0
Composite(%)	85.4	87.8	## ##

Composite Score

- YBT requires proper neuromuscular control and proprioceptive function, good musculoskeletal strength, coordination, and range of motion
- YBT can help predict the risk of developing a running overuse injury

Finding Risk Factors for Running Injuries

- Test for excessive pronation (flatfoot)

- Navicular drop test



- Difference in height of the navicular bone between loaded and unloaded conditions
- A greater navicular drop is associated with overuse injuries like medial tibial stress syndrome, and patella-femoral pain syndrome
- Pronated feet : exceeds 10 mm
- Normal: 6 to 9 mm
- Supinated foot: below 6 mm

Finding Risk Factors for Running Injuries

- Gait analysis



Gait Retraining in Injured Distance Runners: A Clinical Review

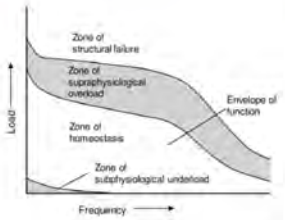
Strategies to Reduce Running-Related Injury



Running-Centred Injury Prevention Support: A Scoping Review on Current Injury Risk Reduction Practices for Runners

106 studies

Training load management



Running

- Envelope of Function
  Exceeding current capacity → injury
- 10% rule
  Increase running mileage less than 10%

Strength Training - Foot



Short foot exercises have additional effects on knee pain, foot biomechanics, and lower extremity muscle strength in patients with patellofemoral pain



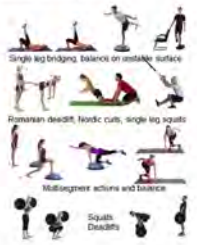
- Activating small intrinsic muscles that help control the initial impact loading and stability during stance and push-off.

Incorporating Flexibility



- Conflicting evidence exists on frequency and type of stretching to prevent overuse injury.
- Static measures of flexibility may not meaningfully translate to the dynamic processes in the running motion
- Dynamic warm-up before training that includes some movements that involve multisegment coordination and the lower body

Trunk and Lower Body Neuromuscular Strength and Balance



- Hip strengthening addresses the kinetic chain proximal to the knee, which helps to improve neuromuscular control over the patellofemoral joint for females
- Balance training improve intermuscular coordination and joint stability and reduce knee valgus during load-bearing.
- Incorporating a core-strengthening program into a conventional physical therapy program has been shown to improve pain and dynamic balance, reducing knee abduction movement in female patients with PFPS

Plyometrics

Effects of Plyometric Training on Endurance and Explosive Strength Performance in Competitive Middle- and Long-Distance Runners



- Plyometric training comprises movements with serial stretch shortening cycles that cause repeated lengthening and shortening of muscle-tendon complexes. (jumps, bounds, hops, and/or skips)
- Adaptations include improved neural drive to agonists, improved intermuscular coordination and activation strategies, and favorable changes to mechanical qualities and architecture of the muscle-tendon complex
- Several studies that incorporated plyometric exercises demonstrated 17–26% reduction in ground reaction force (GRF) on landing after 6–9 weeks of training, while reducing knee injuries

Plyometrics

Periodization of Plyometrics: Is There an Optimal Overload Principle?

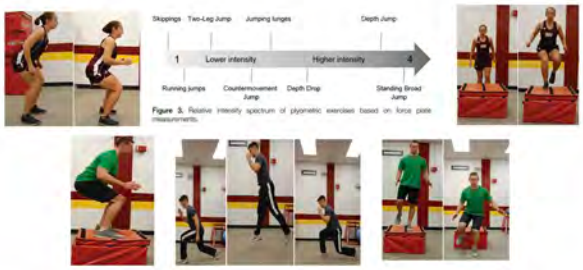


Figure 3. Relative intensity spectrum of plyometric exercises based on force plate measurements.

Plyometrics

Periodization of Plyometrics: Is There an Optimal Overload Principle?

Exercise selection	The type of movement	Bilateral to unilateral, goal specific
Length of training	Program duration in weeks	7-12 weeks
Frequency of training	Training days per week	1-2 days/week
Volume of training	Number of ground contacts per session	Beginner: 60 ground contacts Intermediate: 80-120 ground contacts Advance: 120+ ground contacts
Recovery of training	Rest in between sessions, sets, and reps	Intersession recovery: High intensity session: 48-72 hrs Low intensity session: 24 hrs Inter-set Recovery: 60-240s
Intensity	The amount of ground reaction force, torque, and RFD needed to perform an exercise	Initial intensity determined by exercise selection, increase intensity by 9-12% when progressing a specific exercise

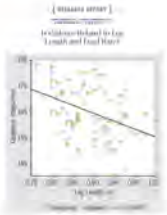
Plyometrics

Jumping rope training improves 3 km time trial performance by improving lower limb reactivity and foot arch stiffness in endurance runners



- Jumping rope (Skipping rope) – type of plyometric training with low-cost and time efficient
- Compared to running, the bounce rope-skip generated low lower extremity joint loading
- Jump-rope training (2-4 times/weeks) improved 3-km running performance, reactive strength index, arch stiffness in amateur runners, compared to CG

Injury Prevention - Cadence



- Cadence (defined as the number of steps per minute) - modifiable factors for optimizing running mechanics and reducing injury risk
- Typical cadence values in recreational runners range from 150 to 170 steps per minute, while elite runners often exceed 180 steps per minute
- the main effects is a reduction in ground reaction forces and vertical loading rate, attributed to a shorter stride and the placement of the foot closer to the body's center of mass.

Injury Prevention - Cadence



- Increasing cadence 5-10% reduced vertical ground reaction forces, lower loading rates, shorter stride length, decreased vertical oscillation of the center of mass, and improved lower-limb joint alignment, particularly at the hip and knee, without compromising energy efficiency

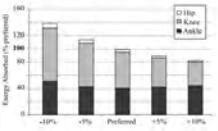
↓

Lower risk of common overuse injuries, such as patellofemoral pain, tibial stress fractures, and medial tibial stress syndrome

Injury Prevention - Cadence



Effects of Step Rate Manipulation on Joint Mechanics during Running



Injury Prevention – Foor orthosis



The effect of foot orthoses for patients with patellofemoral pain syndrome: A systematic review and meta-analysis

- Foot orthotics can help reduce the Q angle, promoting more normal patellofemoral contact pressure.

Injury Prevention – Nutrition

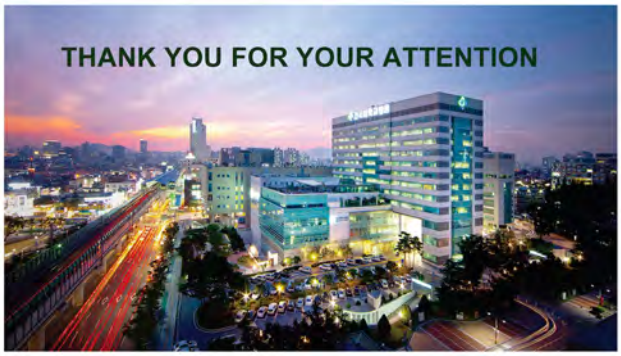
- Nutrition and the role of calcium and vitamin D

- In the prevention of bone stress injuries consideration of the sex would probably benefit from awareness of RED-S, including screening for low energy availability and low mineral bone density

- Risk of bone stress injuries was reduced by 20% after daily supplementation with vitamin D (800 IU) and calcium (2,000 mg)

- Identification and prevention of female athlete triad
: Identifying and correction of energy imbalance, and recovery of menstrual function may be the best way to maintain proper bone health during adolescence





The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

심포지엄 12: 팀주치의, 필드닥터 현장 경험

Team Physician, Field Doctor: Sharing On-Site Experience (대외협력위원회)

좌장: 서울대병원 최호천, 국가대표재활의학과 윤정중



최승호

학력

2003년 연세대학교 의과대학 졸업

2006~2011년 강남세브란스병원 재활의학과 수련

주요 경력

2012년 런던올림픽 축구대표팀 의무지원

2012년 소치동계올림픽 피겨, 빙상팀 의무지원

2013년~(현재) KLPGA, KPGA 다수 대회 의무지원

2023년~(현재) 산악연맹 주치의

2024년~(현재) 대학육상연맹 의무의원

현재 소속 및 직위

솔병원 재활의학과 진료원장.

KLPGA 의무지원 : 투어주치의 역할 및 향후 방향성
KLPGA Medical Support: Role of Tour Physicians and Future Direction

솔병원
최승호

본 발표는 한국여자프로골프투어(한국여자프로골프협회)와 대한스포츠의학회 간의 양해각서에 근거하여, 대한스포츠의학회 스포츠의학 인증전문의에게 한국여자프로골프협회(이하 KLGPA)의 정규투어 각 대회 라운드 별로 활동 중인 '투어 주치의'에 대한 안내 및 향후 방향성 제시를 위해 준비되었습니다. 보통 '투어 주치의'는, KLPGA 국내 정규투어 대회에서 선수들의 경기력 향상과 경기 중 부상 예방을 위한 활동, 그리고 경기장 내 의무지원 활동을 주로 시행하게 되며, 이를 위해 의무실에 검진 및 치료장비와 치료인력이 준비되어 있습니다. 올 해부터는 인증전문의 멘토-멘티 프로그램이 새롭게 진행 예정이기도 합니다. 이에 대하여 본 위원은 10 여년동안 KLPGA 투어 주치의 활동을 바탕으로 투어현장에서 효과적이고 유익한 활동을 위한 제언과 추천사항 등을 소개하고자 합니다.

이제형

학력

한림대학교 의학과 학사

주요 경력

두산베어스 프로야구단 수석 주치의

KB손해보험 스타즈 프로 배구단 주치의

한국 여자 야구 대표팀 주치의

현재 소속 및 직위

청담리온정형외과 원장

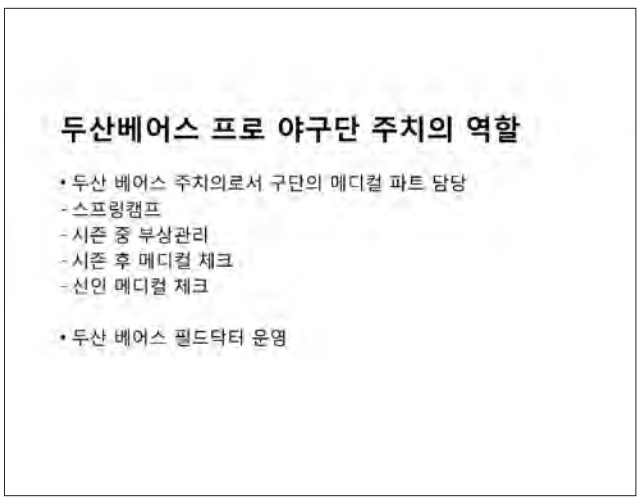
두산베어스 팀주치의의 시즌 전 후, 시즌 중 역할
Doosan bears Professional Baseball team Physician's Roles Before and After the Season, and During the Season

청담리온정형외과
이제형









대략적인 일정...

1. 스프링캠프
2. 시범경기
3. 시즌 (페넌트레이스)
4. 신인 메디컬 체크
5. 포스트시즌
6. 마무리캠프



스프링캠프 일과

1. 7:00 기상
2. 7:30 아침식사
3. 8:30 출발
4. 9:30 연습장 도착
5. 12:00 점심식사
6. 13:30 시합시작
7. 17:30 마무리 훈련 및 귀가
8. 18:30 저녁식사
9. 19:30 치료 시작 (US, injection)
10. 23:30 치료 종료 및 간식
11. 24:30 취침

야간 훈련 할 수도.....



Cellulitis

난감...

일본 병원 방문...

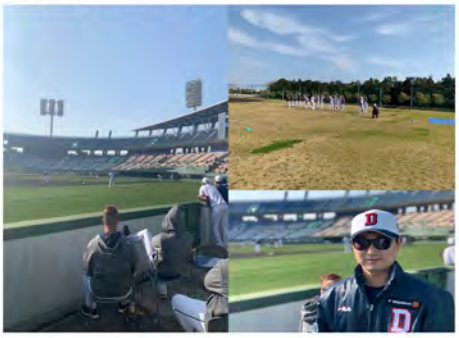
Fever...

영어도 안 통하고...

Cephazolin 구걸...



미야자키 스프링캠프



INTERNAL OBLIQUE TEAR
<RTP Painful memory!>

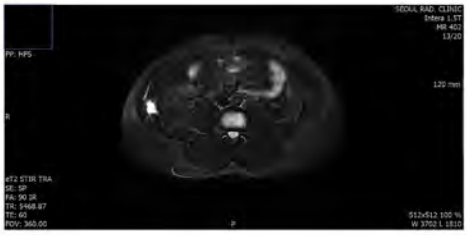
2월말? 미야자키... 배가 계속 당기고 아픕니다

초음파로 봤는데 잘 모르겠음
한국가서 MRI 찍자





Internal oblique ~~~



Internal oblique ~~~

그런데 통증이 별로 없답니다.

'내복사근 부상' [redacted] 상태호전, 복귀 초읽기



'지난해 커리어 하이' [redacted] 7일 NC전서 1군 복귀..5번 지명타자로 선발출전

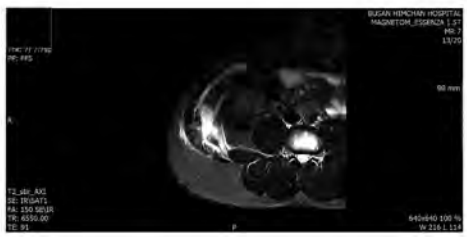
통증 없다니....

3주만에 복귀 합니다.....

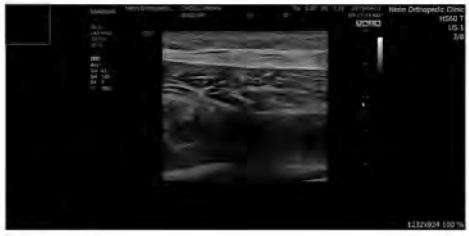
김태형 감독의 근심,'통증' [redacted] 11일 재검진 예정

4.7. 복귀
4타수 1안타

4.8. 월요일 경기 없음
4.9. 무천 휘스
4.10. 경기 라인업 제외
4.11. MRI

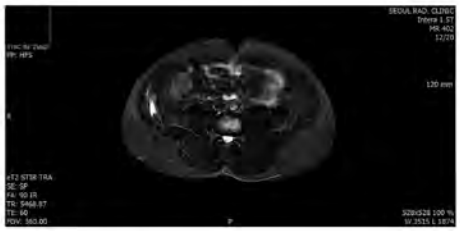


후...
선수도 짜증내고...
구단 및 트레이닝파트 PANIC...
저도 짜증내고...



이번엔 길게 가자...

선수 : FA때문에 안됩니다....

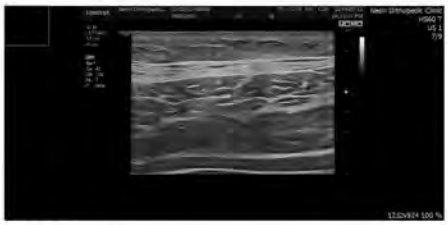


2nd 부상 후 11일 후 MRI

Hematoma 는 빠졌으나, 하나도 안붙었다



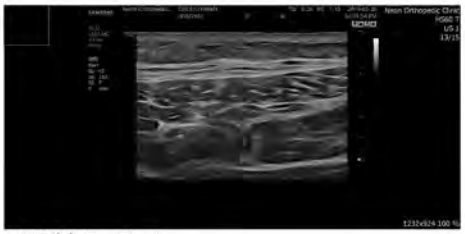
2nd 부상 후 15일 후 US
범위 줄었다 지켜보자.....



2nd 부상 후 1month

좋기는 한데 아직은 아니다....

슬슬 짜증냅니다...



2nd 부상 후 1month 1week

아직도 아니다....

말도 안합니다...



2023 스프링캠프 호주-시드니

23.2.26



Next day 23.2.27

LIVE BP 도중....

Temporal bone Fx. + EDH



난 정형외과 의사인데...

In-season

2017.08.29.

해당영상 및 의학 자료는 의학적 발전을 위해 선수 본인이 사용에 대한 동의를 함



Next day 2017.8.30.



AC Joint dislocation



AC joint dislocation - CONSIDERATIONS

X-ray / MRI / CT / US

Type (I II III IV V VI)

Season situation

Surgery vs. Conservative

Immobilization

Compliance

ROM

Strength

Sports training

RTT



Type III

Treatment of this injury has been debated in the literature

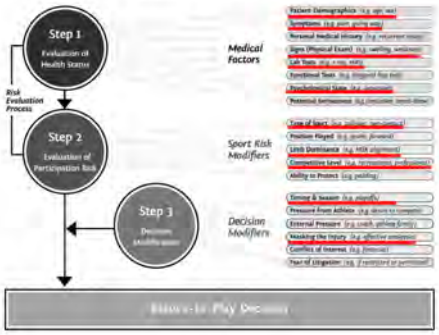
Anatomic reduction
- Not necessary for a satisfactory outcome
- Level I and II studies on treating conservatively
  - → less pain
  - → less weakness
  - → better function
  - → earlier return to work/sport
  - → fewer complications



The sling is discontinued after 3 weeks
Gentle ROM and strengthening therapy may begin as tolerated

Typically, 6 weeks is required before returning to sports.

Decision-Based RTP Model



다음날 8.30.



Player vs AT vs Team vs Doctor



Conserve (6-8weeks return)
PT / Rehab / Sling / Injection

OP (more than 3months return)
Hook plate / Phemister / Recon.

10월 중순 부터 플레이오프 (6주 뒤)
10월 말에 코리안 시리즈 (8주 뒤)

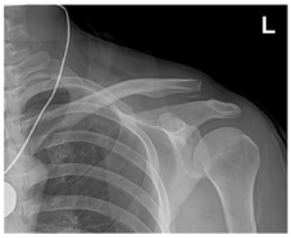
Kenny howard sling 3-4wks
X-ray f/u

IN FIELDER
NON DOMINANT
NOT a POWER HITTER

0주째 부터 isometric contration
3주째 부터 passive ROM (under 90)
4주째 부터 passive ROM (over 90)
5주째 부터 passive-assisted ROM
6주째 부터 weight

그리고 PO out / KS 상황 봐서 결정 합시다!

수상 6주



수상 6주차

ROM : Near Full (155/80/90/T8)

SMP : 90% compared to opposite

Function Test : FMS, CKC, OKC test 90%

Sports related training : Slight discomfort

Compliance : Good

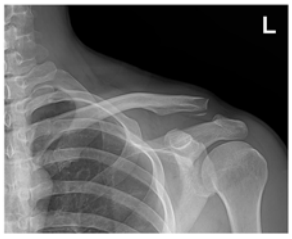
Mental status : Willing to PLAY!!!

6주 만에 합류



20

2017.11.02. KS 직후



2022년도, 두산 투수, Different case...





PITCHER
DOMINANT

Different Decision MADE!!!



해당영상 및 의학 자료는 의학적 발전을 위해 선수 본인이 사용에 대한 동의를 함



RTP ?

수술 안 해도 붙는다?
수술 하면 붙긴 RTP?
시즌 절마 안 남았는데..
비우세수 팔이다
팀에 투수가 없다
본인의 빠른 복귀 의지가 강하다

의사 혼자면의 결정이 아닙니다!!!
의사/팀/AT/선수/가족의 결정





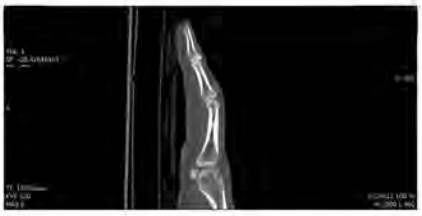
[KBO 이야기] [redacted], 등 향한 사구에 갈비뼈 골절상
… 양 팀 감독 간 벤치클리어링





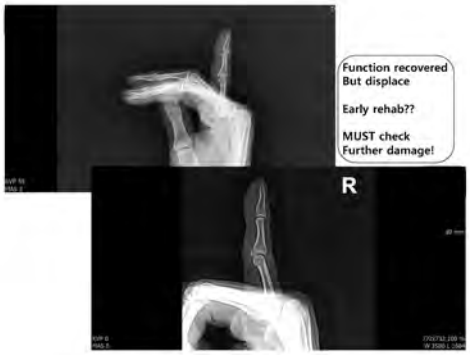
RTP 몇 주?????????????

Volar plate avulsion
RTP ?



Volar plate avulsion
RTP ?

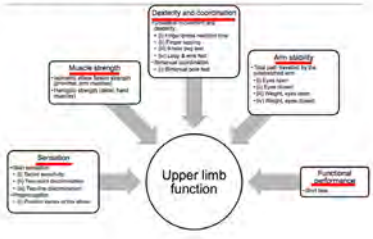


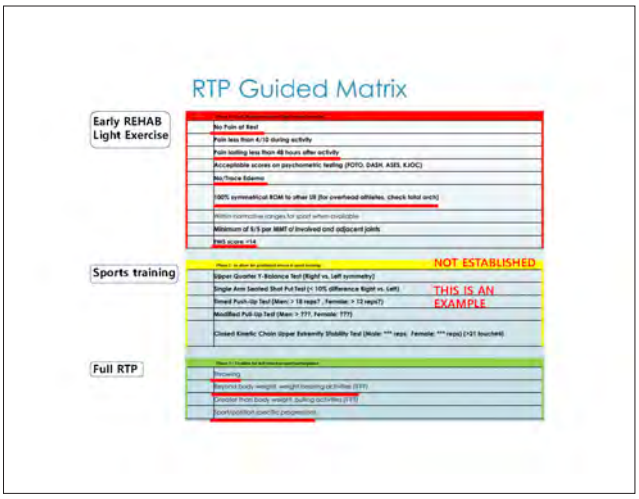


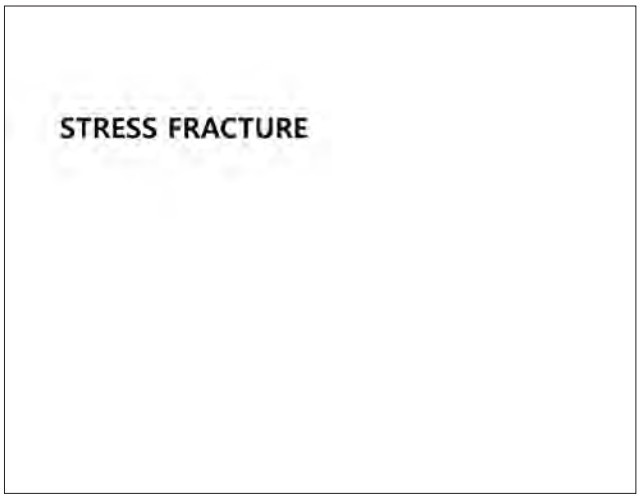
Few years later...

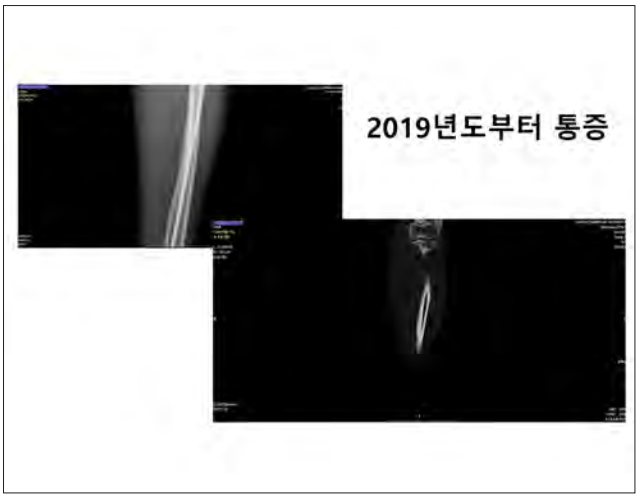


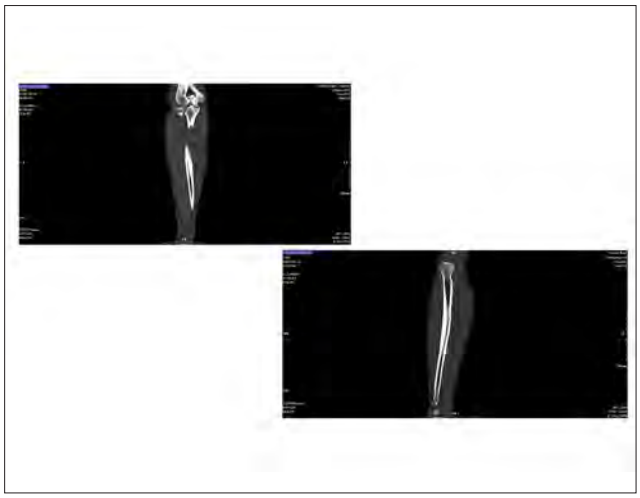
FUNCTION?



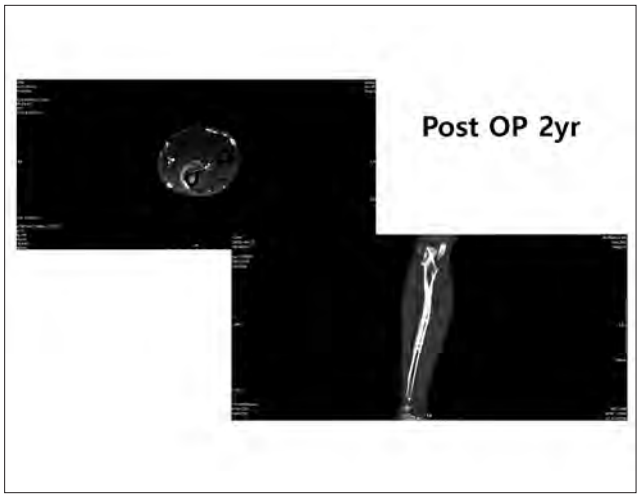

RTP Guided Matrix
Early REHAB
Light Exercise
Sports training
NOT ESTABLISHED
THIS IS AN
EXAMPLE
Full RTP


STRESS FRACTURE


2019년도부터 통증



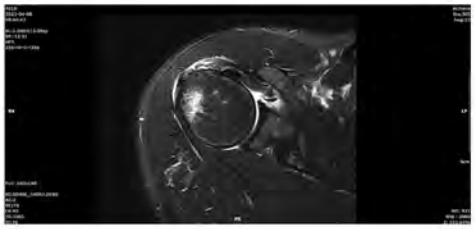

결국 OP


Post OP 2yr

FTRCT + Bankart



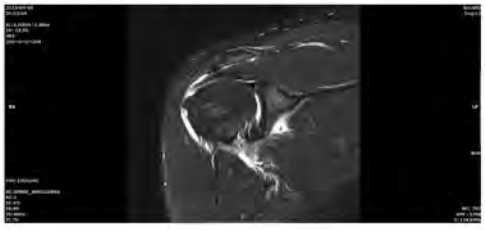
Hill sachs



Bankart



FTRCT (OMG) / OP? CONSERVE?



그 외에..

우승..
감기..
허리..
두통..
근육통..
2군 방문..
아앤드 컨트롤 방법..

가족 및 지인 진료..
여자친구 상담..
투자 상담..
자동차 상담..
골프 스윙 봄 상담..

포스트 시즌...

제일 힘든 시기...

예민...
욕설 난무...

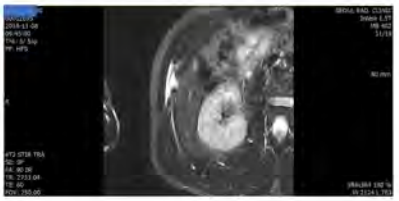
필드닥터 출입금지 / 팀 닥터만 출입합니다!

POST SEASON

- 진료
- 호텔로 출근
- 상태 체크
- 경기장 이동
- 시합
- 호텔복귀
- 식사
- 치료
- 귀가

RTP?

[KS] '두산 악재' [redacted] 옆구리 부상 선발 제외..."MRI 예정"



2018년도 SK와 KS도중...



시합만 뛰게 해달라....

당일에 테이핑, 압박, medication (ultracet, NSAID)

다음날에 Mypol, NSAID

주사 놔달라.... 제가 refuse

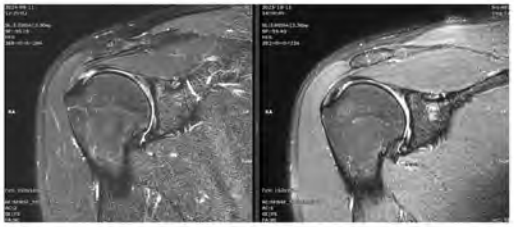
신인 메디컬 체크...





시즌 후 메디컬 체크

이전 영상들과 비교....





필드닥터의 임무





프로야구 필드닥터 운영 지침
(KBO의무위원회 및 프로야구 주치의 협의회 권고)

필드닥터의 선발

구단에서 지정한 팀 닥터 혹은 선임 필드닥터에게 선발권을 부여하며, 지역별 상황에 맞는 인원수 및 인력을 의사로만 구성, 단, 구성이 어려울 경우 대한스포츠의학회 등 스포츠 전문가들이 모여 있는 단체를 통해 공개 모집이 가능.

필드닥터의 임무 시간

시작 시간 : 경기 시작 15분전 도착

종료 시간 : 경기 종료 직후

필드닥터의 상주 위치

임에서 지정해준 장소에서 시합을 주시하면서 대기하는 것을 원칙으로 한다. 팀에서는 필드 닥터가 응급 환자 발생 시 신속히 대처할 수 있는 (구장으로의 접근이 손쉽게 가능한 관람석 및 대회본부, 덕아웃, 의무실등) 공간을 확보해서 제공한다. 응급환자 발생 시에 대처할 수 있는 위치에서 경기를 관람, 응급구조시 및 기타 의료전과의 위치가 가까우며 트레이너 그라운드 출두시에 닥터 콜이 잘 보이는 위치로 선정.

필드닥터의 복장

구단별로 지정이 가능하나, 단정한 복장으로, 공통으로 사용하는 가운을 상주장소에 보관하며 그라운드 출두 시에 가운을 착용한다.

필드닥터의 품위 유지

경기 관계 중 필드닥터의 의무지원은 일반적인 의료인의 근무 지침을 따르며, 경기전 혹은 경기중 일절 음주 등은 금한다. 또한 서든 죽 팀 트레이너 및 직원들에게 무리한 요구(심기다툼, 선수와의 만남, 사진 및 확인 요청 등)는 하지 않도록 한다.

필드닥터 치료 대상

홈팀 선수들 및 코칭 스탭, 어웨이팀 선수들 및 코칭 스탭, 심판진의 케어

(관중들은 원칙은 대기중인 응급구조사, 간호사 혹은 필드닥터가 아닌 의료인력)

예시> 실제 예로 관중으로 부상으로 필드닥터와 앰블런스가 추송을 갔으나, 선수 부상이 발생하며 선수를 돕기 위해 구급과 앰블런스의 부재가 발생한 예가 있음

필드 닥터의 업무

경기장에서 발생하는 부상 및 응급상황에 대처. 경기장 출근시 필드닥터 관리 트레이너와 스톱하여 경기전 부상선수의 진료 그리고 경기중 부상선수의 진료를 원칙으로 한다.

경기장내에 발생하는 부상에 대처. 일반적인 응급상황 (두부손상, 경부 손상, 출혈, 의식상명, 심정지, 골절, 탈구 등)에 경기장내로 출두하여 의학적 판단으로 응급 후송여부를 결정한다.

경기장내 출두의 판단이 언팀 경우, 담당 트레이너의 호출을 기다리며 상황을 예의주시한다.

필드닥터의 개인적 홍보 범위

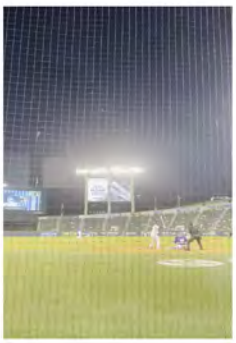
•구단별로 협의가 가능하나, 기본적으로 홈페이지에 필드닥터 이력 게재, 팀내 홍보물에 활용 등으로 규정한다.



청담리온정형외과

잠실 야구장내 임원실





청담리온정형외과

야구를 관람하기에 최적의 뷰

시구자들을 만날 수 있는 기회

청담리온정형외과



필드닥터 상주 시간

청담리온정형외과

시작 : 경기 시작 15-20분전

종료 : 경기 종료 시



필드닥터 식사

청담리온정형외과



경기 시작 15-20분 전에 구내 식당

단장님 : 이 원장, 필드닥터들이 일 끝나고 와서 맨날 배고프니 과자만 먹네...

이제형 : ... 아 ... 단장님 ... 과자를 못 먹게 할까요?

단장님 : 아니 그런 뜻이 아니라, 일찍 와서 구내 식당에서 식사를 하라고 하셔...

이제형 : 네, 단장님, 감사합니다

시즌 중 경기장 지원시에 업무는?

청담리온정형외과

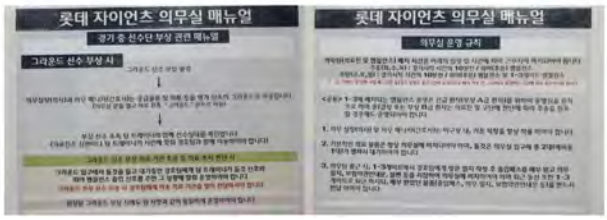
경기장내...

주된 업무 (active)
- 경기중 선수 그라운드 부상 지원

보조 업무 (passive)
- 부상 선수 상태 점검 (트레이너실)

GOOD MANUAL

청담리온정형외과


롯데 자이언츠 의무실 매뉴얼

롯데 자이언츠 의무실 매뉴얼

두산베어스는...



1. 환자 발생시 먼저 구단 트레이너가 1차적으로 그라운드 진입
2. 응급구조사 대기 (3루측 쪽문)
3. 이때, 필드 닥터도 같이 대기, 호출이 있으면 바로 투입
4. 단, 응급상황 (두경부손상, 헤드샷, 출혈, 탈구, 의식손실 ....)

→ 판단이 안 되는 경우가 많으므로, 트레이너의 닥터 호출도 중요

AWAY 선수 그라운드 부상 시...

청담리온정형외과

- 상당히 애매합니다. 과연 반길까? 오지랖...?
- 두산 트레이너와 필드닥터, 경기전 상호 인사 →유대감 형성

- 응급구조사가 투입되는 상황이거나 응급상황에서는 반드시 투입되어서 도와줘야 한다고 지침을 내리고 있습니다.

BAD EXAMPLE

청담리온정형외과

1. Away팀 투수가 타구를 두부에 맞았으나 닥터가 투입이 안됨
→ hesitation

2. Home팀 타자가 부상을 당했는데, 경기에 집중 안하고 있어서, 응급구조사 출동 이후 한참 지나서 필드닥터 투입
→ lack of concentration

3. Home 팀 투수가 타구에 맞아, 부상, 필드닥터가 그라운드로 들어갔으나, 그날 따라 짧은 미니스커트를 입고 와서 집중이 됨
→ inappropriate dress code

BAD EXAMPLE 2

4. 필드닥터 임무 중에 음주
5. 경기중에 야구장 돌아다니면서 덕 아웃 방문
6. 일정을 변경하고 알려주지 않음
7. 필드닥터 아닌 사람의 출입

단체 톡방 - 정보교환



필드닥터의 의무

청담리온정형외과



My experiences

1. Diagnosis
2. Play or Rest
3. OP or Conserve
4. Return to play
5. Out of game issues
6. Mental control
7. Must know every field !!!
8. Not in textbook → Must experience



Thank you for kind attention !

배중현

학력

중앙대학교 의과대학 학사
중앙대학교 의과대학 재활의학 석사
가톨릭대학교 의과대학 예방의학 박사

주요 경력

2024 파리올림픽 주치의
2026 밀라노코르티나 올림픽 주치의
전 솔병원 진료원장

현재 소속 및 직위

대한체육회 진천국가대표선수촌 메디컬센터 재활의학과

대표논문

Bae, J., et al. (2025). “Team Korea injury and illness surveillance at the 2024 Paris Olympic Games.” Injury Epidemiology 12(1): 55.

대한체육회 의사의 업무 : 선수촌 일상과 대회 출장
Duties of the Korean Sport & Olympic Committee Physician

대한체육회
배중현







The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

3월 21일(토요일)

Room C



The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

구연 1

좌장: 노원을지대병원 양기원, 분당서울대병원 이용석



전방머리자세 교정에서 중재 방식에 따른 훈련 효과 비교: 대면 훈련, 온라인 실시간 훈련, 멀티미디어 자가훈련

Training Effects of Forward Head Posture Correction Across Delivery Methods: Face-to-Face, Real-Time Online, and Multimedia Self-Training

국립부경대학교 체육학과 대학원, 국립부경대학교 체육진흥원,
국립부경대학교 스마트헬스케어학부 해양스포츠전공
임나단, 주동연, 최지영, 최호경, 김영훈, 김태규

목적

The purpose of this study was to classify adults with forward head posture into three groups (face-to-face, online, and multimedia) and, after applying corrective exercises and ergonomic advice for six weeks, to compare the effects and sustainability of each intervention modality on postural alignment, pain, muscle activity, muscle function, and proprioception, thereby determining the extent to which online- and multimedia-based interventions provide effectiveness comparable to that of face-to-face intervention.

대상 및 방법

Adults with a craniovertebral angle (CVA) ≤ 53° were randomly assigned to one of three groups (n = 13 each). The face-to-face group received supervised training; the online group received the same program via Zoom; and the multimedia group followed videos and PDFs independently. All interventions were performed three times per week for six weeks. Outcomes were assessed at baseline, immediately post-intervention, and at 4- and 8-week follow-up, and included craniovertebral angle (CVA), neck pain (VAS), neck disability index (NDI), cervical muscle activity, neck strength, joint position error (JPE), and range of motion (ROM).

결과

Significant changes in CVA were observed across all groups; however, a tendency to decrease again was noted at the 4- and 8-week follow-up assessments. NDI and VAS decreased in the face-to-face

and online groups, and these reductions tended to be maintained at the 4- and 8-week follow-ups. Cervical ROM improved or showed a tendency to improve in all three groups, and isometric neck strength increased across all groups; these improvements were generally maintained at the 4- and 8-week follow-up assessments. Cervical JPE during flexion decreased in the face-to-face group immediately post-intervention as well as at the 4- and 8-week follow-ups, and was lower than in the multimedia group at both follow-up time points. Sternocleidomastoid and anterior scalene muscle activity showed a decreasing trend in the 22–30 mmHg range in the face-to-face and online groups, with this reduction tending to be maintained at follow-up.

결론

This study found that face-to-face, online, and multimedia interventions were all associated with improvements in CVA, neck flexion–extension strength, and cervical ROM, suggesting that these structural indices may be improved through non-face-to-face interventions alone. In contrast, significant improvements in VAS, NDI, and superficial cervical muscle activity were observed in the face-to-face and online interventions that provided real-time feedback, indicating that pain-related outcomes and the reorganization of muscle recruitment patterns may be related to immediate postural correction and the provision of sensory feedback. In addition, JPE improved significantly only in the face-to-face intervention, implying that changes in variables requiring high-precision sensorimotor control may be influenced by real-time feedback–based sensorimotor relearning. Overall, CVA, NDI, neck strength, and cervical ROM were amenable to improvement even in non-face-to-face formats. Furthermore, VAS and superficial cervical muscle activity showed significant improvements when real-time feedback was provided, and JPE demonstrated significant improvement only in the face-to-face intervention. Therefore, incorporating real-time feedback elements may be considered to enhance the effectiveness of multimedia-based interventions.

24시간 움직임 행동 가이드라인 준수와 고혈압 유병률의 연관성
Association Between Adherence to 24-Hour Movement Guidelines and Hypertension Prevalence

서울시립대학교 스포츠과학과
김선정, 송현수, 정승원, 민호정, 최태구, 김현정, 제세영

목적

Prior studies have typically examined physical activity, sedentary time, and sleep separately, often focusing on each behavior in isolation. However, emerging evidence suggests that an integrated approach considering 24-hour movement behaviors, including physical activity, sedentary behavior, and sleep, has been proposed as a more comprehensive framework for cardiovascular health promotion. Therefore, we aimed to examine the relationship between adherence to the 24-hour movement guidelines and hypertension prevalence among Korean adults.

대상 및 방법

We analyzed data from 23,410 adults aged ≥19 years who participated in the 2018-2023 Korea National Health and Nutrition Examination Survey. These movement behaviors were assessed self-reported questionnaires. Adherence to the 24-hour movement guidelines was categorized according to the number of components met (0, 1, 2, or 3) as follows: (1) physical activity, defined as meeting the WHO recommendation of ≥150 min/week of leisure-time moderate-to-vigorous physical activity (MVPA); (2) sedentary behavior, defined as <8 hours/day of sitting time; and (3) sleep, defined as 7–9 hours/day of sleep duration. Hypertension was defined as systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg, physician-diagnosed hypertension, or current use of antihypertensive medication.

결과

Overall, 19.8% of participants met none of the guidelines, 42.9% met one, 31.7% met two, and 5.7% met all three. The prevalence of hypertension decreased progressively with greater adherence: 35.2% (0 guidelines), 31.5% (1), 30.0% (2), and 21.5% (3) (p<0.001). SBP, DBP, mean arterial pressure, and pulse

pressure decreased significantly with increasing adherence (all p<0.001). Favorable differences were also observed for waist circumference, fasting glucose, triglycerides, and high density lipoprotein cholesterol (all p<0.001), whereas total cholesterol and low density lipoprotein cholesterol did not differ significantly across adherence categories. In logistic regression analyses, meeting 1, 2, or 3 guidelines was associated with significantly lower odds of hypertension in the crude model. However, after adjustment for covariates, only meeting all three guidelines remained significantly associated with reduced odds of hypertension.

결론

Adherence to the 24-hour movement behaviors guidelines was generally low in Korean adults. Nevertheless, greater adherence was associated with lower hypertension prevalence and more favorable cardiometabolic profiles. These findings highlight the potential importance of integrated movement behaviors in hypertension prevention and management.

한국 성인에서 사회경제적 지위에 따른 신체활동 패턴과 고혈압 유병률 간의 연관성

The association between physical activity patterns and hypertension by socioeconomic status in Korean adults

서울시립대

최태구, 송현수, 김선정, 정승원, 김현정, 박상신, 제세영

목적

Weekend warrior physical activity (PA) pattern (ie, 1 or 2 sessions per week) and regular PA have been associated with a lower risk of hypertension. However, it remains unclear whether these associations differ by socioeconomic status (SES). We hypothesized that the association between weekend warrior PA pattern and lower risk of hypertension would be stronger in socioeconomically disadvantaged individuals.

대상 및 방법

This cross-sectional study included 28,039 adults aged ≥19 years from the 2018–2023 Korea National Health and Nutrition Examination Survey. PA patterns were categorized as inactive, insufficiently active, weekend warrior, or regularly active. Educational attainment (high school or less vs. college or higher) was used as the indicator of SES status. Hypertension was defined as SBP ≥140 mmHg, DBP ≥90 mmHg, a physician diagnosis of hypertension, or current use of antihypertensive medication. Multivariable logistic regression models estimated odds ratios (ORs) and 95% CIs for prevalent hypertension across PA patterns, stratified by education level.

결과

In multivariable-adjusted models, compared with inactive participants, active PA patterns were associated with lower odds of prevalent hypertension. In participants with lower educational attainment, insufficiently active (OR 0.80, 95% CI 0.71–0.91), weekend warrior (OR 0.67, 95% CI 0.49–0.92), and regularly active (OR 0.82, 95% CI 0.73–0.92) patterns were associated with lower odds of hypertension. In contrast, participants with higher educational attainment, only the regularly active pattern was significantly associated with lower odds of hypertension (OR 0.87, 95% CI 0.76–0.99); insufficiently active (OR 0.90, 95% CI 0.78–1.04) and weekend warrior (OR 0.80, 95% CI 0.59–1.10) were not.

결론

Weekend warrior and other physical activity patterns were associated with lower odds of hypertension among adults with lower educational attainment, with comparatively stronger associations than among those with higher educational attainment. These findings suggest that promoting PA, including weekend warrior style actively, may support targeted PA promotion strategies for socioeconomically disadvantaged adults who may face time and resource constrains.

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2025S1A5C2A02022644)

발목 및 중간볼기근 키네시오 테이핑이 발목염좌 대상자의 동적균형과 하지 운동역학에 미치는 영향

Effects of Ankle and Gluteus Medius Kinesio Taping on Dynamic Balance and Lower Extremity Biomechanics in Individuals with Ankle Sprain

국립부경대학교 체육학과 대학원

정경열

목적

본 연구는 발목염좌 병력이 있는 성인을 대상으로, 발목과 중간볼기근에 적용한 키네시오 테이핑이 YBT 수행 시 기록과 종합점수, 하지 관절의 각도 및 모멘트에 미치는 영향을 분석하는 것을 목적으로 한다.

대상 및 방법

본 연구의 대상자는 만 19세 이상 남자 대학생으로, 본 연구에 참여 전 24개월 이내에 1-2등급의 발목염좌를 1회 이상 경험하고 6개월 이전에 회복한 자로, 총 16명이 자발적으로 참여하였다. 모든 측정은 준비운동 후 동일한 검사자에 의해 발목염좌를 경험한 하지에서 실시되었으며, 학습효과를 제거하기 위해 복합 테이핑(combined taping, CT), 샴 테이핑(sham taping, ST), 비 테이핑(non taping, NT)의 순서를 제비뽑기를 통해 무작위로 선정하였다. 3차원 동작분석을 통한 하지 운동학 및 운동역학 자료를 수집하기 위해 대상자의 하지에 반사마커를 부착한 후, 테이핑 조건에 따라 Lower Quarter Y-Balance test(YBT-LQ)를 실시하였으며, 각 조건 사이에는 10분간의 휴식시간을 제공하였다.

테이핑 중재는 손상측 발목과 중간볼기근 부위에 적용하였며, 테이핑 실무 경험을 보유한 연구자 1인이 모든 대상자에게 동일한 방법으로 일관되게 적용하였다. 모든 테이핑은 부착 전 피부를 알코올로 정리한 후, 테이프의 시작과 끝 지점은 장력 없이(no tension), 중간 구간은 약 15~25%의 장력을 주어 적용하였다. 복합 테이핑(CT) 중 발목 테이핑은 대상자의 발이 침대 끝으로 나오도록 앉은 자세에서 적용하였으며, 발목을 발등쪽굽힘, 안쪽번짐 및 가쪽번짐한 상태에서 각각 목말뼈와 발꿈치뼈를 기준으로 네 차례 부착하였다. 중간볼기근 테이핑은 대상자가 옆으로 누운 자세에서 엉덩관절을 90도 굽힘한 상태로 Y자 모양 테이핑을 사용하여, 넙다리뼈의 큰돌기와 위앞엉덩뼈가시 및 위뒤엉덩뼈가시 방향으로 부착하였다. 샴 테이핑(ST)은 동일 부위에 위약효과를 확인하기 위해 적용하였으며, 발목에는 안쪽 및 가쪽 복사뼈에서 종아리 측면의 중간까지, 중간볼기근에는 엉덩이 측면을 가로지르도록 부착하였다.

결과

테이핑 적용에 따른 YBT 점수를 분석한 결과, 앞쪽 뻗음에서는 세 조건 간 유의한 차이가 나타나지 않았으나, 뒤안쪽 뻗음에서는 CT 조건이 NT 조건보다 유의하게 높은 기록를 보였으며(P=.012), 뒤가쪽 뻗음에서는 CT, ST 조건이 NT 조건에 비해 유의하게

높은 기록을 확인하였다(P=.002). 또한 YBT 종합점수(Composite score)에서도 CT 조건이 NT 조건보다 유의하게 높게 나타났다(p=.001). 테이핑 적용에 따른 YBT 수행 중 각 방향에 대한 하지 관절 각도 변화를 분석한 결과, 유의한 차이가 나타나지 않았다(p > .05). 테이핑 적용에 따른 YBT 수행 중 각 방향에 대한 하지 관절 모멘트 변화를 분석한 결과, 앞쪽 뻗음과 뒤안쪽 뻗음에서는 세 조건 간 유의한 차이가 나타나지 않았으나, 뒤가쪽 뻗음 엉덩관절의 안쪽돌림/가쪽돌림 모멘트가 NT 조건보다 ST, CT 조건에서 유의하게 더 큰 안쪽돌림 모멘트가 나타났고(p=.002), 무릎관절의 모음/벌림 모멘트는 NT 조건보다 CT 조건에서 유의하게 더 큰 벌림 모멘트가 나타났다(p=.022).

결론

테이핑 조건에서 뒤안쪽, 뒤가쪽 뻗음 및 종합점수가 NT 조건에 비해 유의하게 높은 것을 확인하였으며, 뒤가쪽 뻗음에서 엉덩관절 안쪽돌림 모멘트와 무릎관절 벌림 모멘트가 증가한 것을 확인하였다. 본 연구 결과를 통해 발목과 중간볼기근에 대한 복합적 테이핑은 하지의 안정성과 협응을 증진시켜 발목염좌 병력이 있는 대상자의 기능적 수행 향상을 위한 보조적 중재로 활용될 수 있을 것으로 생각된다.

엘리트 수영선수의 장기 방치된 슬개골 하극 골절로 인한 슬개고위에 대한 슬개건 단축 및 전경골건 동종이식 재건술: 증례 보고
Patellar Tendon Imbrication with Anterior Tibialis Allograft Augmentation

거인병원
김상효

주제 (증례)

A neglected inferior pole patellar fracture can result in a chronic condition characterized by elongation of the patellar tendon, patella alta, and extensor mechanism insufficiency. In athletic individuals, appropriate and effective restoration of the ext

본문 (증례)

A 24-year-old male competitive swimmer presented with long-standing patella alta and functional impairment of the extensor mechanism. Despite multiple prior consultations, no definitive diagnosis or treatment plan had been offered. According to the patient, knee trauma had occurred approximately 15 years prior during childhood but had not been properly diagnosed at the time. Physical examination revealed marked quadriceps muscle atrophy, particularly of the rectus femoris, with no clinical signs of patellar instability such as a positive J-sign or apprehension test. Imaging showed no trochlear dysplasia, chondral damage, meniscal injury, or ligamentous pathology. However, lateral radiographs revealed patella alta, with an Insall-Salvati index of 1.38 and a Caton-Deschamps index of 1.48. MRI and CT identified a large intratendinous ossicle, approximately 2 cm in length, suggestive of a chronic, neglected inferior pole patellar fracture fragment, along with significant patellar tendon elongation. The patient's primary complaint was difficulty with active knee extension, both during sports and daily activities, consistent with extensor mechanism insufficiency. While tibial tubercle osteotomy can be considered in cases of patella alta, it was not the preferred option here, given the absence of bony malalignment, the soft tissue-dominant pathology, and the potential complications associated with bony procedures. Intraoperatively, the ossicle was excised, resulting in thinning and a partial defect of the patellar tendon. Tendon imbrication of approximately 1.5 cm was performed based on preoperative planning to restore functional tendon length. Although quadriceps tendon lengthening was considered, it was not necessary

due to the lack of excessive tension. To reinforce the weakened extensor mechanism and reduce the risk of recurrence, augmentation using an anterior tibialis allograft was performed. Autologous hamstring graft was deemed unsuitable due to severe degenerative changes and adhesions associated with the chronic nature of the condition. Postoperative lateral radiographs demonstrated correction of patellar height, with improvement in the Insall-Salvati index to 1.08 and Caton-Deschamps index to 1.10. At the latest follow-up, the patient was undergoing structured rehabilitation with a goal of returning to competitive swimming. This case highlights a rare, delayed presentation of inferior pole patellar fracture with associated patella alta and extensor mechanism insufficiency, successfully managed with soft tissue reconstruction and tendon augmentation, without the need for bony procedures.

토의

This case highlights that chronic patella alta due to a neglected inferior pole fracture can lead to extensor mechanism insufficiency, and that soft tissue reconstruction, including tendon imbrication and allograft augmentation, can serve as an effective treatment strategy when bony malalignment is absent.

만성 아킬레스건 파열 스포츠인에서 동종건을 이용한 최소침습 아킬레스건 재건술 후 스포츠 복귀: 2증례 보고
Return to Sport after Minimally Invasive Achilles Tendon Allograft Reconstruction

SNU서울병원
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목적
만성 아킬레스건 파열은 파열 후 시간이 경과함에 따라 파열단의 섬유화가 진행되어 일차 봉합이 어려운 경우가 많으며, 재건술이 필요하다. 특히 스포츠인에서는 족저굴곡 근력 보존과 빠른 재활을 통한 스포츠 복귀가 중요하다. 본 증례보고에서는 스포츠 활동 중 발생한 만성 아킬레스건 파열 환자 2예에서 시행한 최소침습적 동종건 아킬레스건 재건술의 임상적 결과와 스포츠 복귀를 보고하고자 한다.

대상 및 방법
증례 1은 킥복싱을 즐기는 38세 남성으로, 스포츠 활동 중 수상 후 1년이 경과한 만성 아킬레스건 파열로 진단되었다. 증례 2는 테니스를 즐기는 43세 남성으로, 수상 후 약 2.5개월 경과한 만성 아킬레스건 파열로 진단되었다. 두 증례 모두 동종건을 이용한 최소침습 아킬레스건 재건술을 시행하였다. 수술 후 4주간 단하지 석고 고정을 시행하였으며, 이후 아킬레스 보조기를 착용하여 단계적인 재활을 진행하였다.

결과
증례 1은 수술 후 8주 까지 보조기를 착용하였다. 수술 후 6개월째 달리기 및 킥복싱으로의 스포츠 복귀가 가능하였으며, 수술 후 1년째 일상생활 및 스포츠 활동에서 기능적 제한 없이 회복되었고 자기공명영상(MRI)에서 아킬레스건의 치유 소견을 확인하였다.
증례 2는 흡연 및 음주력이 있어 보조기 착용 기간을 12주로 연장하였으며, 수술 후 6개월째 스포츠 복귀가 가능하였다. 수술 후 1년째 일상생활 및 스포츠 활동에서 기능적 제한은 없었으며, 임상적으로 만족스러운 회복을 보였다. 두 증례 모두 수술 후 합병증은 발생하지 않았다.

결론
최소침습적 동종건 아킬레스건 재건술은 만성 아킬레스건 파열 스포츠인에서 Triceps surae 를 보존하여 족저굴곡 근력 보존과 빠른 재활을 가능하게 하며, 성공적인 스포츠 복귀를 기대할 수 있는 유용한 치료 방법으로 생각된다.

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

구연 2

좌장: 구로성심병원 김병성, 아주대병원 정준영



급성 흡기근 운동이 고강도 근력 운동 후 동맥경직 반응을 완화할 수 있을까?

Does Acute Inspiratory Muscle Exercise Attenuate Arterial Stiffening After High Intensity Resistance Exercise?

서울시립대

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목적

Resistance exercise is recommended for the prevention and treatment of cardiovascular disease, however, high-intensity resistance exercise can acutely increase arterial stiffness through, potentially via repeated expose to large hemodynamic loads. Inspiratory muscle strength training has recently been shown to effectively lower blood pressure and improve vascular function. However, it remains unclear whether a single session of inspiratory muscle strength exercise (IMSE) attenuates the increase in arterial stiffness following high-intensity resistance exercise. This study aimed to determine whether acute IMSE attenuates high-intensity resistance exercise-induced increases in arterial stiffness.

대상 및 방법

Seven healthy adult men (age, 23.6±1.1 years) who had regularly performed high-intensity resistance exercise for more than six months were recruited. In a randomized crossover design, participants completed two conditions: resistance exercise performed with either inspiratory muscle strength exercise (IMSE; 60% PImax) or a sham inspiratory muscle strength exercise (SHAM; 5% PImax). High-intensity RE consisted of 8 exercises performed at 80% 1-repetition maximum for 2 sets of 8–12 repetitions. During the inter-set rest periods, participants performed either IMSE (60% PImax; 9 sets of 6 breaths) or a sham inspiratory intervention (5% PImax; 9 sets of 6 breaths). Measurements were obtained at baseline, immediately post exercise (post1), and 30 minutes post exercise (post2). Brachial and central blood pressure (BP) were assessed using an automated sphygmomanometer and pulse wave analyzer. Vascular function indices included augmentation index (AIx), carotid-femoral pulse wave velocity (cfPWV), brachial-ankle pulse wave velocity (baPWV), carotid ????-stiffness, and carotid arterial compliance (AC), assessed via pulse wave analyzer and ultrasound.

결과

Brachial systolic BP did not change over time (p=.247). Diastolic and mean BP decreased over time, and pulse pressure changed over time, with no differences between the conditions (all p>0.05). AIx@75 increased significantly over time (p=0.023), without a time × condition interaction (p=0.506). cfPWV and baPWV did not change over time and did not differ between the conditions (all p>0.05). However, carotid β-stiffness increased and carotid arterial compliance decreased significantly over time (all p<.001), with no differences between the conditions (all p>.05).

결론

Arterial stiffness increased after high-intensity resistance exercise, and acute inspiratory muscle strength exercise did not attenuate this response. Future studies are needed to identify effective strategies to attenuate high-intensity resistance exercise-induced increases in arterial stiffness.

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (RS-2024-00357595).

봉합 불가능한 회전근개 파열 환자에서 하부 승모근 건 이전술 후 임상 증상과 등속성 근력 평가
Clinical outcomes and isokinetic muscle performance after lower trapezius tendon transfer for irreparable rotator cuff tear

고려대 안암병원
정웅교, 이진혁, 최정훈

목적

회복 불가능한 후상방 회전근개 파열의 치료를 위해 하부 승모근 건 이식술(Lower trapezius tendon transfer, LTT)의 적용이 점차 증가하고 있다. LTT 시행 후 양호한 임상적 결과들이 보고된 바 있으나, 수술 후 근육 수행 능력에 대한 객관적인 평가는 여전히 미비한 실정이다. 본 연구에서는 회복 불가능한 후상방 회전근개 파열에서 하부 승모근 건 이전술(lower trapezius tendon transfer, LTT) 후 임상 결과와 등속성 검사를 통한 근력을 평가하고자 하였다.

대상 및 방법

1년 이상 추시가 가능하였던 LTT 시행 환자 19명을 대상으로 후향적 분석을 시행하였다. 임상 평가는 ASES 점수, UCLA 점수, 관절가동범위(range of motion), 외회전 지연(external rotation lag), 가성마비(pseudoparalysis) 정도를 평가하였다. 수술 후 1년 후 등속성 근력 검사를 시행하여 건측과 비교 하였다. 등속성 근력검사는 견관절 외회전과 전방거상 시 peak torque, total work, time to peak torque, 견갑근육의 protraction 및 retraction 근력을 측정하였다

결과

ASES 점수는 52.9 ± 11.4에서 93.4 ± 6.8로; UCLA 점수는 18.2 ± 4.1에서 31.3 ± 3.2 수술 후 유의하게 향상되었다(p < 0.001). 외회전 지연은 10명 중 8명(80%)에서 소실되었고(p = 0.021), 가성마비는 모든 환자에서 회복되었다(p = 0.008). 전방거상 각도는 유의하게 증가하였으나(p < 0.01), 외회전 각도는 유의한 변화가 없었다. 등속성 검사에서 수술측은 반대측에 비해 외회전 및 전방거상 시 최대 토크와 총 작업량이 유의하게 감소하였으며, 최대 토크 도달 시간은 유의하게 지연되었다(p < 0.001). 반면, 견갑골 전인 및 후인 근력에서는 양측 간 유의한 차이가 없었다

결론

회복 불가능한 회전근개 파열에서 하부 승모근 건 이전술은 임상적 결과를 유의하게 개선하고 외회전 지연 및 가성마비를 효과적으로 회복시킨다. 그러나 등속성 근력 평가에서는 수술 후 1년이 경과하였음에도 불구하고 근력 및 근육 수행 능력의 저하가 지속됨을 확인할 수 있었다.

만성 발목 불안정증 환자에서 올인사이드(All-inside) 외측 발목 인대 복합체 봉합술과 개방형 브로스트롬 술식의 임상 결과 비교: 무작위 대조 연구

Clinical results of all-inside lateral ankle ligament complex repair were comparable to open Brostrom procedure in patients with chronic ankle instability: Randomized controlled study.

분당차병원

정심호

등척성 운동 유형이 고혈압 전단계 젊은 남성의 24시간 활동 혈압에 미치는 영향 비교: 무작위 교차 연구

Acute effects of different Isometric Exercise modalities on 24-hour Ambulatory Blood Pressure in Young Men with Prehypertension: A Randomized Crossover Trial

서울시립대학교 스포츠과학과, 서울시립대학교 도시보건대학원

송현수, 김선정, 정승원, 최태구, 김현정, 제세영

목적

Isometric resistance exercise has emerged as a promising strategy for blood pressure (BP) reduction; however, the comparative acute effects of different modalities on 24-h ambulatory blood pressure monitoring (ABPM) in young adults with prehypertension are unclear. We compared the acute effects of isometric handgrip and wall squat exercise on 24-h ABPM in young adults with prehypertension.

대상 및 방법

Ten young adults with prehypertension (25.0 ± 2.3 years) completed a randomized crossover trail consisting three conditions: isometric handgrip (IHG), isometric wall squat (IWS), and a non-exercise control (CON). Conditions were separated by at least three days. Twenty-four-hour ABPM was measured to assess 24-hour, daytime, and nighttime BP, blood pressure variability (BPV), morning BP, and nocturnal dipping pattern.

결과

Mean 24-h systolic and diastolic BP did not differ among conditions (p=.897, p=.942, respectively). Daytime (p=.710, p=.858) and nighttime BP (p=.947, p=.882) were also similar across conditions. Indices of BPV were not different for 24-hour average real variability (ARV; p=.811, p=.972), 24-hour standard deviation (SD; p=.221, p=.599), daytime ARV (p=.338, p=.730), daytime SD (p=.467, p=.383), nighttime ARV (p=.726, p=.747), or nighttime SD (p=.978, p=.794). No differences were observed in nocturnal dipping pattern (p=.625); dipping averaged 5-8?ross conditions, consistent with a non-dipper pattern profile . Morning systolic BP (p=.557), sleep-trough surge (p=.814), and pre-waking surge (p=.214) were not different among conditions. Office BP also showed no between-condition differences for systolic (p=.280, p=.944, p=.456) and diastolic BP (p=.099, p=.811, p=.549).

결론

Acute isometric handgrip and wall squat exercise did not induce significant changes in 24-hour mean BP, BP variability, morning BP indices, or nocturnal dipping in young adults with prehypertension. Larger, adequately powered and longer-term intervention studies are needed to confirmed these null acute effects.

This work was supported by the Basic Study and Inter-Disciplinary R&D Foundation Fund of the University of Seoul (2025).

만성 목 통증이 있는 사무직 근로자에서 견갑골 운동이상 검사와 측면 견갑골 슬라이드 검사 간의 관계: 단면 연구

Relationship between Scapular Dyskinesis Test and Lateral Scapular Slide Test in Office Workers with Chronic Neck Pain: A Cross-Sectional Study

목포과학대

문성은

목적

Scapular dyskinesis is associated with shoulder dysfunction and chronic neck pain, particularly in computer-based office workers. Although scapular dyskinesis and lateral scapular slide tests are commonly used in clinical settings, each has limitations when used independently. In addition, only a few studies have examined the clinical relationship between these two testing methods, particularly in individuals with chronic neck pain in whom scapular dysfunction is highly prevalent. This study aimed to examine the relationship between scapular dyskinesis and lateral scapular slide tests and explore their combined use for a comprehensive assessment of scapular dysfunction in individuals with chronic neck pain.

대상 및 방법

This was a cross-sectional study. Eighty-three office workers (49 males and 34 females) with chronic neck pain were recruited from three information technology companies in Seoul, Korea. The severity of scapular dyskinesis was assessed using a three-category classification scapular dyskinesis test (normal, subtle, and obvious), and the scapulothoracic distance was measured at three arm positions using the lateral scapular slide test. Neck disability index and visual analogue scale scores were also assessed. One-way ANOVA and correlation analyses (Kendall's and Pearson's) were used to examine the relationships between the variables.

결과

Significant differences were found in the lateral scapular slide test position 2 distance between the scapular dyskinesis test grades in both the dominant ($p = 0.0021$) and non-dominant arms ($p = 0.0195$). In both the dominant and non-dominant arms, individuals with subtle or obvious scapular dyskinesis

exhibited significantly greater scapulothoracic distances than those with normal scapular motion. A weak positive correlation was observed between scapular dyskinesis test severity and lateral scapular slide test position 2 in both arms (dominant, r = 0.22, p = 0.040; non-dominant, r = 0.21, p = 0.0492). Participants with scapular dyskinesis also had higher neck disability index scores on the dominant side (p = 0.0214), but no significant associations were found with the visual analogue scale.

결론

Combining dynamic scapular dyskinesis and static lateral scapular slide tests provides a more comprehensive evaluation of scapular dysfunction in office workers with chronic neck pain. Notably, the severity of scapular dyskinesis was associated with greater neck disability. These findings underscore the need to assess postural alignment and dynamic scapular control in clinical settings.

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

체화된 소마틱 움직임 뉴로사이언스, 임상적 이해, 그리고 실제 적용

Embodied Somatic Movement Neuroscience, Clinical Understanding, and Practical Application

(스포츠과학위원회 2 실기세션)

좌장: 연세대학교 송경택



Yoshi Inada

EDUCATION

Centre for the Alexander Technique 1997-2000 (MSTAT)
Music Therapy Course, Guildhall School of Music & Drama 1995-1997
Advanced Course, Royal Academy of Music, London 1993-1995 (LRAM)
Junior Doctor training (Rehabilitation Medicine),Tokyo Jikei University Hospital 1991-1993
Performers' course, London College of Music, 1989-1991 (LLCM)
Tokyo Jikei University of Medicine 1983-1989 (M.D.)
Kaijo High School, Tokyo 1980-1983

Work Experience

Director, Green Roof Rehabilitation Clinic, Tochigi, Japan 2019-present
Director, Tokyo Alexander Centre, Alexander Technique teachers' training school, Japan2019-present
Doctor, YS Mental Clinic, Monzennakacho, Tokyo 2023-2025
Consultant, Brain Clinic Tokyo(private TMS clinic)2019-2023
Assistant Director, AMAC Alexander Technique teachers' training school, Japan 2012-2017
Alexander Technique teacher, Trinity College of Music, London 2002-2019
Visiting Alexander Technique teacher, The centre for the Alexander Technique, London, 2003-2019
Visiting Music Teacher & Alexander Technique Teacher, Kingston Grammar School 2005-2019
Alexander Technique teacher (privately) 2000-present
Alexander technique teacher, Redroof Film & Television School 2008-2010
Alexander technique teacher, Rio Tinto HQ, Piccadilly, London 2007-2009
Visiting Professor, Escuelas Municipal de musica y Danze de Arona, Teneriffe, Spain 2002-2005
Music (bassoon) lecturer, Richmond-upon Thames College 2001-2005
Health Screening Consultant, Japanese Clinic, London Medical Centre 1997-2002
Senior training doctor (neurologist), Neurology Dept. Kanto Teishin Hospital (for 6 months) 1993

Alexander Technique presentation

Alexander technique international congress(2011 Lugano, Switzerland, 2025 Dublin, Irteland)

Japanese Theatre groups including Seinen gekijo, Mingei 2019-present,
Trinity College of Music 2017& 2019, International Alexander technique and music conference 2016, Tokyo College of Music 2016, International Double reed Society Conference 2011 & 2015, Tokyo Jikei Medical school 2015, London School of Economic 2014, St George's Hospital 2009 & 2010, Rio Tinto 2007-2009, Sky TV 2008, STAT student network 2006 & 2009, Bhavan (Indian Music College) 2006, Harley Street Clinics 2005, Charing Cross Hospital 2003-2005, Escuelas Municipal de musica y Danze de Arona 2002-2005, The Bridge Theatre training company 2004, Cannon Health Clubs 2002, Japanese Theatre Actors' Guild 2005-2012

Activities & Interests

Martial Art—Judo & Boxing (black belt in Judo, former amateur boxer)
Cranio-sacral therapy & Bowen technique
Science (former member of scientific research committee at STAT 2009-2015)
Psychotherapy & Coaching
Philosophy & Moral foundation (teaching research method at Japanese Alexander schools)
Gardening
Football (watching only)

소마틱 움직임의 뉴로사이언스 기반 이해: 작용 메커니즘과 임상적 의미: 이론 강의
Neuroscience-Based Understanding of Somatic Movement: Mechanisms and Clinical Implications

Tokyo Alexander Centre, Japan
Yoshi Inada

①We are composed of memories!
(From Neurological point of view)

②Consciousness: Attention vs Awareness

③Evolution: Body & Brain

④Friction(tension) and Balance

⑤Movement (To get the essentials!)

⑥To explores the unknown (Summary)

①We are composed of memories! (From Neurological point of view)

Human identity is a compilation of past experiences, decisions, and emotions, acting as a mental mosaic that defines who we are.

Messages, information, data, DNA
Survival strategies of ancestors
the force of homeostasis
life history
Upbringing, episodewith emotion
climate



②Consciousness: Attention vs Awareness

*Attention: to get information based on what "brain" wants.

It signifies the active focus or direction of the mind, stemming from a physical sense of extending one's senses or mind towards something.

*Awareness: viewed as a process of the forming consciousness

It signifies to sense with minimum biases, to accept as it is.

Attention-based activity is:

(end-gaining)

1. Narrowing the view of the outer world, creating blind spots.
2. Distorting the sense of reality.
   (Faulty sensory perception)
3. Limiting the full use of human potential.

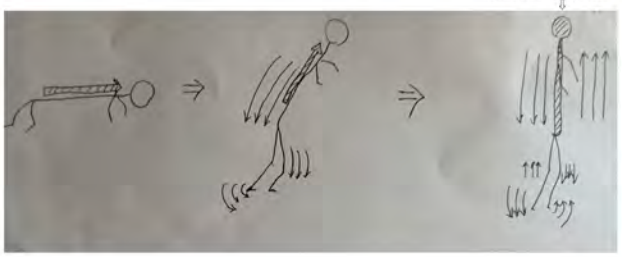
Awareness based movement (Somatic movement)

- movement with deep, Internal "Awareness", related to how the body changes from the inside rather than how it looks externally, to improve the mind-body connection and release chronic tension
- On the contrary, Internal "Attention" can only focus on the inner results

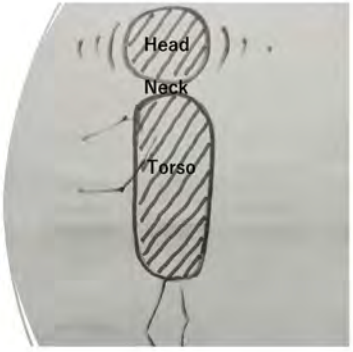


③Evolution: Body & Brain

Gravity vs Anti-Gravity
(Zero Gravity Space)

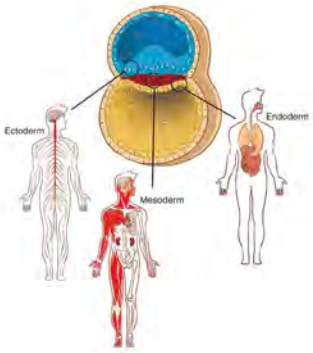


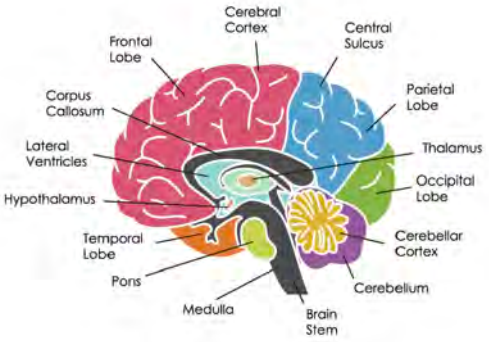
- System organized through Verticality(gravity)
  (head-neck-torso integration)
- The integration through "Balance
  (The balanced head allows whole body to be together)



The deeper in the body, the more fundamental for the survival.

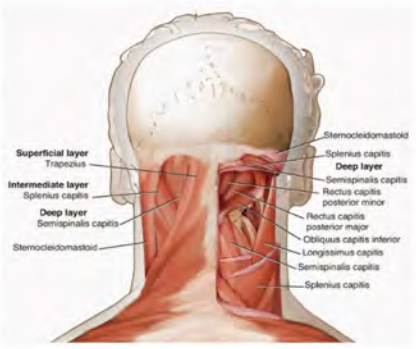
Nervous system is not as vital as digestion system !





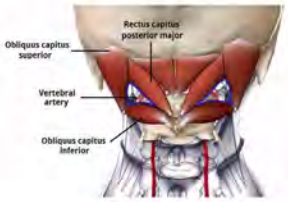
Neck Muscle Layers by Depth

- Superficial Layer: These muscles are located closest to the skin and are often involved in large-scale movements like rotating or tilting the head.
  - Platysma: A thin, broad sheet of muscle just beneath the skin.
  - Sternocleidomastoid (SCM): The large, prominent muscle on the side of the neck used for rotation and flexion.
  - Trapezius: A wide muscle covering the back of the neck and upper shoulders.
- Intermediate Layer: This layer contains muscles that primarily support the hyoid bone (crucial for swallowing and speech) or assist in breathing.
  - Suprahyoid Muscles: (e.g., Digastric, Mylohyoid) Located above the hyoid.
  - Infrahyoid (Strap) Muscles: (e.g., Sternohyoid, Omohyoid) Located below the hyoid.
  - Scalene Muscles: Three muscles (anterior, middle, posterior) on the side of the neck that help with neck flexion and rib elevation during breathing.
- Deep Layer: These are positioned close to the cervical vertebrae and are vital for spinal stability and fine-tuning head movements.
  - Prevertebral Muscles: (e.g., Longus colli, Longus capitis) Located on the front of the spine.
  - Suboccipital Muscles: A group of four small muscles (including Rectus capitis posterior major and minor) at the very base of the skull.
  - Transversospinalis Muscles: (e.g., Semispinalis capitis, Multifidus) Deep muscles of the back of the neck that stabilize the spine.



Sub-occipital muscles

a group of four paired muscles located at the base of the skull, in the posterior neck region.

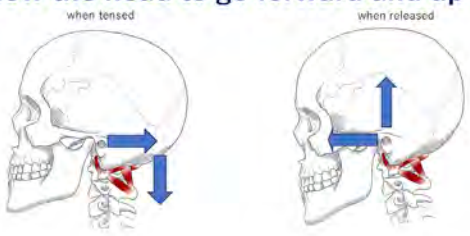




The more centered (deeper)in the body, the smaller the change affects powerfully.



What is 'allow the head to go forward and up'?



④Friction(tension) and Balance

Balance in Unbalance (Psycho-Physical Unity)

- Physiology is based on friction in order to keep things together
- Homeostasis as an Adaptation to Change



⑤Movement (To get the essentials!)

* Plants to Animals: water, food, air, warmth, moisture, temperature (to change the outer environment)

* Animals to humans: to get in "touch" with the outer world
  to get physical(body) experience
  to understand her(him)self and the outer world
  to change inner algorithms
  to live with the reality

* To experience (soul food)

⑥To explores the unknown

- We need to expose ourselves with naked reality for survival.
- Our conscious world is only the tip of the iceberg
- "Experience" is to let the self and the world exchange something unknown, as well as discover inside us which has been unknown.

Alexander decided that *the idea of speaking and the body pattern he had always used when speaking must be inseparably fused*, and that to eliminate the old faulty pattern he would have to eliminate the idea of speaking. His problem was to get rid of speaking yet speak!

Lulie Westfeldt
from 'The Man and his Work'
(Chapter 15)

To live as the psycho-physical unity,

Our aim is
to get rid of (the idea of)moving
yet move!

①We are composed of memories! (From Neurological point of view)

②Consciousness: Attention vs Awareness

③Evolution: Body & Brain

④Friction(tension) and Balance

⑤Movement (To get the essentials!)

⑥To explores the unknown

Summary

We human has numerous survival strategies(memories) inside.

These need to be easily retrieved and to be expressed from deep inside us for unforeseeable situations.

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Posterior Cervical Approach | Musculoskeletal Key

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www.pocketdentistry.com/growth-and-development-2/

김수연

학력

서울대학교 체육교육과 학사

New York 대학교 교육대학원 Dance Education 석사

서울대학교 사범대학원 체육교육과 박사

주요 경력

알렉산더테크닉 국제지도자 자격증 (ATI 인증)

펠든크라이스 국제지도자 자격증 (펠든크라이스 길드 인증)

처음 만나는 알렉산더테크닉 (저서)

채널 A <나는 몸신이다> 295회 자율신경계 조절을 위한 방법_알렉산더테크닉 편 출연

현재 소속 및 직위

알렉산더테크닉 PnM 대표

차의과대학교 스포츠의학대학원 겸임교수

체화된 소마틱 실습:
알렉산더테크닉 기반 일상 자세 및 동작 실습: 실기 강의
Embodied Somatic Practice: Alexander Technique-Based Practice of Everyday Posture and Movement (Lying Down, Sitting, Standing, and Breathing)

Alexander Technique PnM, Korea
김수연

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

Hands on: Sono 1 (Shoulder, Elbow, Hand)

좌장: 청담리온정형외과 이제형



Shoulder

청담리온정형외과
이제형



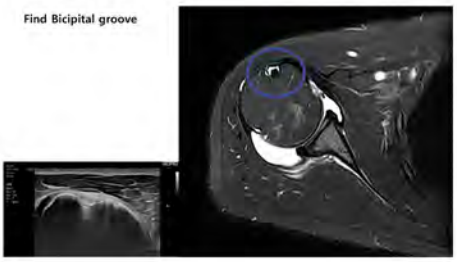






Anterior Structure

Find Bicipital groove



Long head of Biceps tendon
상완 이두 근 장두

다리 위에 편하게 손바닥 하늘 보게 올려 놓으세요

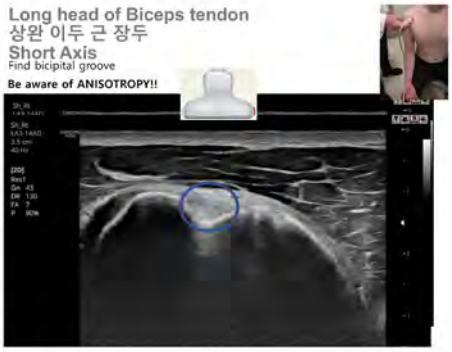




Long head of Biceps tendon
상완 이두 근 장두
Short Axis

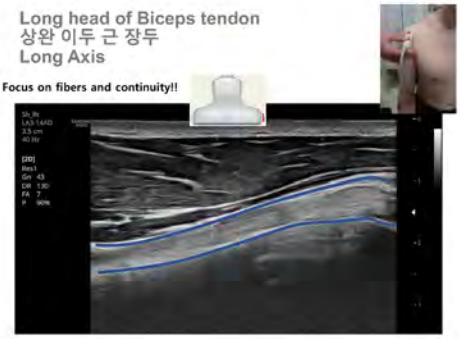
Find bicipital groove

Be aware of ANISOTROPY!!



Long head of Biceps tendon
상완 이두 근 장두
Long Axis

Focus on fibers and continuity!!



Subscapularis
견갑하건

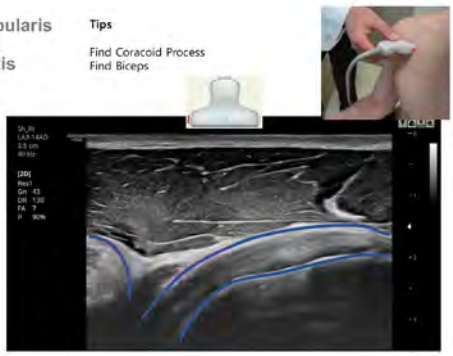




Subscapularis
견갑하건
Long Axis

Tips

Find Coracoid Process
Find Biceps



Subscapularis
견갑하건
Long Axis

Tips

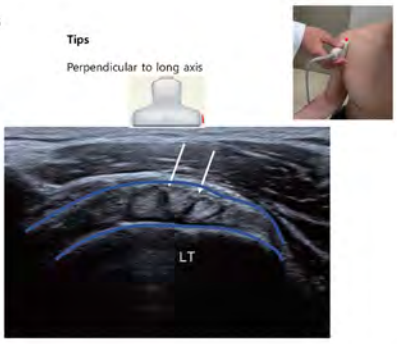
Find Coracoid Process
Find Bicipital Groove
Watch Subscap. gliding under CP



Subscapularis
견갑하건
Short Axis

Tips

Perpendicular to long axis



Supraspinatus
극상건

CRASS Position ; Internal rotation, Extension
뒷짐 지세요. 열중쉬어 하세요



Supraspinatus
극상건

Modified CRASS Position ; limited internal rotation, Extension
할 수 있는 정도만 뒷짐지세요. 손을 엉덩이에 깔고 앉으세요



Supraspinatus
극상건

Anterior shift of SS foot print

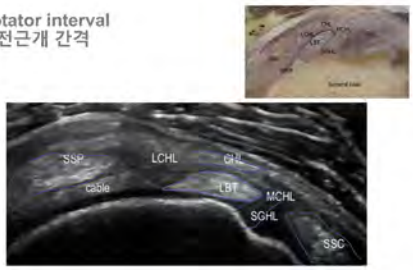


Rotator interval
회전근개 간격





Rotator interval
회전근개 간격



1. Capsule thickening
2. LHB orientation between SS and SC
3. Coracohumeral ligament

Supraspinatus
극상건
Long Axis



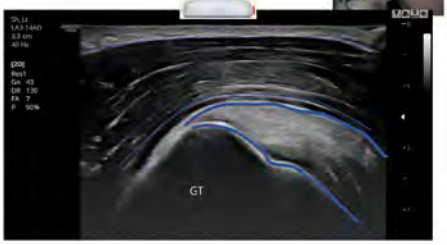


Supraspinatus
극상건
Long Axis

CAUTION

Anisotrophic hypoechoic lesion
Stay with long Axis



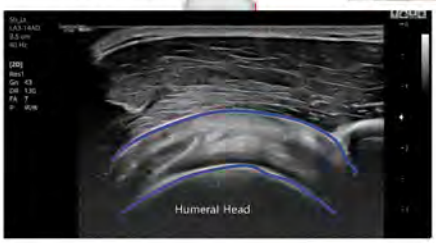


Supraspinatus
극상건
Short Axis

Tips

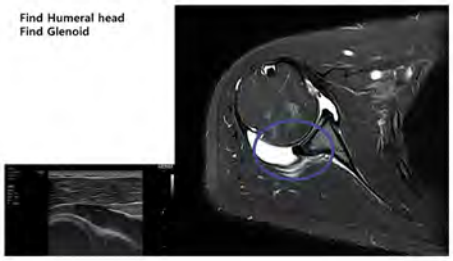
Find Biceps
Perpendicular to SS long axis
Similar to RI inspection





Posterior Structure

Find Humeral head
Find Glenoid

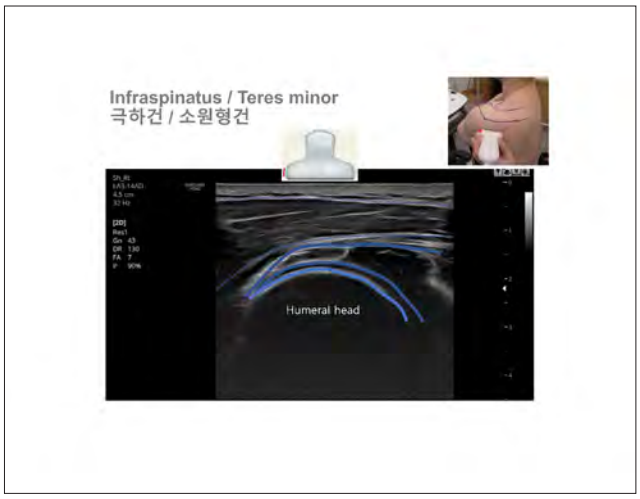


Infraspinatus / Teres minor
극하건 / 소원형건

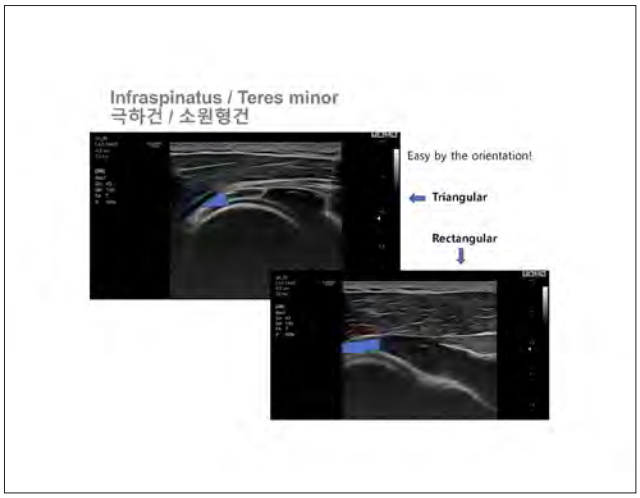
Adduction and Internal Rotation ;
반대편 어깨 위에 손 올리세요

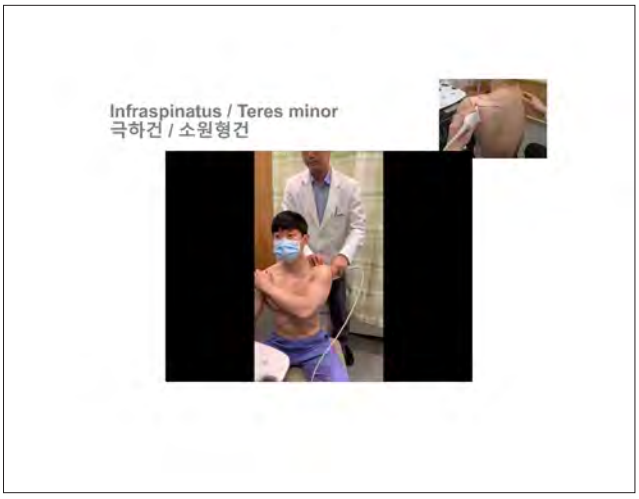



Infraspinatus / Teres minor
극하건 / 소원형건


Infraspinatus / Teres minor
극하건 / 소원형건
Humeral head


Infraspinatus / Teres minor
극하건 / 소원형건
Humeral
Head
Glenoid


Infraspinatus / Teres minor
극하건 / 소원형건
Easy by the orientation!
Triangular
Rectangular


Infraspinatus / Teres minor
극하건 / 소원형건


Infraspinatus / Teres minor
극하건 / 소원형건
Infraspinatus
Teres minor

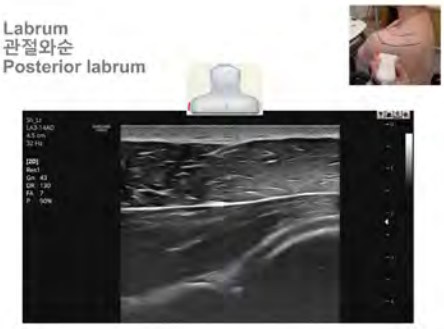
Gleno-humeral joint
관절와-상완골두 관절



Labrum
관절와순
Anterior labrum



Labrum
관절와순
Posterior labrum



Labrum
관절와순
Anterior-Inferior labrum



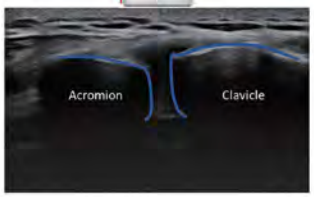
Acromio-clavicular joint
견봉쇄골 관절



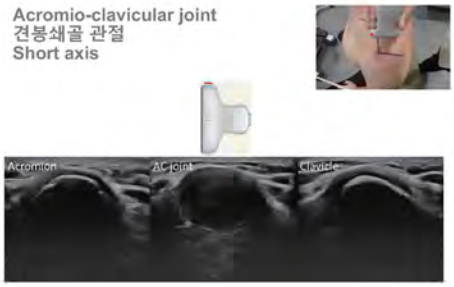
Acromio-clavicular joint
견봉쇄골 관절
Long axis

TIPS

Palpate the AC joint



Acromio-clavicular joint
견봉쇄골 관절
Short axis





US GUIDED INJECTION

Contents

1. Set up / Preparation
2. Sub-acromial
3. Intra-articular
4. Long head of biceps tendon
5. AC joint
6. Calcific tendinitis - Barbotage









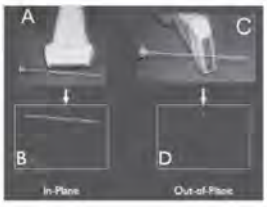


In-plane / Out-of-plane

Which is better??

Under different circumstances

The Comfort way, the better !!!!



Preparation

1. US
2. Syringe
3. Needle
4. Sterilization
5. Gauze
6. Pillow
7. Chair/Bed
8. Sterilized Gel
9. Plaster
10. Glove





Sub-Acromial Space Injection

Sub-Acromial Space Injection Position

CRASS Position ; Internal rotation, Extension
뒷짐 지세요. 멀중쉬어 하세요



Sub-Acromial Space Injection Position

Modified CRASS Position ; limited internal rotation, Extension
할 수 있는 정도만 뒷짐지세요. 손을 엉덩이에 깔고 앉으세요



Sub-Acromial Space Injection Position

23G NEEDLE !!!

From FRONT



From BEHIND



Sub-Acromial Space Injection Position





Inside bursal tissue





Above bursal tissue

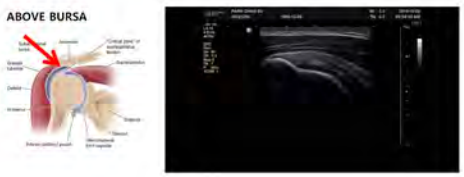




INSIDE BURSA



ABOVE BURSA





Gleno-humeral joint Injection

Glenohumeral joint Injection Position

Adduction and Internal Rotation ;
반대편 어깨 위에 손 올리세요



Glenohumeral joint Injection Position

Find Humeral head
Find Glenoid



Glenohumeral joint Injection Position

SPINAL NEEDLE !!!





Nice Angle





Bad Angle





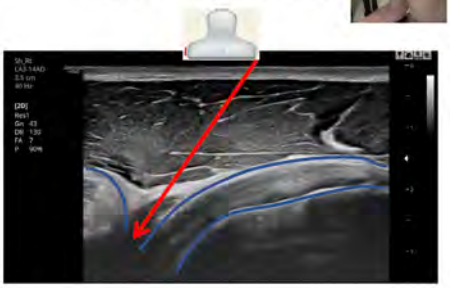


Glenohumeral joint
Injection Position (ANTERIOR)



Glenohumeral joint
Injection Position (ANTERIOR)





Glenohumeral joint
Injection (ANTERIOR)





Long head of Biceps
Injection

Long head of Biceps
Injection Position

다리 위에 편하게 손바닥 하늘 보게 올려 놓으세요

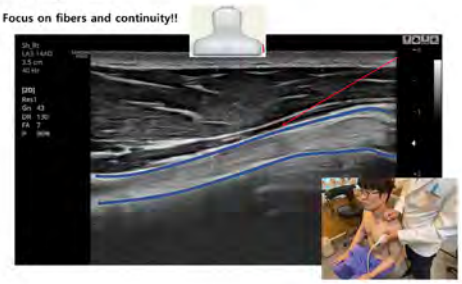


Long head of Biceps tendon
상완 이두 근 장두
Short Axis
Find bicipital groove
Be aware of ANISOTROPY!!



Long head of Biceps tendon
상완 이두 근 장두
Long Axis

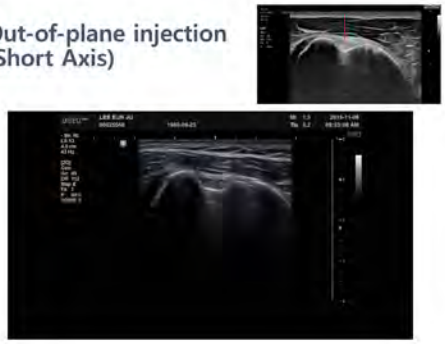
Focus on fibers and continuity!!



In-plane injection
(Long Axis)



Out-of-plane injection
(Short Axis)



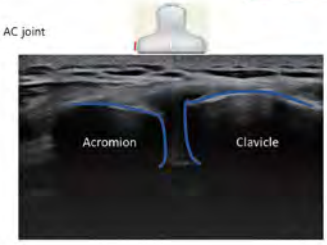
Acromio-clavicular
joint injection

Acromio-clavicular joint
injection position (out-of-plane)



TIPS

Palpate the AC joint



Acromio-clavicular joint
injection position (out-of-plane)



Needle from the FRONT →

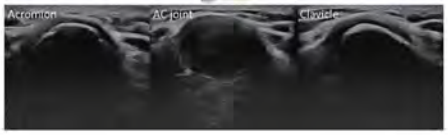
Needle from the Back →



Acromio-clavicular joint
injection position (in-plane)



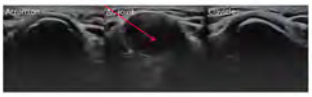


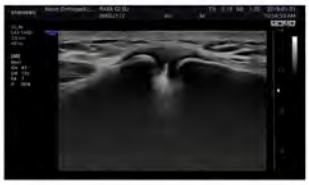


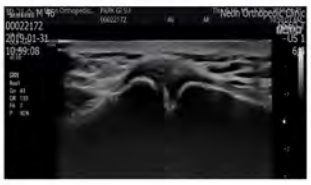
Acromio-clavicular joint
injection position (in-plane)













Calcific tendinitis (barbotage)

Calcific tendinitis (barbotage)





Calcific tendinitis (barbotage)



Calcific tendinitis (barbotage)

X-ray (multiple view) / Location of Calcium deposit

Stage / Just needling? Aspiration?

Long treatment time / Lidocaine

Watch out for pain shock

Pain from absorption (sub-acromial space injection)



Thank you for kind attention !

Elbow, Hand

서울삼성의료원
심재우

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

Hands on: Sono 2 (Knee, Foot & Ankle)

좌장: 세종스포츠정형외과 차민석



Around knee including muscle

세종스포츠정형외과
차민석

Foot and Ankle

중앙보훈병원
여의동

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

3월 22일(일요일)

Room A



The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

심포지엄 13: 글로벌 브릿지 구축: 글로벌 네트워킹에 관한 관점
Building Global Bridges: Perspectives on Global Networking (인증 SAT 관리위원회 2)

좌장: 명지병원 김용균, 연세대학교 서상훈



한국스포츠과학원 소개와 중국스포츠과학원, 일본스포츠과학원과 교류
Introduction to Korea Institute of Sport Science(KISS) and Mutual Exchange with China Institute of Sport Science(CISS) and Japan Institute of Sport Science(JISS)

한국스포츠과학원
임정준

일본임상스포츠의학회 펠로우십 프로그램
Travelling Fellowship Program with JSCSM

부경대학교
김대희

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

해외연자 초청 강연 1

좌장: 삼성서울병원 유재철, 한양대병원 이진규



Patrick Yung

General Information:

Professor YUNG Shu Hang, Patrick, MH, JP

Chairman, Department of Orthopedics and Traumatology, Faculty of Medicine, CUHK

Expertise

Sports Medicine Sports Injuries (Knee, Shoulder, Ankle & Hip Sports Injuries) Community Sports Health

Education

MBChB (CUHK), FRCS(Edin), FRCS (Edin Ortho Surg), FCSHK, FHKAM (Ortho Surg), FHKCOS

Services

International

- Vice President, Executive Committee, International Federation of Sports Medicine (FIMS)
- Immediate Past President, Asian Federation of Sports Medicine (AFSM)
- Chief Editor, Asia-Pacific Journal of Sports Medicine, Arthroscopy, Rehabilitation and Technology (AP-SMART)
- Secretary General, Asia Pacific Knee Arthroscopy & Sports Medicine Society (APKASS)
- Board Member, Aspetar Scientific Advisory Board (ASAB), Aspetar, Doha, Qatar • Member, Asian Shoulder Elbow Group (ASEG)
- Member, Asian Knee Arthroscopy Think-tank (AKAT)
- Member, AFC Medical Committee, Asian Football Confederation (AFC)
- Hon. Fellow, Academy of Medicine, Singapore
- Hon. Fellow, Academy of Medicine, Malaysia Local (Community): • Chairman, Community Sports Committee, Leisure and Cultural Services Department, The Government of HKSAR • Member, Sports Commission, The Government of HKSAR
- Chairman, Student Sports Activities Co-ordinating Sub-committee, Leisure and Cultural Services Department, The Government of HKSAR
- Board member, Racing Talent Training Centre RTTC (the previous Racing Development Board RDB), Hong Kong Jockey Club
- Chairman, Quality Assurance Committee (QAC), Racing Talent Training Centre RTTC, Hong Kong Jockey Club Apprentice Jockeys' School
- Hong Kong Anti-Doping Committee, Sports Federation & Olympic Committee of Hong Kong, China (SF&OC)
- Honorary Sports Medicine Consultant, Hong Kong Sports Institute (HKSI)
- Chairman, Medical Committee, Hong Kong Football Association

- Honorary Sports Medicine Consultant, Hong Kong Cycling Association
- Honorary Sports Medicine Consultant, Hong Kong Shuttlecock Association
- Honorary Sports Medicine Consultant, Hong Kong Volleyball Association
- Honorary Medical Advisor, Hong Kong Football Association
- Honorary Medical Advisor, Hong Kong Hockey Association
- Honorary Medical Advisor, Hong Kong Rope Skipping Association, China
- Member, Supplementary Medical Professional Council, The Government of HKSAR
- Member, Examination Sub-Committee, Licentiate Committee of the Medical Council of Hong Kong Local (Academic):
- Associate Dean, Faculty of Medicine, CUHK
- Chairman, Department of Orthopedics & Traumatology, Faculty of Medicine, CUHK
- Director, The Hong Kong Jockey Club Sports Medicine and Health Sciences Centre
- Director, Hong Kong Centre of Sports Medicine and Sports Science, Faculty of Medicine, CUHK
- Director, Centre of Neuromusculoskeletal Regenerative Medicine (CNRM) • Clinical Director, Institute for Tissue Engineering and Regenerative Medicine (iTERM), Faculty of Medicine, CUHK
- Convener & Member of the SMART theme, Lui Che Woo Institute of Innovative Medicine (LCWIIM), CUHK
- Adjunct Professor, Dept of Biomedical Engineering, The Hong Kong Polytechnic University • Member, Advisory Committee of Department of Biomedical Engineering, CUHK
- Immediate Past President, Hong Kong Association of Sports Medicine and Sports Science (HKASMSS)
- Hon. Consultant Surgeon, Department of Orthopedics & Traumatology, Prince of Wales Hospital
- Chairman, Advisory Committee, Department of Sports and Physical Education, Hong Kong Baptist University
- Member, Advisory Committee, Department of Health and Physical Education, The Education University of Hong Kong
- Past President, The Hong Kong College of Orthopedic Surgeons (HKCOS) (201 • Council Member, Hong Kong Academy of Medicine (2016-2018)

Summary

Prof. YUNG Shu Hang Patrick, a MBChB graduate of the Faculty of Medicine of The Chinese University of Hong Kong (CUHK) in 1994, working in Hospital Authority and underwent Orthopaedic specialist training in Prince of Wales Hospital thereafter, and joined CUHK as a Clinical Professor in 2016. Recognized as a global leader in Orthopedic Sports Medicine, Professor YUNG is the current Chairman of the Department of Orthopedics and Traumatology, and the Associate Dean of the Faculty of Medicine, of CUHK, focused on Orthopedics sport medicine and arthroscopic surgery. He serves as the leader of a lot of international & local centers of sports medicine & health science, including being the Vice President of international Federation of Sports Medicine (FIMS), Past President of the Asian Federation of Sports Medicine (AFSM), Past President of the Hong Kong Association of Sports Medicine & Sports Science (HKASMSS), as well as the Past President of the Hong Kong College of Orthopedic Surgeons. He is also the Director of the Hong Kong Centre of Sports Medicine and Sports Science, The Hong Kong Jockey Club Sports Medicine and Health Sciences Centre, and the Centre of Neuromusculoskeletal Restorative Medicine (CNRM) of InnoHK research centers.

A keen researcher and educator, Professor YUNG leads a team of CUHK members devoted to making advances in sports medicine and arthroscopic surgery. He has published over 300 scientific papers in international journals, contributing significantly to the establishment of Hong Kong's leading position in sports medicine. Being the director & co-directors of two startup companies based in HKSTP, with the support of fundings from HK Government through InnoHK and RAISe+ schemes, Prof. Yung leverages world-class academic researchers together, with the dynamic spirit of innovation, aiming to translate science in regenerative medicine & tissue engineering into real-world biomedical products, benefiting human being suffering from different musculoskeletal disorder, conjoining different efforts to strengthen Hong Kong as the leading biomedical R&D hub internationally. As the head of the first ever Master Course in Sports Medicine & Health Science in Hong Kong & Asia - he has trained over 1200 medical professionals in the field of sports medicine since 2004. He also conducted hundreds of training courses to teach people ranging from amateur sports lovers to medical professionals about the management of sports injuries, from delivering emergency care on the field to the treatment and rehabilitation of injuries. In his capacity as director of the Orthopedic Learning Centre (OLC) of CUHK, he has contributed to the training and development of more than 12,000 Orthopedics surgeons from all over the world over the past 20 years.

Professor YUNG is also an experience sports surgeon committed to delivering medical services in amateur and professional sports communities in Hong Kong, China & overseas. As Medical Consultant for the Hong Kong Sports Institute, he has been volunteering his services for athletes of Hong Kong's elite sports teams and has been holding a weekly clinic at the Hong Kong Sports Institute since 2001. He is also the Team Physician for Hong Kong teams competing in many major national & international sports tournaments, providing and coordinating medical supports for HK elite athletes. His commitment to the promotion of sports medicine education and delivery of clinical services extend to public amateur sports lovers, as he has been serving sports teams across all levels (primary, secondary and college level) in the community. He is also an active member of the Medical Committee of the Asian Football Federation (AFC), and an experience Anti-Doping Officer conducting Anti-Doping works as well as being chief medical officer in major local and international sports competitions for the last 20 years. He remains an active member of the Anti-Doping Organization of Hong Kong & the Sports Federation & Olympic Committee of Hong Kong, China (SF&OC) and is a key figure in Anti-Doping in Asian football.

Professor YUNG is known for his selfless dedication to community service in promoting sports participation as an important part of an active and healthy lifestyle, as well as advocating for safety in sports for all participants. In his capacity as the Chairman of the

Community Sports Committee, the Chairman of the Student Sports Activities Co-ordinating Sub-committee of The Government of HKSAR as well as in his functions of Member of the Sports Commission of the Government of HKSAR, Professor YUNG advises the Hong Kong government on strategies and initiatives aimed at promoting community participation in sports, particularly in schools. He also works on fostering partnerships between different sectors of the community to promote major community sports programs, develop territory-wide community sports facilities, improve existing sports facilities, as well as promoting "Exercise is Medicine" in the community.

Professor YUNG's commitment to community services has helped make Hong Kong a global leader in the field of Sport Medicine & Arthroscopy Surgery. In recognition of his local and international contributions in the advancement of Sports Medicine & Health Science, he has been awarded the "Ten Outstanding Young Persons of Hong Kong" in 2009, the "FIMS (International Federation of Sports Medicine) Fellows" in 2011, the "Award of Secretary for Home Affairs' Commendation Scheme" of the Government of HKSAR in 2015. He also received the prestigious "Chinese Sports Medicine Magnolia Award" in 2017, the highest "Takagi & Watanabe Award" of Asia Pacific Knee Arthroscopy & Sports Medicine Society in 2018 as well as the "Golden Cradle Award" of the Hong Kong Elite Athletes Association in 2018 and the "Hong Kong Health Award" in 2018. He was made "Justice of the Peace" and awarded the "Medal of Honor" by the Government of Hong Kong SAR in 2018 and 2021 respectively, as well as being awarded the highest & most prestigious medical award of Asian Football Confederation (AFC) – "The AFC Football Medicine Merit Award" in 2025.

AI application in tackling Sports injury: from prevention, to surgical treatment & rehabilitation

Hong Kong
Patrick Yung

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

초청세션 2: 한국운동생리학회 - 혈관 기능 조절과 운동 생리학

Regulation of Vascular Function and Exercise Physiology

좌장: 솔병원 나영무, 서울아산병원 최경효



윤은선

학력

건양대학교 운동처방학과 학사

성균관대학교 일반대학원 스포츠과학과 석사

성균관대학교 일반대학원 스포츠과학과 박사

주요 경력

한국운동생리학회 상임이사

대한운동학회 이사

대한고혈압학회 학술위원

심장대사증후군학회 연구위원

현재 소속 및 직위

한국방송통신대학교 생활체육지도과 조교수

대표논문

1. Jae SY, Yoon ES, Kim HJ, Cho MJ, Choo J, Kim JY, Kunutsor SK. Isometric handgrip versus aerobic exercise: a randomized trial evaluating central and ambulatory blood pressure outcomes in older hypertensive participants. J Hypertens. 2025 Feb 1;43(2):351-358.
2. Yoon ES, Lee JY, Kim YJ. Exercise-induced hypertension, atherogenic lipid subfractions, and cardiorespiratory fitness in marathon runners. Prev Med Rep. 2025 Nov 29;61:103326.
3. Yoon ES, Kim YJ. Exercise-induced Hypertension and Carotid Intima-media Thickness in Male Marathon Runners. Int J Sports Med. 2024 Jun;45(7):519-525.

고혈압 환자에서 유산소 운동이 혈관기능에 미치는 영향
Effects of Aerobic exercise on vascular function in hypertensive patient

한국방송통신대학교
윤은선

Hypertension is one of the leading modifiable risk factors for cardiovascular disease worldwide, and impaired vascular function particularly endothelial dysfunction is a central pathophysiological feature in hypertensive patients. Aerobic exercise is widely recommended as a first-line non-pharmacological therapy for blood pressure control; however, the underlying vascular mechanisms remain an area of active investigation.

The purpose of this presentation is to synthesize current evidence on the effects of aerobic exercise on vascular function in individuals with hypertension and to discuss the physiological mechanisms underlying exercise-induced vascular adaptations.

Recent randomized controlled trials and meta-analyses consistently demonstrate that regular aerobic exercise significantly reduces both systolic and diastolic blood pressure in hypertensive populations. A comprehensive meta-analysis by Cornelissen and Smart (2013) reported average reductions of approximately 8.3 mmHg in systolic blood pressure and 5.2 mmHg in diastolic blood pressure following aerobic training interventions. More recent systematic reviews have also shown improvements in endothelial function, commonly assessed by flow-mediated dilation (FMD), with increases of approximately 2–3% after structured aerobic exercise programs.

These vascular adaptations are largely attributed to increased laminar shear stress during exercise, which stimulates endothelial nitric oxide synthase (eNOS) activity and enhances nitric oxide bioavailability. Improved nitric oxide signaling leads to vasodilation, reduced peripheral vascular resistance, and improved arterial compliance. In addition, aerobic exercise has been shown to reduce oxidative stress,

improve autonomic balance, and attenuate vascular inflammation, all of which contribute to improved vascular health.

Collectively, the current body of evidence supports aerobic exercise as a potent intervention for improving vascular function and reducing blood pressure in hypertensive individuals. Future research should further investigate sex-specific responses to exercise and the role of exercise intensity and modality in optimizing vascular adaptations.

Keywords
Aerobic exercise; Hypertension; Vascular function; Endothelial function; Nitric oxide; Flow-mediated dilation

신준철

학력

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성균관대학교 스포츠과학과 석사

Tohoku University, 의과대학 의과학박사

주요 경력

2020~2024 Cleveland Clinic Lerner Research Institute Research associate

2016~2020 Temple University Lewis Katz School of medicine Postdoc

현재 소속 및 직위

경북대학교 체육학부 체육학전공 조교수

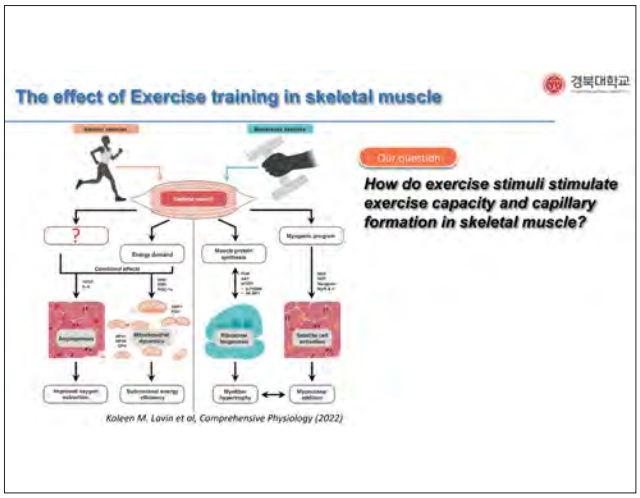
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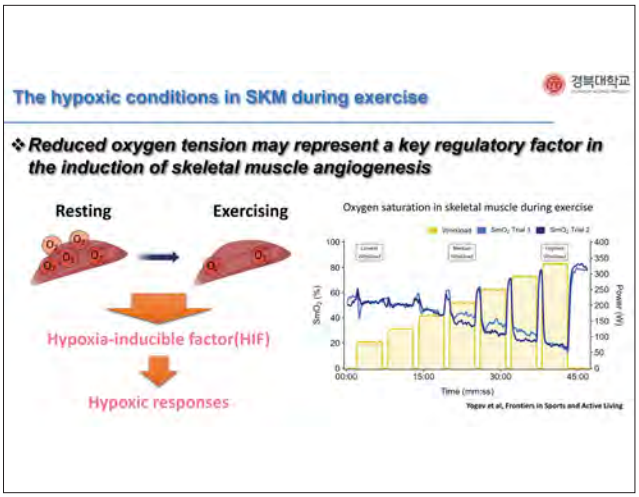
1. Sex-specific angiogenic responses in endothelial cells—role of the pluripotency factor OCT4. Angiogenesis (2026) 29:10, Junchul Shin et al.
2. Unraveling the Role of Sex in Endothelial Cell Dysfunction - Evidence from Lineage Tracing Mice and Cultured Cells. Atherosclerosis, Thrombosis and Vascular Biology Vol 11. No 1 (2023) Junchul Shin et al.
3. Flow-induced endothelial mitochondrial remodeling mitigates mitochondrial reactive oxygen species production and promotes mitochondrial DNA integrity in a p53-dependent manner, Redox Biology vol. 50 (2022).

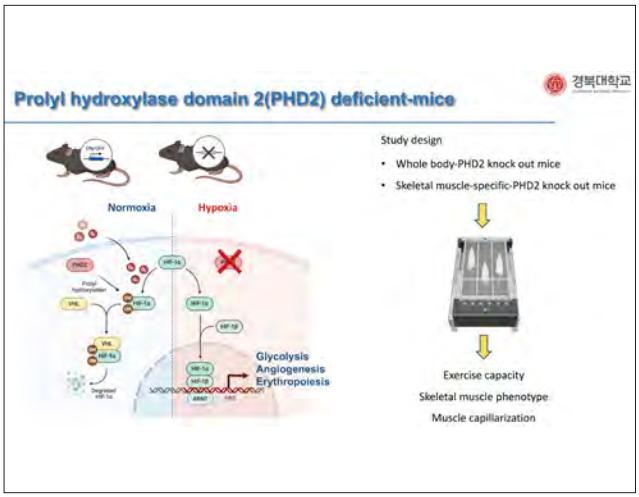
골격근에서의 저산소증 반응과 혈관세포 간의 관계 규명
Unraveling the Intricate Relationship Between Hypoxia Responses in Skeletal Muscle and Vascular Cells

경북대학교
신준철









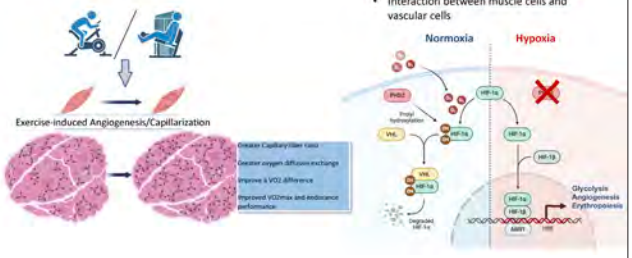
Physiological and biological approaches to exercise stimuli

The interaction between skeletal muscle cells and vascular cells in Angiogenesis

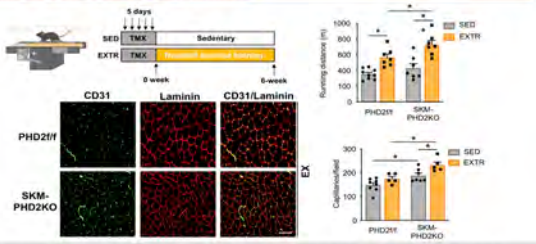
The purpose of study is to investigate the capillary formation in skeletal muscle during exercise

Study design

- *Skeletal muscle specific-PHD2KO mice*
- Interaction between muscle cells and vascular cells



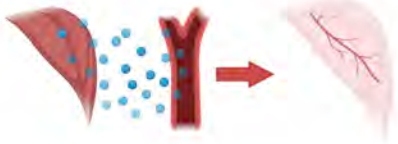
Research topic: The interaction between skeletal muscle cells and vascular cells in Angiogenesis



Hypoxic-response pathway in skeletal muscle promoted muscle capillarization

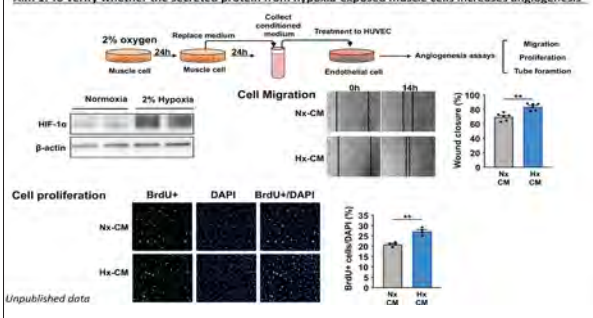
Research topic: The interaction between skeletal muscle cells and vascular cells in Angiogenesis

Hypoxic-response pathway in skeletal muscle secretes biological mediators to vessels



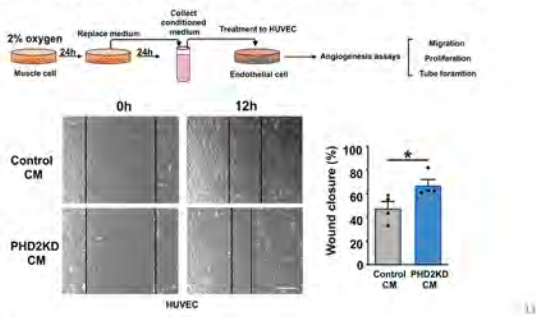
The biological mediators may promote skeletal muscle vascularization

Aim 1. To verify whether the secreted protein from hypoxia-exposed muscle cells increases angiogenesis



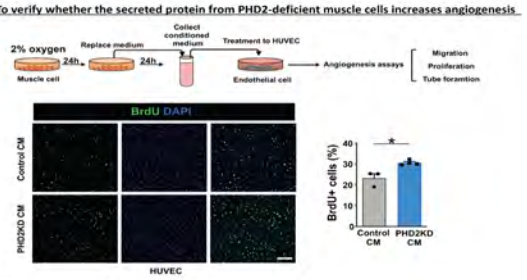
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Aim 1. To verify whether the secreted protein from PHD2-deficient muscle cells increases angiogenesis



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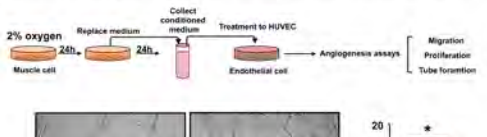
Aim 1. To verify whether the secreted protein from PHD2-deficient muscle cells increases angiogenesis

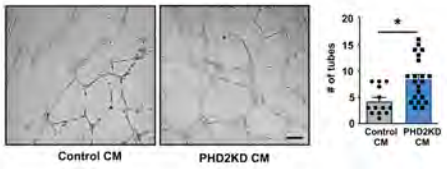


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Aim 1. To verify whether the secreted protein from PHD2 deficient muscle cell increases angiogenesis

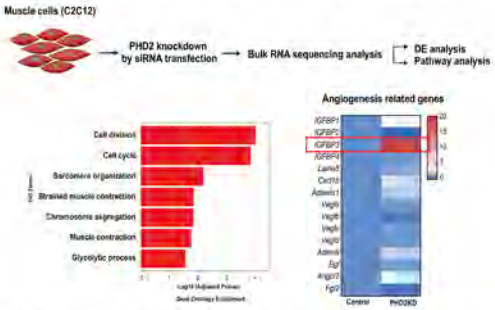




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Aim 2. To seek the putative mediator communicating endothelial cells

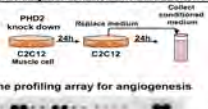


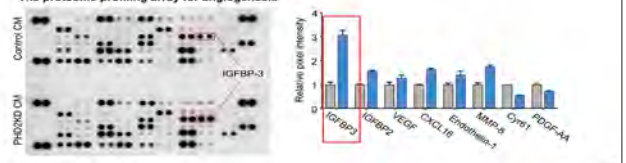
❖ Insulin Growth factor binding protein 3 (IGFBP3) might be important mediator in hypoxic response pathway

Unpublished data

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Aim 2. To seek the putative mediator communicating endothelial cells

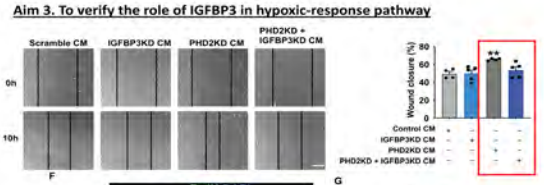


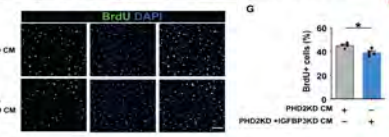


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Aim 3. To verify the role of IGFBP3 in hypoxic-response pathway

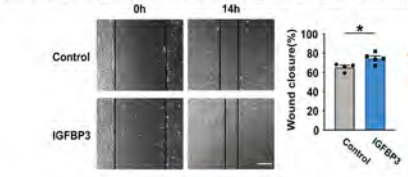




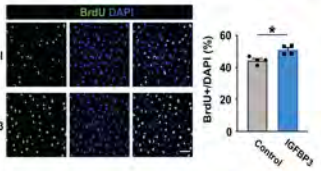
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Aim 3. To verify the role of IGFBP3 in hypoxic-response pathway



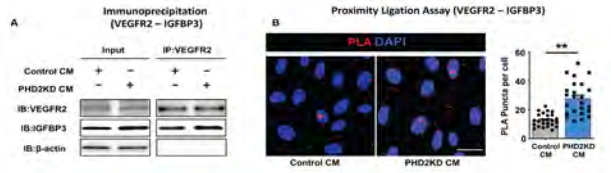
✓ IGFBP3 increased endothelial cell angiogenic functions



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Aim 4. Interaction between VEGFR2 and IGFBP3 in endothelial cells

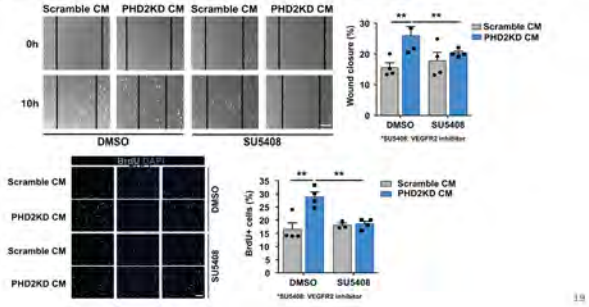


✓ IGFBP3 binds to VEGFR2 in endothelial cell membrane surface

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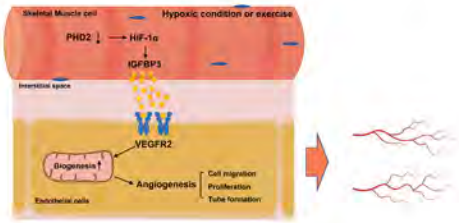
Aim 5. The role of VEGFR2 in angiogenic functions of endothelial cell



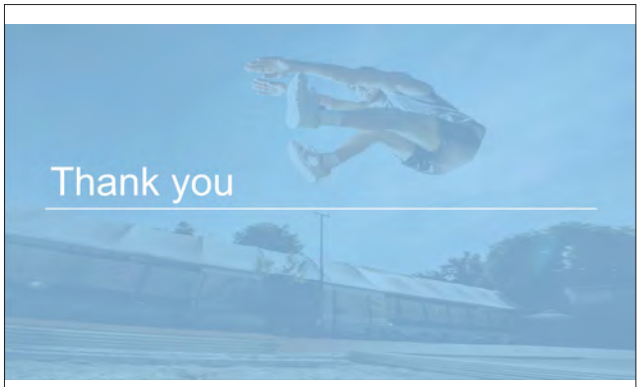
19

Summary

1) HIF-1α by PHD2 inhibition increases capillary formation
2) IGFBP3-derived from muscle promotes endothelial cell functions
3) IGFBP3 interacts with endothelial cell VEGFR2



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The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

초청세션 3: 대한육상연맹

- 육상 선수들의 경기력 극대화와 부상 관리 분야의 최신 지견

Cutting-edge insights in maximizing athletic performance and injury management for track and field athletes

좌장: 분당척병원 성상철, 닥터핏 박원하



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주요 경력

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현재 소속 및 직위

솔병원 재활의학과 진료원장

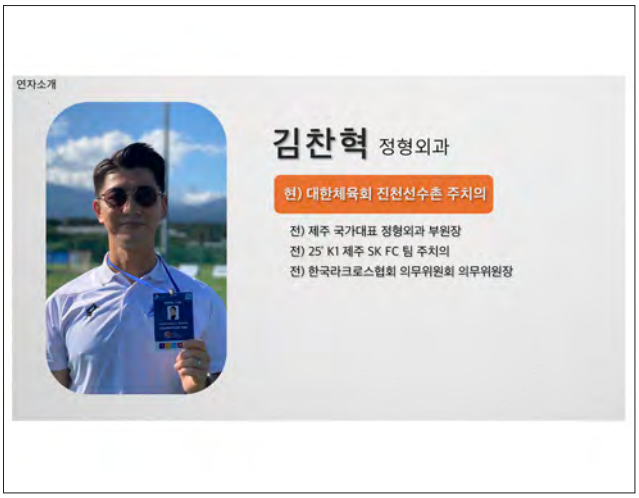
육상 선수의 경기력 향상과 부상 방지 전략
Strategies for improving track and field athletes' performance and preventing injuries

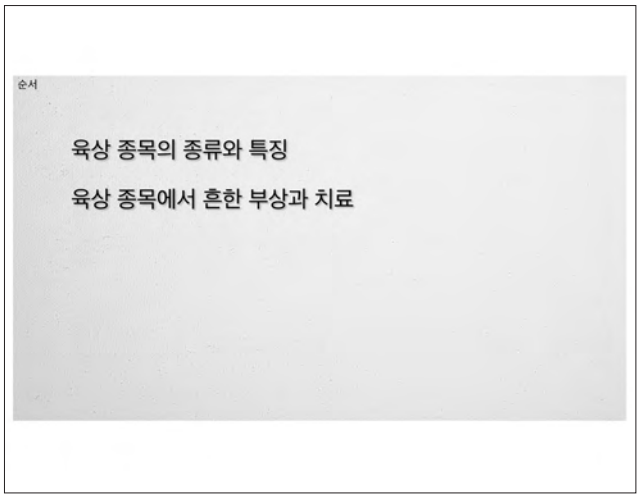
육상연맹 의무위원회
최승호

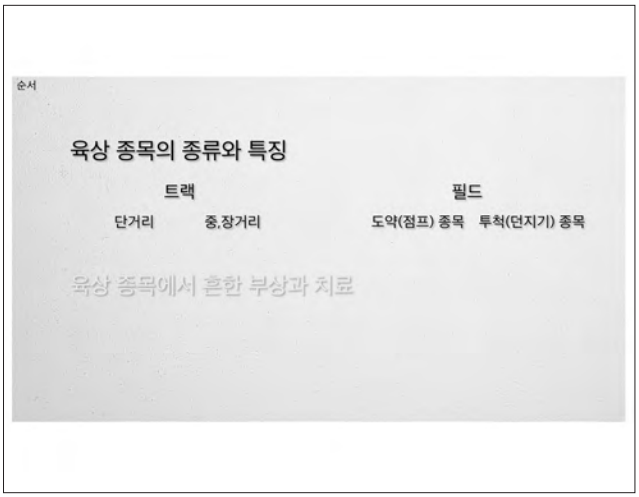
본 발표에서 2025년부터 구성된 대한육상연맹 의무위원회의 현재까지의 활동에 대한 소개 및 육상선수들의 부상 및 컨디션 관리 계획 수립에 대한 향후 활동을 위한 제언을 하기 위해 준비되었습니다. 본 위원은 대한육상연맹에서 주관하여 경상북도 예천군에서 시행하는 강화 훈련 프로그램과 대한육상연맹에서 주최하는 경기현장 등에 2024년부터 파견되어, 국가대표 및 상비군부터 유소년 유망주에 대한 검진 및 치료를 시행하고 있으며, 지도자와 선수들을 위한 스포츠 의학 강의도 진행하였습니다. 그 과정에서 아직 구축되지 못한 육상 종목 선수들의 검진 프로그램에 대한 아쉬움을 느꼈고, 부상선수에 대한 과학적인 평가와 이에 적합한 훈련프로그램 제공 등이 부족하다는 사실을 알게 되었습니다. 이에 대하여 본 발표에서, 대한육상연맹 의무위원회에서 육상선수의 경기력 향상과 부상방지를 위해 현재 하나씩 준비해서, 현재 추진 중인 내용에 대해 소개하고자 합니다.

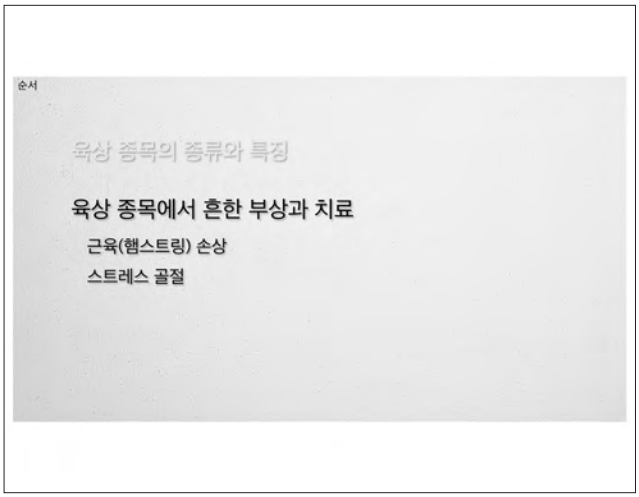
육상 종목별 흔한 손상과 수술/비수술 치료 접근법
Common Injuries by Track and Field Event: Surgical and Non-surgical Approaches

진천선수촌
김찬혁

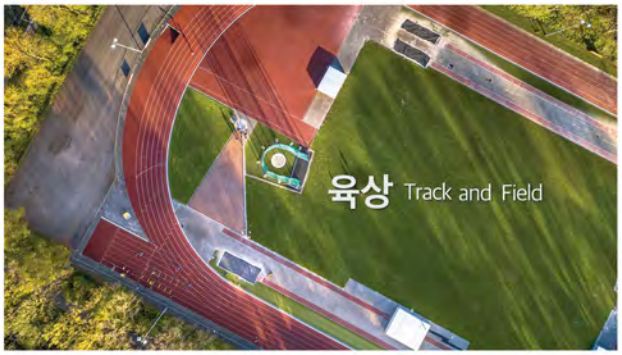


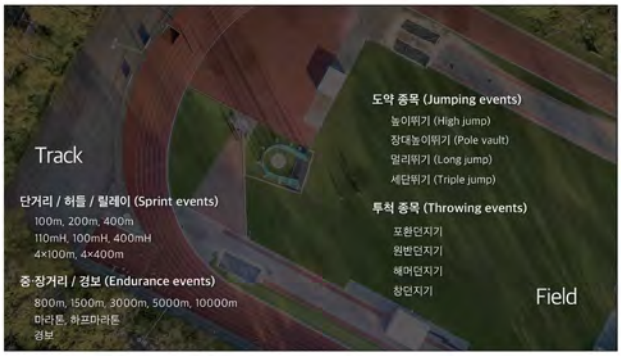






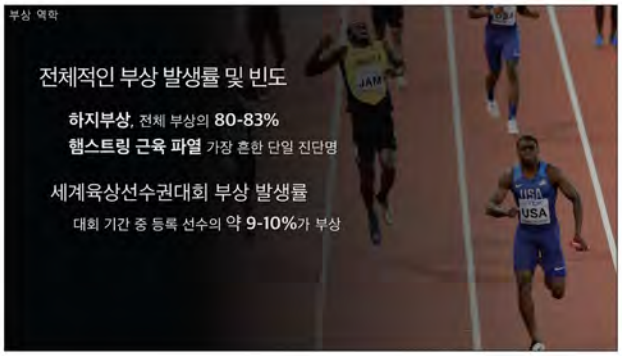

더 빨리, 더 높이, 더 멀리.
달리기
뛰기
던지기

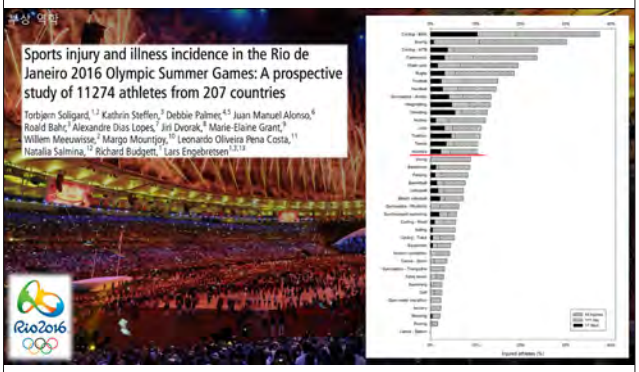

육상 Track and Field

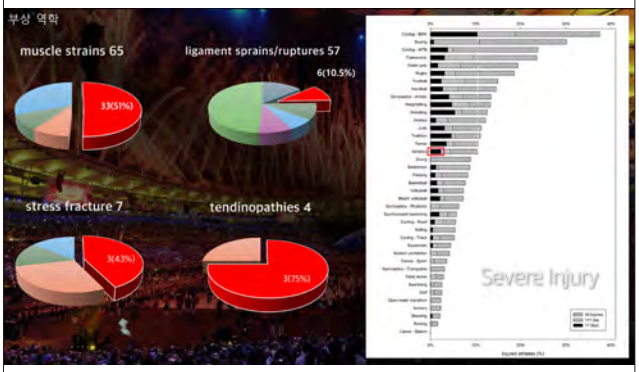

Track
단거리 / 허들 / 릴레이 (Sprint events)
100m, 200m, 400m
110mH, 100mH, 400mH
4×100m, 4×400m
중·장거리 / 경보 (Endurance events)
800m, 1500m, 3000m, 5000m, 10000m
마라톤, 하프마라톤
경보
도약 종목 (Jumping events)
높이뛰기 (High jump)
장대높이뛰기 (Pole vault)
멀리뛰기 (Long jump)
세단뛰기 (Triple jump)
투척 종목 (Throwing events)
포환던지기
원반던지기
해머던지기
창던지기
Field


2024 파리 올림픽 육상 종목의 금메달 수
24개
Track Event
100m(남/여) - 2
200m(남/여) - 2
400m(남/여) - 2
800m(남/여) - 2
1500m(남/여) - 2
5000m(남/여) - 2
10000m(남/여) - 2
110mH(남) - 1
100mH(여) - 1
400mH(남/여) -2
4×100m(남/여) - 2
4×400m(남/여) - 2
4x400m 혼성계주 - 1
5개
Road Event
마라톤(남/여) - 2
경보 20km(남/여) - 2
경보 혼성 릴레이 -1
16개
Field Event
높이뛰기(남/여) - 2
장대높이뛰기(남/여) - 2
멀리뛰기(남/여) - 2
세단뛰기(남/여) -2
포환던지기(남/여) - 2
원반던지기(남/여) - 2
창던지기(남/여) - 2
해머던지기(남/여) -2
2개
Combined Event
10종경기(남) - 1
7종경기(여) - 1


2024 파리 올림픽 육상 종목의 금메달 수
24개
Track Event
100m(남/여) - 2
200m(남/여) - 2
400m(남/여) - 2
800m(남/여) - 2
1500m(남/여) - 2
5000m(남/여) - 2
10000m(남/여) - 2
110mH(남) - 1
100mH(여) - 1
400mH(남/여) -2
4×100m(남/여) - 2
4×400m(남/여) - 2
4x400m 혼성계주 - 1
5개
Road Event
마라톤(남/여) - 2
경보 20km(남/여) - 2
경보 혼성 릴레이 -1
16개
Field Event
높이뛰기(남/여) - 2
장대높이뛰기(남/여) - 2
멀리뛰기(남/여) - 2
세단뛰기(남/여) -2
포환던지기(남/여) - 2
원반던지기(남/여) - 2
창던지기(남/여) - 2
해머던지기(남/여) -2
2개
Combined Event
10종경기(남) - 1
7종경기(여) - 1

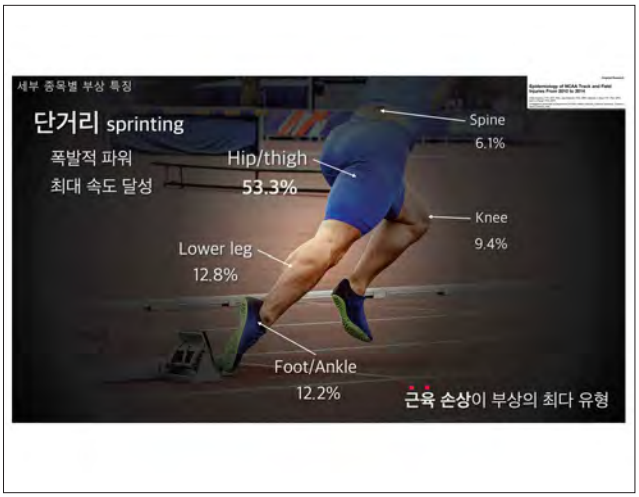

부상 역학
전체적인 부상 발생률 및 빈도
하지부상, 전체 부상의 80-83%
햄스트링 근육 파열 가장 흔한 단일 진단명
세계육상선수권대회 부상 발생률
대회 기간 중 등록 선수의 약 9-10%가 부상


부상 역학
Sports injury and illness incidence in the Rio de Janeiro 2016 Olympic Summer Games: A prospective study of 11274 athletes from 207 countries
Rio2016


부상 역학
muscle strains 65
ligament sprains/ruptures 57
6(10.5%)
stress fracture 7
tendinopathies 4
Severe Injury


부상 역학
Overall injury
3.99 / 1000 athletic - exposure
Woman
Injury rate 18%
Missed Time 41%
Original Research
Epidemiology of NCAA Track and Field Injuries From 2010 to 2014

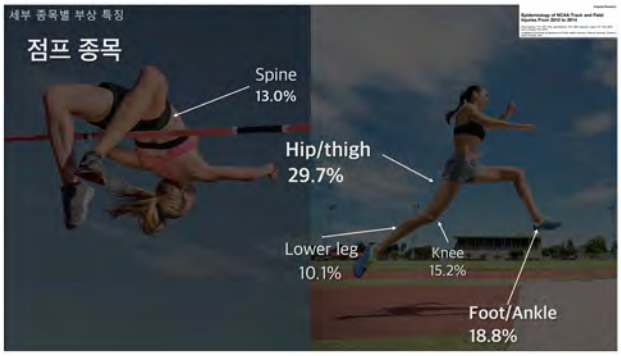

부상 역학
Competition > Practice
Injury rate 71%
Missed Time 59%
Distant runner
Overuse Injury
Time loss 168%
Epidemiology of NCAA Track and Field Injuries From 2010 to 2014


세부 종목별 부상 특징
단거리 sprinting
폭발적 파워
최대 속도 달성
Hip/thigh
53.3%
Spine
6.1%
Knee
9.4%
Lower leg
12.8%
Foot/Ankle
12.2%
근육 손상이 부상의 최다 유형

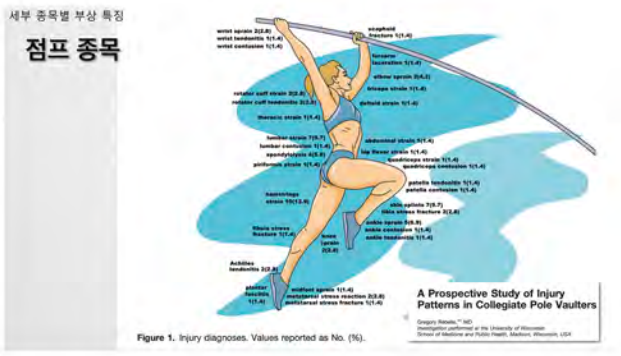

세부 종목별 부상 특징
허들 Hurdle
Lead leg
Trail leg
비대칭성
과도한 관절 가동범위

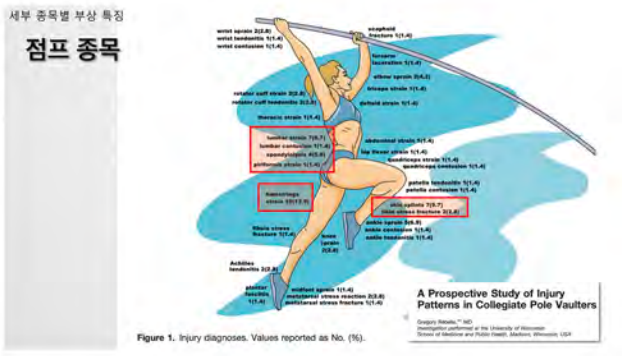

세부 종목별 부상 특징
중장거리 Distance running
지구력 + 파워
Spine
5.3%
Hip/thigh
20.6%
Knee
12.2%
Lower leg
22.9%
Foot/Ankle
26.7%
반복적 부하에 의한 건, 뼈, 관절의 과사용 손상


세부 종목별 부상 특징
경보
한쪽 발은 지면 접촉 유지
지면 접촉 순간부터 수직 상태까지 무릎 펴기
무릎의 과신전 및 과도한 골반 회전


세부 종목별 부상 특징
점프 종목
Spine
13.0%
Hip/thigh
29.7%
Lower leg
10.1%
Knee
15.2%
Foot/Ankle
18.8%


세부 종목별 부상 특징
점프 종목
Spine hyperextension
Spondylolysis fracture
Hip/thigh
도약을 위한
최대 스프린트 필요
도약과 착지 과정
Take off 하는 발에서 더 많은 부상
Foot/Ankle


세부 종목별 부상 특징
점프 종목
A Prospective Study of Injury Patterns in Collegiate Pole Vaulters
Figure 1. Injury diagnoses. Values reported as No. (%).

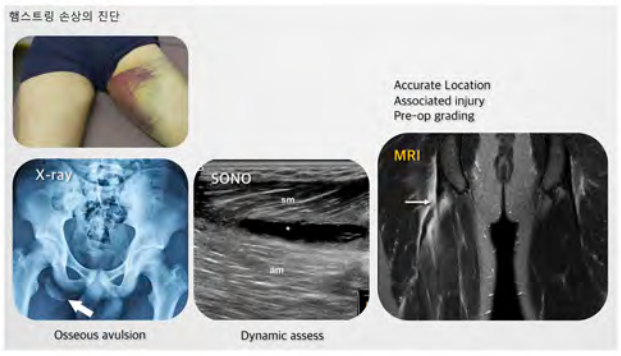

세부 종목별 부상 특징
점프 종목
A Prospective Study of Injury Patterns in Collegiate Pole Vaulters
Figure 1. Injury diagnoses. Values reported as No. (%).

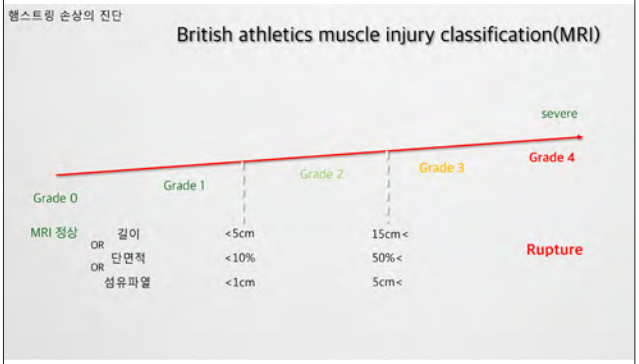

세부 종목별 부상 특징
투척 종목
Wrist/hand
18.5%
Elbow/Forearm
13.0%
Shoulder
3.7%
Spine
22.2%
Hip/thigh
18.5%
Knee
1.9%
Foot/Ankle
5.6%

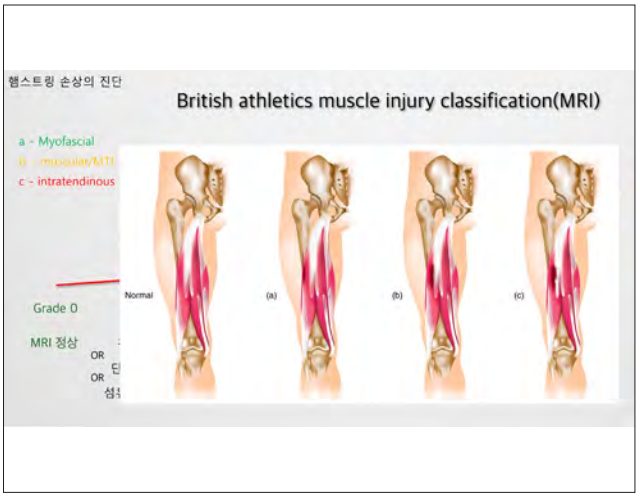

세부 종목별 부상 특징
투척 종목
Shoulder
21.7%
M/C injury type
Muscle strain 26.14%
Ligament sprain 25%
Knee
12%
Foot/Ankle
16.5%
Epidemiology of injuries in U.S. high school track and field throwing events from 2008 to 2019

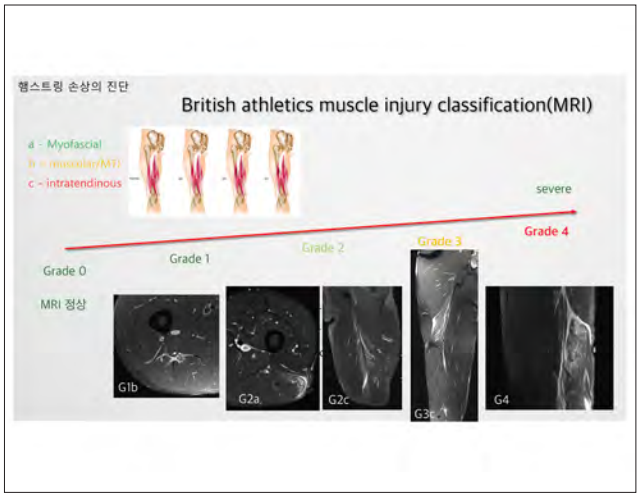

흔한 손상의 수술적 비수술적 치료
근육손상
스트레스 골절


근육 손상의 수술적 비수술적 치료
햄스트링 손상
단거리 부상의 3-40%
Biceps femoris short head(m/c)
최고속 질주 구간에서 주로 발생
대퇴직근, 장요근
스타트 가속 구간에서 흔함
비복근 가자미근
지면접촉 순간 ankle plantarflexion torque 급증
노면, 스파이크, 피로도 영향
200-400m에서 상대적 빈도 증가

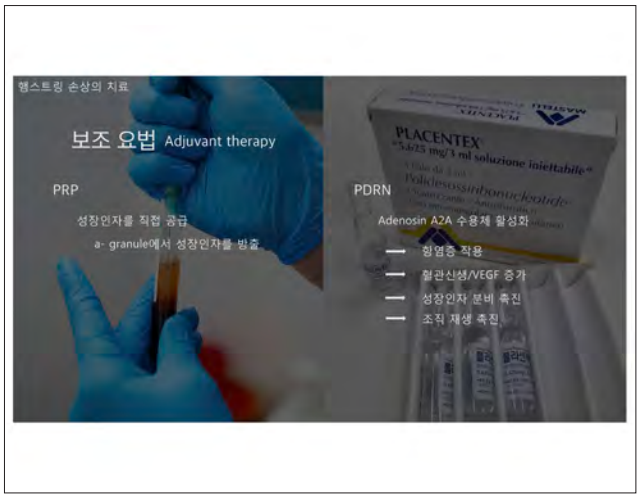

햄스트링 손상의 진단
Accurate Location
Associated injury
Pre-op grading
X-ray
SONO
MRI
Osseous avulsion
Dynamic assess


햄스트링 손상의 진단
British athletics muscle injury classification(MRI)
severe
Grade 0
Grade 1
Grade 2
Grade 3
Grade 4
MRI 정상
길이
OR
단면적
OR
섬유파열
<5cm
<10%
<1cm
15cm<
50%<
5cm<
Rupture


햄스트링 손상의 진단
British athletics muscle injury classification(MRI)
a - Myofascial
b - musculer/MTJ
c - intratendinous
Grade 0
MRI 정상
Normal
(a)
(b)
(c)


햄스트링 손상의 진단
British athletics muscle injury classification(MRI)
a - Myofascial
b - musculer/MTJ
c - intratendinous
severe
Grade 4
Grade 3
Grade 2
Grade 1
Grade 0
MRI 정상
G1b
G2a
G2c
G3c
G4


햄스트링 손상의 치료
86% 가 보존적 치료
초기 48시간, RICE
Early immobilization
protected weight bearing
Low Grade(grade0-1) myofascial injury
10-18일 후 return to full training
10% 재발
High grade(G2 to 3)
Return to play 까지 >50일


햄스트링 손상의 치료
보조 요법 Adjuvant therapy
PRP
성장인자를 직접 공급
a- granule에서 성장인자를 방출
PDRN
Adenosin A2A 수용체 활성화
항염증 작용
혈관신생/VEGF 증가
성장인자 분비 촉진
조직 재생 촉진
PLACENTEX


PRP
2014, RCT(Lv.2)
Platelet-Rich Plasma Injections for the Treatment of Hamstring Injuries
A Randomized Controlled Trial
재활군보다 PRP 주사를 맞고 재활한 군에서 경기 복귀일 단축
2016,다기관RCT(Lv.1)
다리근육 파열 환자에서 PRP와 위약 간 회복 기간 단축 없음
2018, 메타분석 RCT(Lv.1)
Is Platelet-Rich Plasma (PRP) Effective in the Treatment of Acute Muscle Injuries? A Systematic Review and Meta-Analysis
PRP 효과는 질적 근거 낮음/불확실


2021, 동물실험 연구
토끼 아킬레스건 손상 모델에 PDRN, PN 주사군
대조군에 비해 콜라겐 배열이 더 정렬되고 신생혈관, 섬유 밀도 증가
2022, 동물실험 연구
Cast 고정으로 증아리 근육 위축 및 손상 유발한 토끼 모델
생리식염주 주입군, PDRN 단독 주입군, ESWT 단독 치료군에 비해
PDRN + ESWT 군에서 (유의미한) 근섬유 단면적 증가, 신생혈관지표 증가, 근전도상
PDRN
PLACENTEX

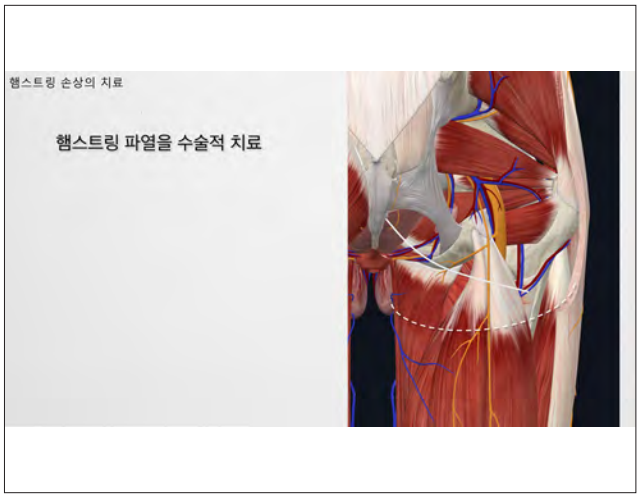

햄스트링 손상의 치료
2023
PDRN은 외상과염, 회전근개 건병증, 아킬레스건병증에서
통증 감소 및 기능 개선 효과가 있으나 아직 그 근거가 충분하지 않음
2023, 동물실험 연구
2주간 cast고정으로 비복근이 위축된 토끼 모델
G1. 대조군(생리식염수 주사)
G2. PDRN 단독 주사
G3. 방사형 ESWT 단독시행
G4. PDRN -> ESWT
G5. ESWT -> PDRN
병합치료 군에서 근섬유 단면적 근육 두께, CMAP 진폭 회복에서 우수


햄스트링 손상의 치료
86% 가 보존적 치료
보존적 치료
PRP, PDRN
ESWT
재활


햄스트링 손상의 치료
햄스트링 파열을 수술적 치료
보존적 치료에 실패
예후가 좋지 않은 급성 손상
2cm 이상 견열된 근위부 햄스트링 손상


햄스트링 손상의 치료
햄스트링 파열을 수술적 치료


햄스트링 손상의 치료
햄스트링 파열을 수술적 치료


햄스트링 손상의 치료
햄스트링 파열을 수술적 치료

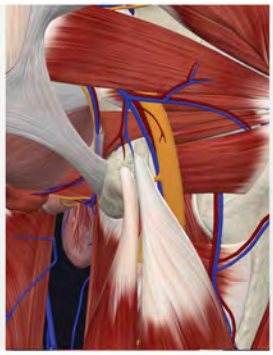
햄스트링 손상의 치료

햄스트링 파열을 수술적 치료



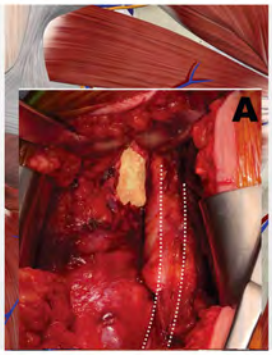
햄스트링 손상의 치료

햄스트링 파열을 수술적 치료



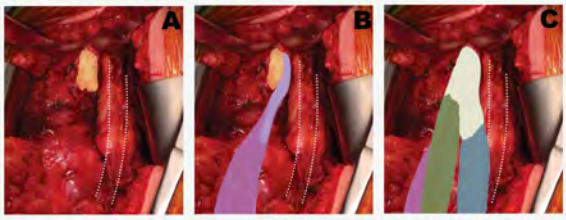
햄스트링 손상의 치료

햄스트링 파열을 수술적 치료



햄스트링 손상의 치료

햄스트링 파열을 수술적 치료



스트레스 골절

반복적인 submaximal 부하에 대한 반응

조직학적

파골세포의 활성이 조골세포의 신생골 형성 속도를 초과하여 뼈가 일시적으로 약화

신체활동이 지속될 경우

해면골 미세골절이 발생 ➡ MRI 상 초기 골수 부종으로 관찰

피질골의 완전 골절



스트레스 골절

호발 부위와 위험도

High risk

Lat. Femoral neck
(Tension side)

Ant. Tibial diaphysis

Medial malleolus

5th Metatarsal base



Low risk

Medial Femoral neck
(compression side)

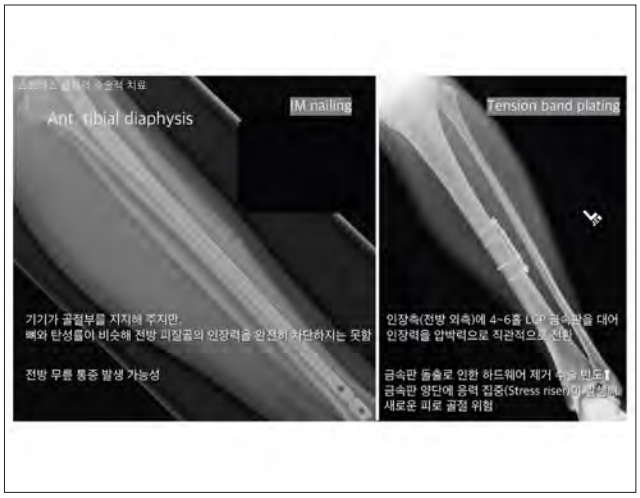
Femoral shaft

Postero-medial tibial diaphysis

Lateral malleolus

Metatarsl shafts


스트레스 골절의 보존적 치료
부하감소
6주, 통증이 사라질 때까지
골 치유 촉진
ESWT, LIPUS(Low-intensity Pulsed Ultrasound)
증거 수준은 다양하며 명확한 표준 치료로 확립 x
골 대사 촉진
Teriparatide(Forteo)
적응증 외 처방
엘리트 선수의 경골 골절 2달간 teriparatide를 매일 주사
7주만에 통증없이 RTP


Ant. tibial diaphysis
IM nailing
Tension band plating
기기가 골절부를 지지해 주지만,
뼈와 탄성률이 비슷해 전방 피질골의 인장력을 완전히 차단하지는 못함
전방 무릎 통증 발생 가능성
인장측(전방 외측)에 4~6홀 LCP 금속판을 대어
인장력을 압박력으로 직관적으로 전환
금속판 돌출로 인한 하드웨어 제거 수술 빈도↑
금속판 양단에 응력 집중(Stress riser)이 발생해
새로운 피로 골절 위험


스트레스 골절의 수술적 치료
5th Metatarsal Fx.
Screw fixation
Canal fill 원칙
대구경 solid screw
수술 시 생물학적 보강
L
Tension band wiring

부상 예방과 기술 향상을 위한 운동역학적 현장 적용
Biomechanical Approaches to Injury Prevention and Performance Enhancement

한국스포츠개발원
김주년

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

해외연자 초청 강연 2

좌장:서울적십자병원 이경태, 하병원 하철원



How JSCSM make relationship and leadership with field Coaches and trainer group?

Japan

Hideo Matsumoto

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

심포지엄 15: 러닝 심포지엄: 달리기 성능의 과학 및 실전

Running Symposium: Science & Practice of Running Performance

좌장: 용인세브란스병원 이태임, 가톨릭대성빈센트병원 김준성



김동진

학력

연세대학교 의과대학 졸업

세브란스병원 인턴 및 재활의학과 전공의 수련

주요 경력

대한 스포츠의학회 스포츠의학 인증전문의

마라톤 풀코스 수차례 완주

연세의대 러닝크루 <SeveRuns> 창립멤버

현재 소속 및 직위

전) SRC재활병원 호흡재활센터 센터장

현) 연세진재활의학과 의원 대표원장

현) 연세대학교 의과대학 외래 부교수

달리기의 생체역학
Biomechanics of Running

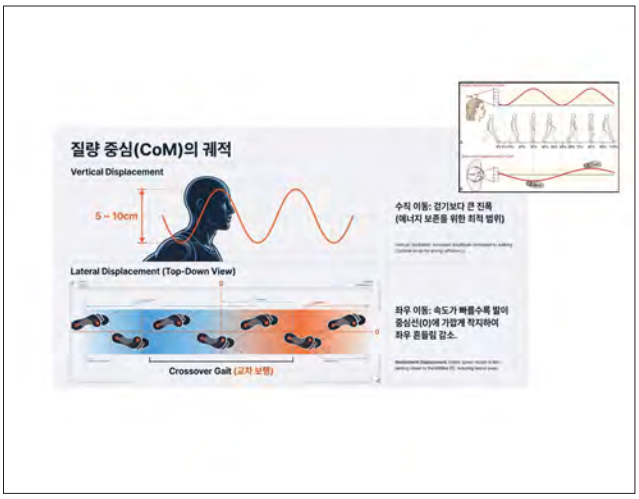
연세진 재활의학과
김동진

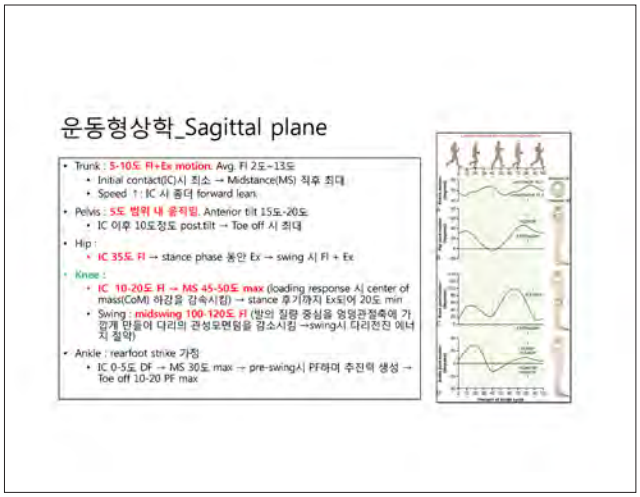


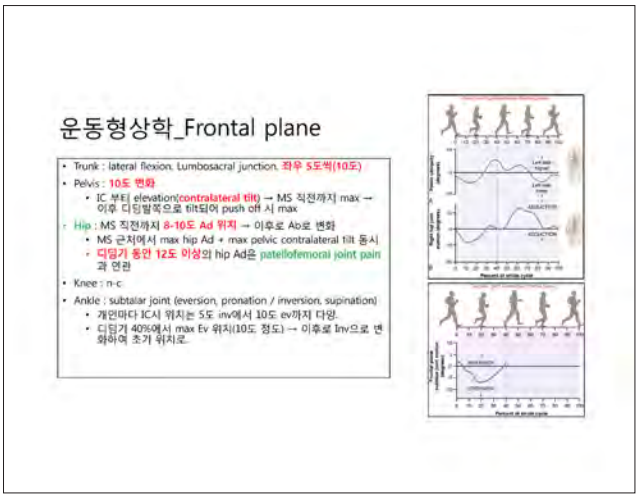


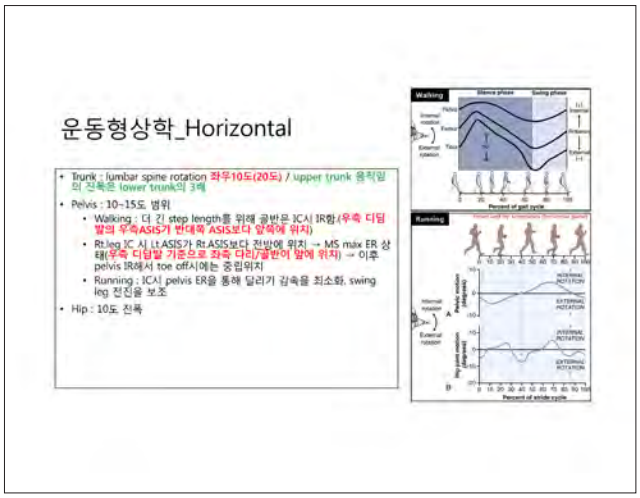


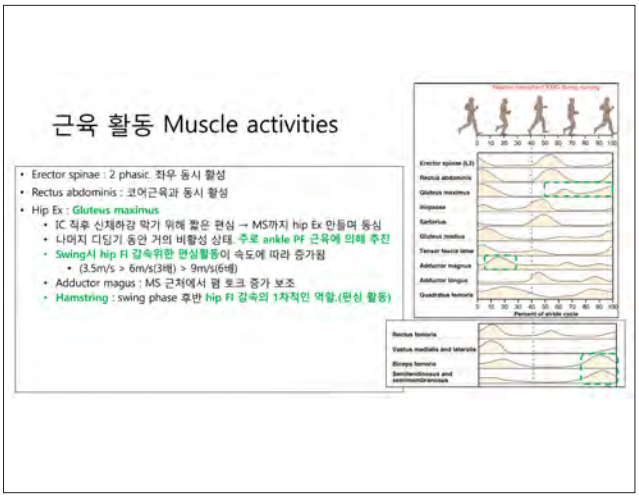


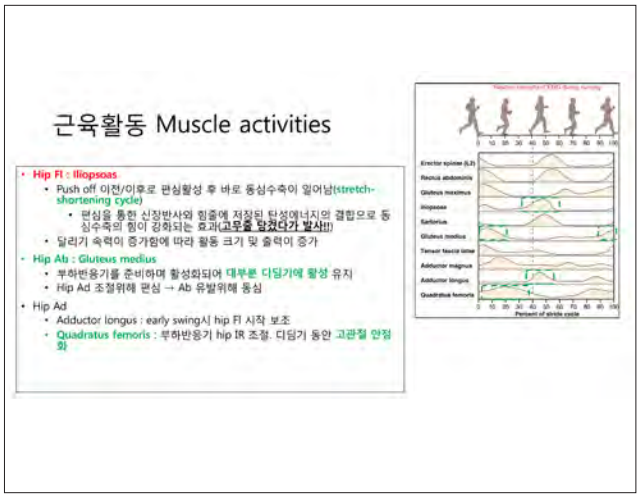

질량 중심(CoM)의 궤적
Vertical Displacement
5 ~ 10cm
Lateral Displacement (Top-Down View)
Crossover Gait (교차 보행)
수직 이동: 걷기보다 큰 진폭
(에너지 보존을 위한 최적 범위)
좌우 이동: 속도가 빠를수록 발이
중심선(0)에 가깝게 착지하여
좌우 흔들림 감소.


운동형상학_Sagittal plane
• Trunk : 5-10도 FI+Ex motion. Avg. FI 2도~13도
• Initial contact(IC)시 최소 → Midstance(MS) 직후 최대
• Speed ↑ : IC 시 증더 forward lean
• Pelvis : 5도 범위 내 움직임. Anterior tilt 15도-20도
• IC 이후 10도정도 post.tilt → Toe off 시 최대
• Hip :
• IC 35도 FI → stance phase 동안 Ex → swing 시 FI + Ex
• Knee :
• IC 10-20도 FI → MS 45-50도 max (loading response 시 center of mass(CoM) 하강을 감속시킴) → stance 후기까지 Ex되어 20도 min
• Swing : midswing 100-120도 FI (발의 질량 중심을 엉덩관절축에 가깝게 만들어 다리의 관성모멘텀을 감소시킴 →swing시 다리전진 에너지 절약)
• Ankle : rearfoot strike 가정
• IC 0-5도 DF → MS 30도 max → pre-swing시 PF하여 추진력 생성 → Toe off 10-20 PF max

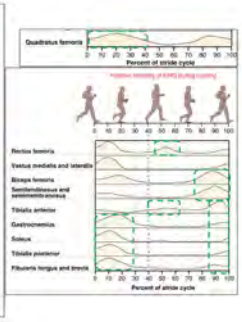

운동형상학_Frontal plane
• Trunk : lateral flexion. Lumbosacral junction. 좌우 5도씩(10도)
• Pelvis : 10도 변화
• IC 부터 elevation(contralateral tilt) → MS 직전까지 max → 이후 디딤발쪽으로 tilt되어 push off 시 max
• Hip : MS 직전까지 8-10도 Ad 위치 → 이후로 Ab로 변화
• MS 근처에서 max hip Ad + max pelvic contralateral tilt 동시
• 디딤기 동안 12도 이상의 hip Ad은 patellofemoral joint pain 과 연관
• Knee : n-c
• Ankle : subtalar joint (eversion, pronation / inversion, supination)
• 개인마다 IC시 위치는 5도 inv에서 10도 ev까지 다양.
• 디딤기 40%에서 max Ev 위치(10도 정도) → 이후로 Inv으로 변화하여 초기 위치로.


운동형상학_Horizontal
• Trunk : lumbar spine rotation 좌우10도(20도) / upper trunk 움직임의 정확은 lower trunk의 3배
• Pelvis : 10~15도 범위
• Walking : 더 긴 step length를 위해 골반은 IC시 IR함.(우측 디딤발의 우측ASIS가 반대쪽 ASIS보다 앞쪽에 위치)
• Rt.leg IC 시 Lt.ASIS가 Rt.ASIS보다 전방에 위치 → MS max ER 상태(우측 디딤발 기준으로 좌측 다리/골반이 앞에 위치) → 이후 pelvis IR해서 toe off시에는 중립위치
• Running : IC시 pelvis ER을 통해 달리기 감속을 최소화. swing leg 전진을 보조
• Hip : 10도 전후
Walking
Running


근육 활동 Muscle activities
• Erector spinae : 2 phasic. 좌우 동시 활성
• Rectus abdominis : 코어근육과 동시 활성
• Hip Ex : Gluteus maximus
• IC 직후 신체하강 막기 위해 짧은 편심 → MS까지 hip Ex 만들며 등심
• 나머지 디딤기 동안 거의 비활성 상태. 주로 ankle PF 근육에 의해 추진
• Swing시 hip FI 감속위한 편심활동이 속도에 따라 증가됨
• (3.5m/s > 6m/s(3배) > 9m/s(6배)
• Adductor magus : MS 근처에서 큰 토크 증가 보조
• Hamstring : swing phase 후반 hip FI 감속의 1차적인 역할.(편심 활동)

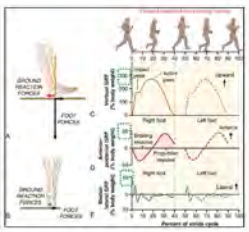

근육활동 Muscle activities
• Hip FI : Iliopsoas
• Push off 이전/이후로 편심활성 후 바로 동심수축이 일어남(stretch-shortening cycle)
• 편심을 통한 신장반사와 힘줄에 저장된 탄성에너지의 결합으로 동심수축의 힘이 강화되는 효과(고무줄 당겼다가 발사!!)
• 달리기 속력이 증가함에 따라 활동 크기 및 출력이 증가
• Hip Ab : Gluteus medius
• 부하반응기를 준비하며 활성화되어 대부분 디딤기에 활성 유지
• Hip Ad 조절위해 편심 → Ab 유발위해 동심
• Hip Ad
• Adductor longus : early swing시 hip FI 시작 보조
• Quadratus femoris : 부하반응기 hip IR 조절. 디딤기 동안 고관절 안정화

- Knee Ex : Quadratus femoris
  - Knee Fl 을 편심으로 조절.(부하반응기 시 가장 활발하게 활동)
  - Rectus femoris : swing 시 hip Fl 보조
- Knee Fl : hamstring muscles
  - Knee Ex을 감속시켜, IC 시 발을 적절하게 위치
  - Splint시 hamstring injury에 가장 취약한 지점이 IC 시점.
- **Tibialis anterior**
  - Initial swing시 foot clearing의 위해 동심활성
  - Terminal swing시 ankle PF 근육과 동시에 활성화되어 IC 친 발목 안정성(뻣뻣함)에 기여
- **GCM/Soleus**
  - 디딤기 초기, 정강이뼈의 전진을 편심활성으로 조절
  - **디딤기 후기, 동심수축하며 추진력 형성**
  - 전족부 착지(forefoot strike) 러너는 IC시 편심활성에 대한 과부하로 아킬레스건 손상 위험과 근육손상의 잠재적인 위험이 증가.
- **Tibialis posterior(TP)**
  - 디딤기 전반부, 회내 조절위해 편심활성.
  - 디딤기 후반부, windless mechanism과 함께 ankle PF위해 동심수축
- **Fibularis longus and bravis**
  - 디딤기 초반, **TP와 함께 subtalar jt의 안/가쪽 안정성을 제공**



지면반발력 Ground reaction force(GRF)

- Vertical(300) >>> A-P(50) > Med-lat(10)
- Vertical GRF
  - 5% cycle(impact peak, active peak 60%), B.wt x1.5
  - 20% cycle (max, active peak), B.wt x 2.5
- 충격력(Impact force)
  - ↑ : Down-hill running, slow cadence, rearfoot strike
  - Impact force ↑ : tibia/metatarsal bone stress fracture risk ↑
- Anterior-Posterior GRF
  - Braking impulse(제동) + Propulsive impulse(추진)
  - Initial contact시 foot position과 Center of mass(CoM) 거리에 영향
    - 제동충격량 감소를 위해 IC 시 발을 CoM에 가깝게 위치.
    - 이를 위해 보폭 줄이기(같은 속도라면 케이던스 올리기)

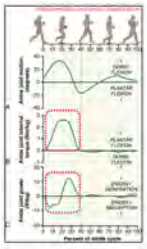


관절 토크와 일률

- 관절 일률(joint power) = 내적 토크 x 관절각속도
- Negative work = Energy Absorption = 편심 활동
- Positive work = Energy Generation = 동심 활동

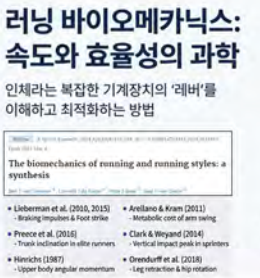
Ankle_sagittal plane

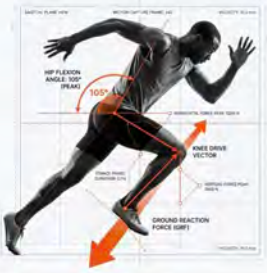
- 디딤기 내내 ankle PF 토크
  - 초기 : 정강이 전진을 조절하는 편심성 토크(negative work)
  - 후기 : ankle PF 근육의 동심성 수축으로 전진을 위한 에너지 생성 (positive work)
- 디딤기 후반의 흡 일률 중 55%는 발목에서 발생(무릎 35%, 고관절 10%)



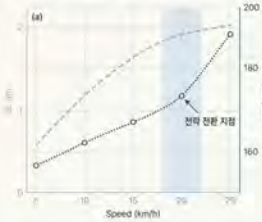
러닝 바이오메카닉스: 속도와 효율성의 과학

인체라는 복잡한 기계장치의 '레버'를 이해하고 최적화하는 방법





속도는 단 두 가지 요소의 곱으로 결정됩니다



속도 = 보폭(SL) x 보속(SF)

속도가 증가함에 따라 SL과 SF는 모두 곡선적으로 증가하지만, 그 전략은 변화합니다.

- ~20 km/h 이하: 주로 보폭(SL)을 늘려 속도를 높입니다.
- ~20 km/h 이상: 보폭 증가가 둔화되고, 보속(SF)을 빠르게 높이는 전략으로 전환합니다.

인사이트

속도에 따른 SL/SF 비율의 변화는 발목 및 고관절 근육군의 활용 전략 변화를 시사하며, 개인의 강점과 한계를 드러낼 수 있습니다.

수평 이동의 엔진: 보속(Step Frequency)

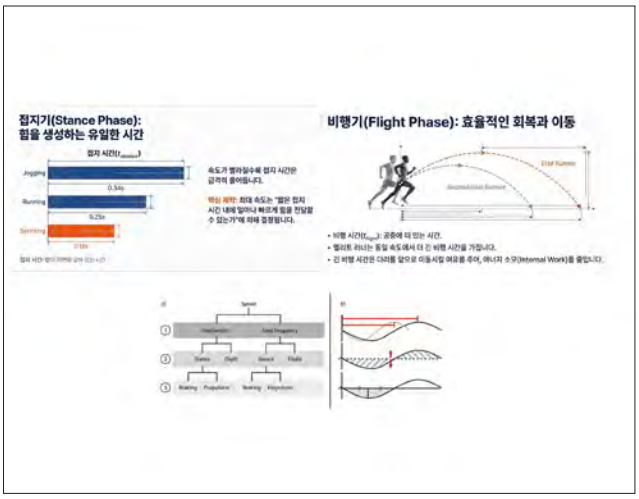
흔히 '180 spm'이 이상적이라고 알려져 있지만, 연구에 따르면 SF는 속도, 다리 길이, 체중, 나이 등 개인적 특성에 따라 달라집니다.

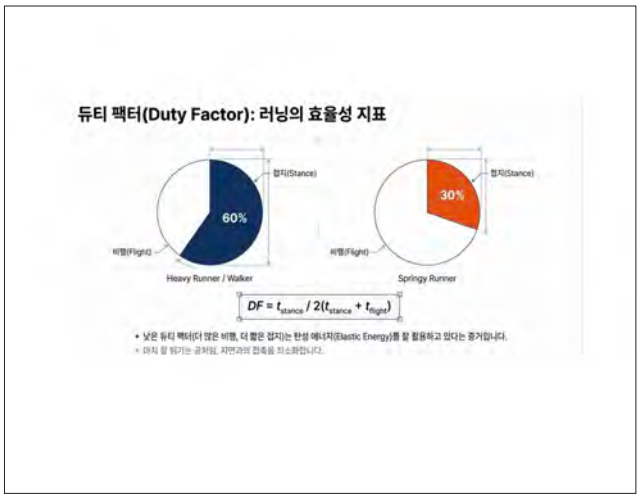
숙련된 러너라고 해서 반드시 더 높은 SF로 달리는 것은 아니며, 오히려 낮은 SF를 보이는 경우도 많습니다.

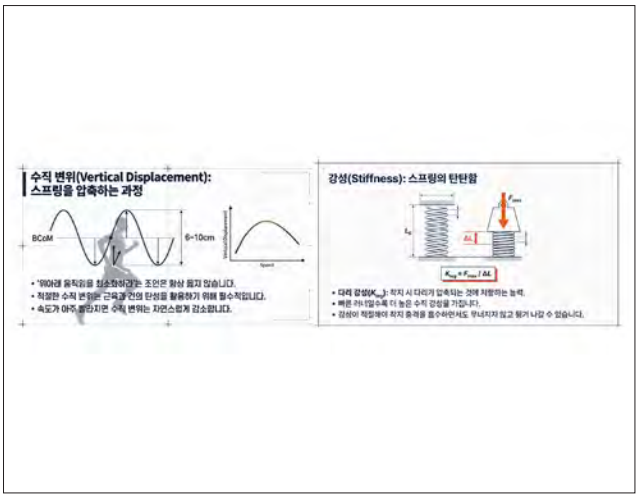
핵심 한계

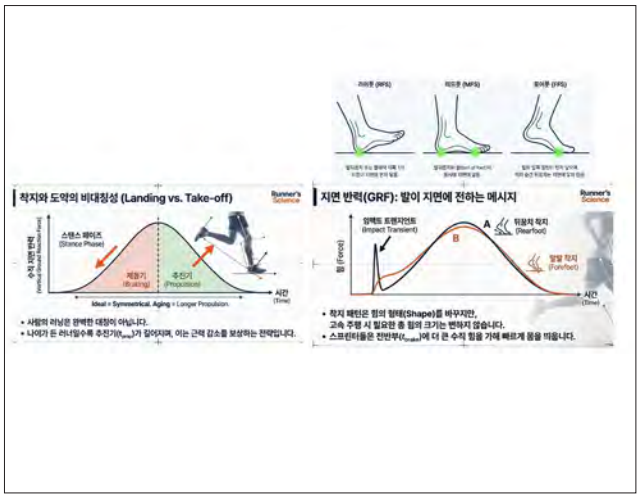
동일한 속도와 SF를 가진 두 러너라도, 한 명은 '짧은 접지 + 긴 체공', 다른 한 명은 '긴 접지 + 짧은 체공'으로 달릴 수 있습니다. 즉, SF만으로는 러닝 스타일을 완전히 정의할 수 없습니다.




접지기(Stance Phase):
힘을 생성하는 유일한 시간
비행기(Flight Phase): 효율적인 회복과 이동


듀티 팩터(Duty Factor): 러닝의 효율성 지표
60%
30%
Heavy Runner / Walker
Springy Runner


수직 변위(Vertical Displacement):
스프링을 압축하는 과정
강성(Stiffness): 스프링의 탄탄함


착지와 도약의 비대칭성 (Landing vs. Take-off)
지면 반력(GRF): 발이 지면에 전하는 메시지


오버스트라이딩 vs 긴 보폭: 중요한 것은 '착지 위치'
다리 회수 (Leg Retraction): 지면 속도와의 동기화


정적 몸통 기울기: 더 많이 기울인다고 더 빨라질까?
동적 몸통 움직임: 다리의 각운동량 보상


신체 비틀림(Body Torsion): 작용과 반작용
Lower Body Angular Momentum = - (Upper Body Angular Momentum)
팔치기(Arm Swing)의 역할: 균형 그 이상


다리 스윙의 효율성: 관성 모멘트 줄이기
에너지 재활용: 햄스트링의 역할


전체론적 관점: 러닝은 하나의 유기적인 시스템
핵심 요약 (Key Takeaways)
• 착지 (Landing): 보폭을 줄이는 것이 아니라, BCoM에 가깝게 착지하는 것이 중요합니다 (다리 회수 기술).
• 자세 (Posture): 과도한 전경(Lean)보다는 '곧게 내리꽂는 자세가 엘리트 러너의 특징입니다.
• 상체 (Upper Body): 팔치기는 단순한 동작이 아니라 하체의 회전력을 상쇄하고 추진 지지력을 돕는 필수 요소입니다.
• 스윙 (Swing): 무릎을 접어 관성 모멘트를 줄이는 것이 고속 러닝의 효율성을 결정합니다.


달리기 부상의
생체역학적 비밀
장거리 러너를 위한 과사용 부상(Overuse Injuries)의 원인과 데이터 기반 분석
Running-Related Biomechanical Risk Factors for Overuse Injuries in Distance Runners: A Systematic Review Considering Injury Specificity and the Potentials for Future Research

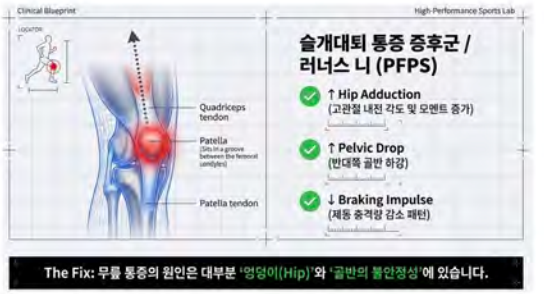

성별 간 차이 (Gender Risk Profile)
+ Females: 무릎(Knee) & 고관절(Hip) 부상 위험 높음
+ Males: 정강이(Shin), 발목(Ankle), 발[Foot] 부상 위험 높음
엉덩이 (Hip): 7%
무릎 (Knee): 28%
정강이 (Shin): 16%
발목 및 발 (Ankle/Foot): 26%
러닝 부상의 1/3은 무릎에서 발생합니다. 하지만 통증의 위치가 반드시 원인의 위치는 아닙니다.


아킬레스 건병증 (Achilles Tendinopathy)
↓ Center of Pressure Displacement
(발바닥 압력 중심의 전후 이동 감소)
↓ Time to Peak Force
(내측 뒤꿈치에 가해지는 힘이 너무 빠르게 정점에 도달)
↑ Inversion/Eversion
(과도한 발목의 내번 및 외번 동작)
Gastrocnemius and Soleus Muscles
Achilles Tendon
Pain is typically felt along the narrow part of the tendon or where it attaches to the calcaneus.
Calcaneus Insertion
The Fix: 단순한 충격보다는 '발목의 안정성'과 '회내(Pronation) 컨트롤'이 핵심입니다.

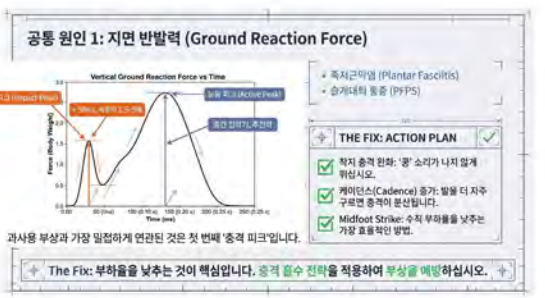

LOCATOR
Plantar fascia
Spans the entire foot arch and is stretched during loading phase
Pain is usually felt at the front of the calcaneus
INFERIOR-MEDIAL VIEW
족저근막염
(Plantar Fasciitis)
↑ Vertical Loading Rate
(수직 지면반발력의 부하율 증가)
Insight
발바닥이 지면에 닿는 순간의 충격 속도가 빠를수록 위험합니다.
↑ Vertical average loading rate
The Fix: '착지 충격(Loading Rate)' 관리가 필수입니다. (Midfoot Strike & Cadence 증가 권장).


LOCATOR
TORSION
(회전 스트레스)
Fracture Point
(피로 골절)
경골 피로 골절
(Tibial Stress Fracture)
↑ Free Moment
(절대적 비틀림 힘 증가)
↑ Hip Adduction
(고관절 내전 증가)
↑ Rearfoot Eversion
(후족부 외번 증가)
The Fix: 뼈는 압력뿐만 아니라 '회전 스트레스(Twisting Force)'에 취약합니다.


Clinical Blueprint
High-Performance Sports Lab
LOCATOR
Soleus and tibialis posterior muscles attach along the posteromedial tibia
Pain presents diffusely along the inside border of the tibia
정강이 통증 /
신스플린트 (MTSS)
↑ Duration of Eversion
(발목 회내(Eversion)가 유지되는 시간 증가)
↑ Contralateral Pelvic Drop
(반대쪽 골반이 떨어지는 각도 증가)
The Fix: 발목이 무너져 왔는 '시간(Time)'이 길어질수록 정강이 근육이 고통받습니다.


Clinical Blueprint
High-Performance Sports Lab
LOCATOR
Quadriceps tendon
Patella
(Sits in a groove between the femoral condyles)
Patella tendon
슬개대퇴 통증 증후군 /
러너스 니 (PFPS)
↑ Hip Adduction
(고관절 내전 각도 및 모멘트 증가)
↑ Pelvic Drop
(반대쪽 골반 하강)
↓ Braking Impulse
(제동 충격량 감소 패턴)
The Fix: 무릎 통증의 원인은 대부분 '엉덩이(Hip)'와 '골반의 불안정성'에 있습니다.


Clinical Blueprint
High-Performance Sports Lab
LOCATOR
LATERAL VIEW
Iliotibial band
(A thick, dense fibrous band that stabilizes the side aspect of the thigh and knee)
Compression of structures deep to the IT band produces pain
장경인대 증후군 (ITBS)
↑ Strain Rate (장경인대의 긴장 속도 증가)
Noto Sans KR Regular
↑ Internal Rotation (무릎의 내회전 증가)
Noto Sans KR Regular
Hip Adduction (고관절 내전은 연구 결과가 상충됨)
Noto Sans KR Regular
The Fix: 단순한 타이트함이 아니라, 무릎과 대퇴골의 '회전 조절(Rotational Control)' 실패가 원인입니다.


공통 원인 1: 지면 반발력 (Ground Reaction Force)
Vertical Ground Reaction Force vs Time
충격 피크 (Impact Peak)
능동 피크 (Active Peak)
Force (Body Weight)
Time (ms)
과사용 부상과 가장 밀접하게 연관된 것은 첫 번째 '충격 피크'입니다.
• 족저근막염 (Plantar Fasciitis)
• 슬개대퇴 통증 (PFPS)
THE FIX: ACTION PLAN
착지 충격 완화: '쿵' 소리가 나지 않게 하십시오.
케이던스(Cadence) 증가: 발을 더 자주 구르면 충격이 분산됩니다.
Midfoot Strike: 수직 부하율을 낮추는 가장 효율적인 방법.
The Fix: 부하율을 낮추는 것이 핵심입니다. 충격 흡수 전략을 적용하여 부상을 예방하십시오.







부상 메커니즘 및 교정 포인트 요약 (Injury Mechanism & Fix Summary)

부상 부위 (Injury)	핵심 메커니즘 (Mechanism)	교정 포인트 (The Fix)
아킬레스 (Achilles)	CoP 이동 감소 (Reduced CoP Excursion)	발목 안정성 강화 (Strengthen Ankle Stability)
족저근막 (Plantar Fascia)	수직 부하율 (Vertical Loading Rate)	부드러운 착지 (Soft Landing)
경골 골절 (Tibia Fracture)	비틀림 힘 (Free Moment)	회전 스트레스 줄이기 (Reduce Rotational Stress)
정강이 (MTSS)	회내 지속 시간 (Pronation Duration)	발 아치 유지 시간 단축 (Shorten Arch Maintenance Time)
무릎 (PFPS)	고관절 내전 & 골반 하강 (Hip Adduction & Pelvic Drop)	둔근(엉덩이) 강화 (Strengthen Glutes)
IT 밴드 (IT Band)	무릎 내회전 & 변형률 (Knee Internal Rotation & Strain)	하체 정렬 및 코디네이션 (Lower Body Alignment & Coordination)

안재기

학력

연세대학교 의학과 학사

연세대학교 의학대학원 의학과 석사

고려대학교 의학대학원 의학과 박사

주요 경력

현 대한재활의학회 이사

현 대한스포츠과학운동의학회 부회장

전 대한신경근골격초음파학회 회장

전 대한발의학회 이사장

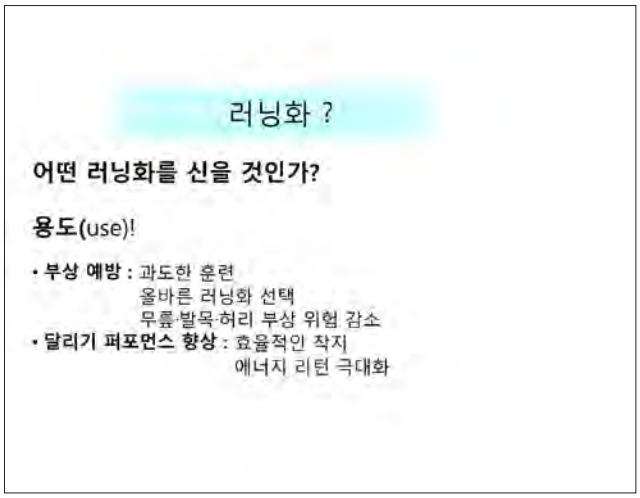
현재 소속 및 직위

인제대학교 상계백병원 재활의학과 교수

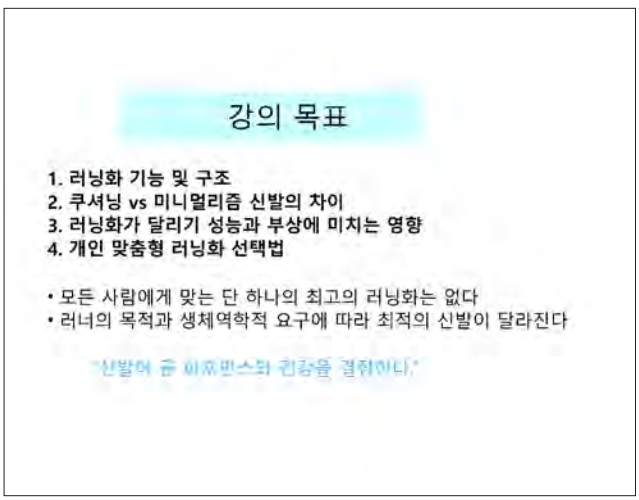
신발 및 러닝 성능
Footwear & Running Performance

상계백병원
안재기



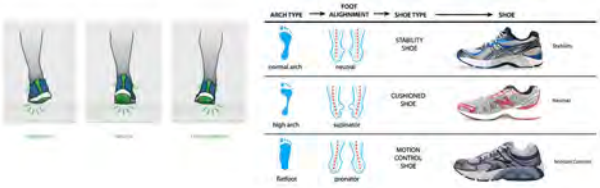






러닝화 기본

FOOT TYPE GUIDE



러닝화 기능



- 러닝화 주요 기능:
  - 충격 흡수 (Shock Absorption)
  - 추진력 보조 (Energy Return)
  - 안정성 제공 (Stability & Support)

~ 균형~
충격 흡수,
에너지 반환,
구조적 안정성,
기하학적 설계,
발과의 적합성

좋은 러닝화 조건
1. Shock absorption
2. Energy return
3. Geometry
4. Stiffness
5. stability + fit

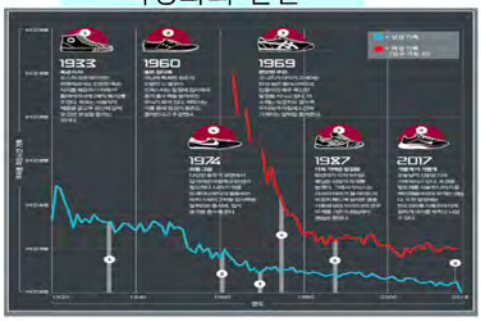
러닝화 역사



1860년대 스파이크화:
영국의 육상선수였던 조셉 포스터
러닝화에 못을 박아 접지력을 높인 신발
현존하는 최초의 러닝화
영국 노샘프턴박물관 전시.

Moon Shoe: 나이키 와플 레이싱 플랫 문슈
나이키 공동창업주 빌 바워먼이
1972년 올림픽 예선전 육상 선수들을 위해
디자인한 수제화 ; 12 켤레 제작.
Cf) 소더비 경매 43만7천500달러

러닝화의 변천



러닝화의 변천

- **초창기 (1960년대 이전)**
- 주로 **가죽 소재**와 단순한 고무 밑창으로 제작
- 충격 흡수 기능이 거의 없이 달리기기능보다는 **가벼운 운동화**에 가까움
  (1953 아식스 Onitsuka tiger 1st cushioned heel)
- 대표적: 아디다스 초기 러닝 슈즈, 컨버스 등
  → PF 경골 stress 빈번

- **기능성 시작 (1970년대)**
- 조깅 붐과 함께 러닝화가 본격적으로 발전
- **나이키 와플솔(Waffle Sole, 1972)**
  → 접지력과 쿠션감 향상
- EVA(에틸렌-비닐 아세테이트) 소재
  미드솔 도입 → **가볍고 충격 흡수**
  → **충격흡수 개선 경골통증 감소**



러닝화의 변천

- **기술 경쟁 시대 (1980~1990년대)**
- **에어쿠셔닝(Air, Nike), 젤(Gel, Asics),**
  파워쿠션(Yonex) 등 충격 흡수 기술 경쟁
- 안정성을 위한 **모션 컨트롤(MC)** 신발 등장
  → 과회내전 방지 목적
- 러너의 부상 예방이 주요 키워드
  과회내 교정 무릎통증 관리

- **경량화 & 스피드 지향 (2000년대)**
- **경량 레이싱화**와 데일리 트레이너의 구분 뚜렷
- 신소재(PEBA, TPU) 도입으로 **반발 탄성 강화**
- "Barefoot Running"
  트렌드(베브람 파이브핑거스 등) 확산
  → 맨발 러닝 철학 유행
  → AT, PF 재증가



- **현대 러닝화 (2010년대 이후)**
- **맥시멀리즘 신발 (Hoka One One)** → 두꺼운 미드솔로 충격 흡수 극대화
- **카본 플레이트 내장** (Nike Vaporfly, 2017) → 반발력 & 효율성 극대화, 마라톤 기록 경신
  → 전족부 부상 보고
- 빅데이터·웨어러블을 통한 **개인 맞춤형 러닝화** 개발 가속화

러닝화의 변천

- **최신 동향 (2020년대)**
  - **지속가능성(Sustainability)** → 재활용 소재, 친환경 접착제
  - **스마트 러닝화** → 센서 탑재, 보행 분석, 실시간 피드백
  - 브랜드별 특화 기술:
    - Nike: ZoomX + 카본 플레이트
    - Adidas: Lightstrike Pro + Energy Rods
    - Asics: FF Blast + PureGel
    - Hoka: Meta-Rocker 디자인
  - Cf) FF Blast ; FlyteFoam Blast

주요 기술 기전 (Mechanism of Action)
① **충격흡수 (Shock Absorption):**
압자 구조가 미세하게 압축되며 충격 에너지를 분산.
② **반발탄성 (Energy Return):**
TPE 폼핀드가 압축 후 빠르게 복원되어 추진력을 제공.
③ **안정성 (Stability):**
소재가 가볍지만 lateral compression을 줄여 착지 안정성 확보.
④ **온도 내성 (Temperature resistance):**
일반 EVA보다 기온 변화에 따른 경도 변화가 적음.

러닝화의 변천



러닝화 구조

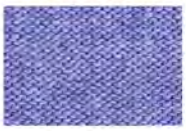
- **구성**: 어퍼(Upper) 갑피
  미드솔(Midsole)중창
  아웃솔(Outsole) 밑창
  인솔(Insole) 깔창





어퍼(Upper) – 소재별 특징





- **메쉬(Mesh)**: 통기성 우수, 가볍지만 내구성 약함
  그물처럼 촘촘한 구멍이 뚫려 있음.
  폴리에스터, 나일론, 스판덱스 등 주로 합성 섬유로 만들어짐.
- **니트(Knit)**: 발에 밀착, 유연성 높음, 디자인적 장점
  편직기계나 손으로 짜서 만든 천이나 옷감
- **합성피혁(Synthetic Leather)**: 내구성 뛰어남, 방수·보호 기능
- 최근 경향: **니트 + 메쉬 하이브리드 구조**
  니트로 만든 원단도 메쉬처럼 구멍이 뚫려있을 수 있고
  메쉬 원단 중에서도 니트 방식으로 만들어진 '니트 메쉬'

Cf))
Jacquard Mesh (자카드 메쉬) ; 자카드 직조기 패턴형, 실을 다층구조로 엮음: 안정
Engineered Mesh (엔지니어드 메쉬) 3D; 기능설계형 부위별로 두께조정 : 감싸는 느낌

미드솔(Midsole) 분류

항목	EVA	TPU(Thermoplastic poly urethane)	PEBA (Pebax 등)
기본 재질/특성	Ethylene vinyl acetate 시트/블록 발포, 압축성형(CMEVA) *슈퍼크리티컬 발포도 가능*	열가소성 폴리우레탄 **eTPU** 발포폼 특징유사(Adidas Boost 계열) 또는 시트 발포	Polyether block amide 초경량 고탄성 그윤지 에듀/시트/슈퍼크리티컬 발포
상대 밀도(무게감)	**가벼움**(저)	**무거움**(중~고)	**매우 가벼움**(최저)
경도(체감 단단함)	중간(조율각 다양)	중~부드러움(반발 있는 말랑함)	부드러움~중간(높신+탄성)
에너지 리턴(반발력)	**중간**	**높음**	**매우 높음(최상) 잘 된다**
측면 안정성	설계확보 유동(사이드월)	넓궁한 편 → **캐이지/사이드월** 필요	안성 한 ~plate/**carrier** 필요
충돌 감쇠(충격 차단)	**양호**(soft damping(감쇠))	**양호~우수**	**우수**(충격 완화+반발 동시)
주행 감각 키워드	"쇼프트·안정 무난"	"말랑+탄성, 통통 튐"	"가볍고 폭신, '팝' 있는 추진"
제조/설계 자유도	아주 높음(가격 저렴, 대량생산)	중(비드 공정/장비 필요)	중(원재료 고가, 공정 정밀)
비용/가격대	**저가**	**중가**	**고가**
권장 용도	데일리·안정성, 가성비 트레이너	데일리~한기리, 쿠션+반발 균형	레이싱·장기리 주구, 슈퍼 슈즈
주의점	빠데못 저온경화	상대적 중량, 측면 지지 설계 필요	**소프트 폼안정** →플레이트/사이드월 필수

러닝화 미드솔

항목	EVA Ethylene vinyl acetate	TPU Thermoplastic poly urethane	PEBA Polyether block amide
장점	가격 저렴 쿠셔닝 좋음 신발 가벼움 편안함 안정성부족	내구성 높은 반발력 고 성능 반응성	내구성 반응성 쿠셔닝
복원속도		빠름	매우빠름 고탄성
단점	오래 사용시 꺼지고 반발력 감소		가격이 비싸다
적용	일상훈련용	장거리 러너 훈련용	마라톤 레이스 스플린터
Cf))	고무기반	ATPU (aliphatic TPU) 충격흡수, 에너지 반환률 높음 →미드솔 "폰독" 안정성? TPEE (Theromplastic polyester elastomer) 내구성 (주로 활경) **TPU**는 "튼튼한 반발형 트레이너 폼" **A-TPU**는 "최신 고반발 고내구 고온도안정성 폼" **TPEE**는 "정든된 고반발 고내구 프리미엄 폼"	미드솔에 Plate/carrier 필요

미드솔(Midsole) – 쿠션 메커니즘

- **EVA (Ethylene Vinyl Acetate)**: 가볍고 저렴, 기본형 쿠션
- **TPU (Thermoplastic Polyurethane)**: 반발력·내구성 강함
- **PEBA (Polyether Block Amide)**: 초경량, 탄성 극대화 (슈퍼슈즈 핵심 소재)
- **쿠션 메커니즘**: ***에너지 흡수 → 저장 → 추진력 변환***

미드솔은 단순한 쿠션이 아니라
발의 생체역학적 정렬을 교정·안정화하는 도구

아웃솔(Outsole)

1. **카본 러버(Carbon Rubber)**: 내구성 강함, 도로용 적합
   고무(러버)에 탄소(카본)를 첨가하여 내구성과 내마모성을 높인 신발 밑창
   러닝화나 MTB 슈즈 등에 사용되어 흙이나 지면에서 미끄러짐을 방지
   신발의 수명을 늘리는데 기여, 레이싱 신발에서 힘 전달력을 향상
2. **블로운 러버(Blown Rubber)**:
   공기가 주입되어 일반고무 보다 가볍고 쿠셔닝이 뛰어나며
   항상된 탄성을 제공하는 아웃솔(밑창); 가볍고 쿠션감, 접지력 우수
3. **스티키 하이그립 러버 (sticky, high-grip)**:
   매우 잘 붙고 미끄러지지 않는 고무 소재의 신발 밑창
   아웃도어 신발이나 작업화 등에서 접지력과 내구성을 높이기 위해 사용.
   내구성과 접지력을 동시에 확보





아웃솔(Outsole)

항목	카본 러버(Carbon)	블로운 러버(Blown)	스티키/하이그립 러버
구조/제조	카본 충진 경질 러버	발포(기포)로 **가벼운** 연질 러버	실리카·모알·특수 폴리머로 **점착↑**
무게	**무거움**	**가벼움**	**중**
경도 감각	딘단·내마모↑	부드럽고 발감 좋음	접착감, 마른/젖은 노면 그립 ↑
내마모/수명	**매우 높음**	**중~낮음**	중~높음(포뮬라에 따라)
젖은 노면 그립	중(패턴 의존)	중~양호	**높음**
건조 노면 그립	**높음**	**양호**	높음
유연성/친아감	중(두껍고 단단)	**우수**(압랑·전이 부드러움)	중
소음	약간 큼	작음	중
일반 배치	**뒤꿈치·외측 고마모 존**	**전족부 접지/유연 존**	**포어 풋/트레일 높은 그립 존**
장점	수명·내절단 가드 ↑	경량·감각/유연성 ↑	젖은/거친 노면 **그립 극대화**
단점	무게·딱딱한 착지감	마모 빠름, 찰날림 등갈 취약	마모/온도 민감성, 가격

인솔(Insole) – 맞춤 교정

- 기본 인솔: 쿠션 보강
- 맞춤형 인솔: 발 형태 교정, 압력 분산
- 즉지근막염 례: 교정 인솔 착용 → 통증 완화




러닝화 주요 분류

1. 데일리 트레이러닝
2. 쿠셔닝형
3. 안정성형
4. 경량-레이싱형
5. 트레일러닝

러닝화 분류 비교

구분	주요 특징	추천 대상	대표 모델
데일리 트레이닝	균형 잡힌 쿠션 & 내구성 / 전천후 사용 가능 / 중립형 지지	초보중급 러너, 주 3-4회 훈련, 장·단거리 모두 소화	Nike Pegasus, Brooks Ghost, NB1080, Asics Nova/Cumulus
쿠셔닝형	쿠션감 극대화 / 충격 흡수 우수 / 무게는 다소 무거움	장거리 러너, 관절 보호가 필요한 러너, 초보자	Asics Nimbus, Brooks Glycerin, Hoka Clifton
안정성형	아치 지지 / 과내전 교정 / 발목 안정화 기능	평발·과회내 주자, 부상 이력 있는 러너	Asics Gel Kayano, Brooks Adrenaline, Saucony Guide
경량·레이싱형	초경량 / 반발력 극대화/ 카본 플레이트 내장	기록 단축 목표, 대회 참가 러너	Nike Vapor/Alpha fly, Adidas Adios Pro, Saucony Endorphin Pro
트레일러닝화	깊은 러그 패턴/ 접지력 강화 / 발목 보호 / 내구성 강화	산길, 오프로드 환경 러너	Salomon Speedcross, Hoka Speedgoat, Brooks Cascadia

데일리 트레이러닝화

- 주자가 **매일 반복적인 훈련 수행(run training, recovery run, aerobic run)**
  -- 안정성과 내구성, 쿠션감을 우선시하여 설계

- **충격흡수**: 반복적인 지면 반발력(Impact force)을 줄여 **슬관절·족관절 부담 완화**
- **폼 안정성**: 과도한 내·외전 제어 → 무릎의 정렬 유지
- **리듬 유지**: 일정한 템포 러닝 시 자연스러운 롤링 지원 (Meta-Rocker 구조 등)
- **회복(run recovery)** 시 근피로 감소


New Balance 1080v13


Asics Novablast 4


Hoka Clifton 9

쿠셔닝형

- 대상: 초보자, 장거리 러너
- 장점: 관절 보호, 피로 완화
- 대표 모델: Asics Gel Nimbus, Brooks Glycerin



안정화형

- 대상: 과회내, 평발 주자
- 기능: 아치 지지, 발목 안정화
- 대표 모델: **Asics GEL Kayano**, Brooks Adrenaline

ASICS : 안정성을 위해 4D GUIDANCE SYSTEM을 사용
- **미드솔 구조 자체 설계로 자연스러운 안정성 확보 (비강제적 안정성)**
-인위적으로 발을 밀지 않고 "폼 자체의 형태"로 정렬을 유도하는 최신 개념
-발의 정렬과 착지-이륙 전 과정

Brooks : 발을 지지하기 위해 GuideRails® 시스템을 사용
-양측 가이드 벽으로 발의 궤도 유지
-발의 흔들림과 무릎 정렬까지 포함



트레일 러닝화

•러그(lug) 패턴 깊어 접지력 강화
•발목 보호 구조
•내구성 있는 아웃솔 적용



경량·레이싱형

- 초경량, 반발력 극대화
- 카본 플레이트 탑재 (N
- 기록 단축 목적

•최신 트렌드 : 슈퍼
•Nike Vaporfly 4% → 마
•Adidas Adios Pro → En

2017 나이키 Zoom vaporfly 4% - 에너지반환율 87%
2018 킵초게 2시간 1분 39초
2019 나이키 alphafly prototype
킵초게 비공식 1시간 59분 40초
(카본플레이트 3개 에어포드45mm)
헌)세계기록: 2시간 35초 켈빈 킵툼

신발규정: 세계육상연맹
40mm 이하 미드솔 높이
카본플레이트1개,
대회전 4개월이내 발매





Supershoes :
midsole : boost 쿠셔닝 에너지반환
carbonplate
200g 미드솔 두껍지만 가볍다

러닝화 평가



러닝화와 Perfomance

1. 쿠셔닝 vs 미니멀리즘 신발의 차이
2. 러닝화가 달리기 성능과 부상에 미치는 영향
3. 개인 맞춤형 러닝화 선택법

쿠셔닝 vs 미니멀리즘 신발의 차이

특성	Minimalist	Cushioning
stack height	낮음	높음
drop	0–4mm	8–12mm
flexibility	높음	낮음
weight	가벼움	상대적 무거움
cushioning	낮음	높음

쿠셔닝 vs 미니멀리즘 : Biomechanics

- **Cushioning shoe**
  impact attenuation
  longer stride
  knee moment 증가
- **Minimalist**
  foot intrinsic muscle activation 증가
  ankle plantarflexor load 증가
  stride length 감소
  cadence 증가

Kulmala JP. 2018
Lower leg loading in maximal shoes

Warne & Gruber 2017
Lieberman DE. 2010
Nature

쿠셔닝 vs 미니멀리즘 : Muscle activity

- **Cushioning shoe**
  (activity 증가)
  quadriceps
  knee extensor moment
- **Minimalist** (activity 증가)
  flexor digitorum brevis
  abductor hallucis
  gastrocnemius

쿠셔닝 vs 미니멀리즘: injury distribution

부상	Minimalist	Cushioning
Achilles tendinopathy	↑	↓
calf strain	↑	↓
metatarsal fracture	↑	↓
PFPS	↓	↑

러닝화가 달리기 성능과 부상에 미치는 영향

- 러닝: 에너지 교환 운동
  (energy exchange system)
- 달리기에서 중요한 3 가지 energy mechanism
  1. **Impact absorption**
  2. **Elastic energy storage**
  3. **Energy return**

- **러닝화가 바꾸는 주요 biomechanical parameter**
  1. vertical loading rate
  2. leg stiffness
  3. ankle moment
  4. running economy

러닝화 미드솔(midsole) 기술의 진화

- **1세대 midsole**
  :EVA foam
  - shock absorption
  - 낮은 energy return
  - 에너지 반환율
    약 **55–65%**
- **2세대 midsole**
  :TPU based foam
  - Adidas Boost
  - 에너지 반환율
    약 **65–75%**
- **3세대 midsole**
  :Supercritical PEBA foam
  - Nike ZoomX
  - Saucony PWRRUN PB
  - 에너지 반환율
    약 **80–90%**

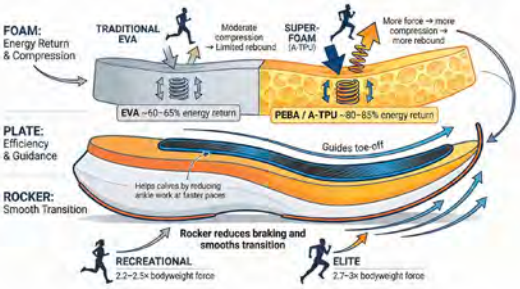
foam	energy return
EVA	60%
TPU	70%
PEBA	85-90%

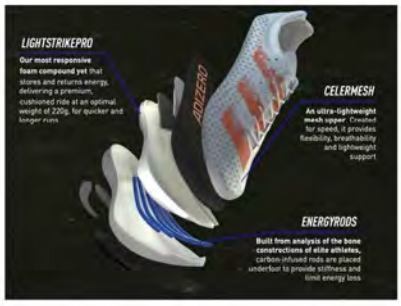
Responsive Foam과 Running Economy

- Nike Vaporfly
- **running economy 약 4% 개선**
  :마라톤; **2–3분 기록 단축 가능**

Hoogkamer W. 2018.
Nike Vaporfly improves running economy

- **Running Economy 개선 이유**
  3가지 mechanism
1. **Elastic energy return**
   midsole이 spring처럼 작동
2. **Energy loss 감소**
   soft foam이 impact energy 일부 저장
3. **Ankle joint work 감소**
   근육이 해야 할 일을 foam이 일부 수행





Carbon Plate Biomechanics

- **Carbon Plate 기능** 3가지

1. Lever effect
2. Bending stiffness 증가
3. Ankle joint moment 감소

Roy & Stefanyshyn, 2006
Effects of bending stiffness on running economy

- **Lever Mechanism**
  carbon plate는 foot의 lever arm을 증가
  MTP 에서 중요한 역할
- **longitudinal bending stiffness** 증가
  toe-off 효율 증가
  bending stiffness 증가
  → running economy 개선
- **Ankle Joint Mechanics**
  carbon plate shoe
  → ankle plantarflexion moment 감소
  Plate + foam이 elastic work 일부 수행
  triceps surae workload 감소

Carbon Plate Biomechanics

- **Rocker Geometry**
  대부분 carbon plate shoe는 **rocker sole** 구조.
- rocker sole 효과
  - ankle dorsiflexion 감소
  - forward rolling 증가
  → toe-off 효율 증가

- **Carbon Plate와 Muscle Activation**
  EMG 연구
- gastrocnemius, Soleus 감소
  (근육 부담 감소)
  → endurance performance 증가

Carbon Plate Biomechanics

- **Carbon Plate Injury Risk(theory mechanism)**

stiffness 증가
altered loading
changed muscle activation

- **Injury pattern**

Mmetatarsal stress fracture
Plantar fasciitis
Achilles tendinopathy

개인 맞춤형 러닝화 -personalized shoe prescription-

1. comfort filter paradigm

- 러너가 **가장 편한 신발**

→ injury risk ↓
: neuromuscular system
optimal movement pattern

개인 맞춤형 러닝화 -personalized shoe prescription-

2. Runner classification

1) Impact dominant runner
high vertical loading rate, heavy heel strike
→ shigh cushioning / rocker sole

1) Elatic runner
high cadence, short ground contact
→responsive foam /carbon plate

3) Muscle dominant runner
strong calf use, forefoot strike
→ low drop shoe

개인 맞춤형 러닝화 -personalized shoe prescription-

- **3 Foot morphology**

중요한 변수
arch height
forefoot width
toe splay

High arch
•cushioning
•flexible midsole

Flat foot

•stability shoe
•wide base

개인 맞춤형 러닝화 -personalized shoe prescription-

- Injury history

과거 부상	추천 신발
Achilles tendinopathy	higher drop
PFPS	softer midsole
metatarsal stress fracture	cushioning
plantar fasciitis	rocker

러닝화 처방 알고리즘

- **러너 평가**

1. Foot strike
2. cadence
3. injury history
4. foot structure
5. comfort test

3 가지 후보신발 선택
↓
treadmill running test
↓
comfort score
↓
최종 선택

Comfort filter paradigm

- **Performance vs Injury ;**
  러닝화는 성능과 부상 사이 **trade-off** 존재
- **러닝화 선택에서 가장 중요한 것 :** 최근 consensus
  "Comfort Filter Paradigm"
- 러너가 **가장 편안한 신발**
  → injury risk 감소
  neuromuscular system이 최적 movement pattern

Nigg BM. 2015
Comfort filter-paradigm

좋은 러닝화란?

"가장 푹신한 신발" X
"가장 반발이 좋은 신발" X

* 당신의 용도·거리·러닝 패턴·지지 요구도에 맞게
shock absorption,
energy return,
geometry,
stiffness,
fit
➔ 균형을 이루는 신발

2026 러닝화 가이드

- **Adidas Adizero EVO SL**
  일반적으로 가장 추천
- 데일리러닝화 ASICS Novablast 5
- 템포러닝화 Endorphin Speed 5
- 레이싱화 Nike Vaporfly 4
- 충격흡수 Mizuno Neo Vista 2
- 에너지 리턴 Saucony Endorphin Elite 2
- 안정성화 ASICS Gel Kayano 32

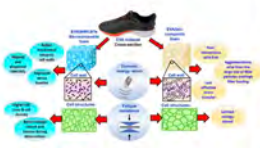
Take Home Message



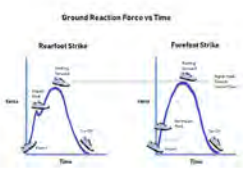


- 러닝화의 구조 재질 특성
- 러닝의 착지 패턴
- 발의 기본 구조
- 적절한 러닝화의 선택

- 현명한 러닝화 선택으로
  즐거운 러닝 라이프를 지속
  (부상없이 건강하게)









달리기 기술 및 부상 예방
Running Technique & Injury Prevention

보라매병원
정세희

달리기 훈련 방법 및 퍼포먼스 최적화
Running Training Methods & Performance Optimization

썬코치 러닝클래스
이선춘

The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

심포지엄 16: 스마트 러닝을 위한 생체역학: 보폭·보빈도 조절에서 관절 부하 관리까지

Biomechanics for Smart Learning: From Stride and Cadence Adjustment to Joint Load Management

(스포츠과학위원회 3)

좌장: 한양대병원 김미정, 동아대학교 박현태



김영욱

학력

영남대학교, 특수체육교육학과 학사

University of Nebraska Omaha, Athletic Training 석사

Utah State University, Pathokinesioloty 박사

주요 경력

스포츠의학과 교수, 순천향대학교 (2024-현재)

Postdoctoral Fellow, Department of Kinesiology & Health Science, Utah State University (미국) (2021-2023)

Clinical Exercise Specialist, Sorenson Center for Clinical Excellence, Utah State University (미국) (2021-2023)

현재 소속 및 직위

순천향대학교 스포츠의학과, 조교수

대표논문

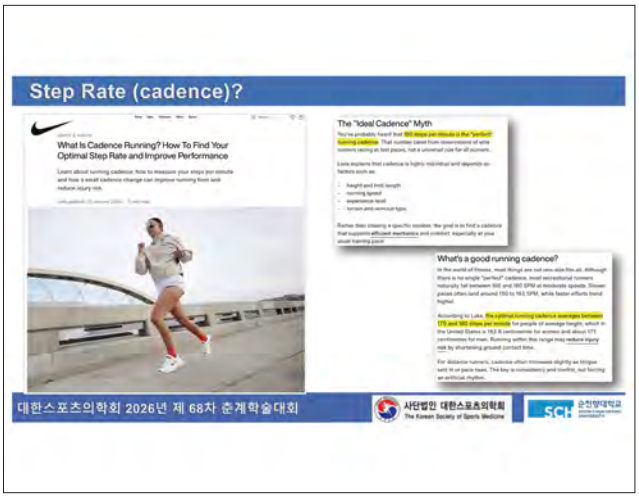
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더 스마트하고 안전하게 달리기 위한 방법, 발착지 운동역학 및 달리기 경제성 개선을 위한 보폭 조절 기법
How to Run Smarter and Safer? Step Rate Manipulation as a Tool to Modify Foot Strike Kinematics and Running Economy

순천향대학교
김영욱









Changing Foot Strike Is Not Universally Beneficial!

Study 2. Benefits and Risks Associated with Changing Foot Strike Pattern



- **Injury risk**
  → inconclusive
- **Running economy**
  → inconsistent findings
- **Biomechanical changes**
  ↓ Vertical loading rate
  ↓ Patellofemoral joint stress
  ↓ Knee flexion range
  ↑ Ankle plantarflexor loading

Key: There is **no strong evidence** to recommend routine conversion from rearfoot strike to non-rearfoot strike

Cadence Manipulation: Practical Biomechanical Tool

Mechanism
Cadence ↑ → Step length ↓
Foot lands closer to the COM

→

Biomechanical changes
↓ Braking impulse
↓ COM vertical excursion
↓ Peak knee flexion

→

Joint loading
↓ Knee energy absorption
↓ Knee extensor moment

→

Clinical Implication
Reduced knee joint loading during running



Long stride (overstriding)
heel far in front of COM
↓
large braking force
↓
high knee loading



Efficient (shorter) stride
foot under COM
↓
less braking
↓
lower knee loading

Consistent biomechanical adaptations with cadence increases

Mechanism
Cadence ↑ → Step length ↓
Foot lands closer to the COM

→

Biomechanical changes
↓ Braking impulse
↓ COM vertical excursion
↓ Peak knee flexion

→

Joint loading
↓ Knee energy absorption
↓ Knee extensor moment

→

Clinical Implication
Reduced knee joint loading during running

Increasing cadence by 5%



Increasing cadence by 10%



Cadence as a Master Variable in Running Mechanics

Cadence influences multiple aspects of running mechanics

- Cadence ↑
- Stride length ↓
  Foot landing closer to COM
- Braking impulse ↓
  Vertical oscillation ↓
- Joint mechanics change
  (knee flexion, joint moments)
- Joint loading distribution changes
- Foot strike behavior may shift

→ Cadence is an upstream variable that influences running mechanics

From Foot Strike Debate to Cadence-Based Gait Modification

What previous studies showed

Foot strike pattern changes
→ redistribute joint loading

Changing strike pattern directly
→ inconsistent evidence

Cadence manipulation
→ alters running mechanics and joint loading

What remains unclear

Does cadence manipulation influence
- **Foot strike behavior?**
- **Running economy?**

Research Question

Can **step rate manipulation** modify **foot strike pattern** and **running economy** in recreational runners?

Methods

Recreational runners (n = 18)



Treadmill running
Cadence: Preferred, −10%, −5%, +5%, +10%



- **Foot strike pattern** (foot strike angle >> Strike index)
- **Submaximal VO_2**

Step Rate Manipulation Alters Foot Strike Behavior

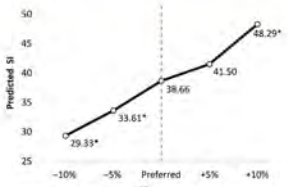


Key finding

Step rate manipulation altered foot strike behavior

Decreasing step rate
→ shift toward **rearfoot strike**

Increasing step rate
→ shift toward **more anterior foot strike**



*SI for each SR condition. *Significantly different from preferred SR; P < .05. SI indicates strike index; SR, step rate.*

Lower Cadence Worsens Running Economy



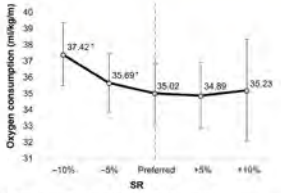
Key finding

Compared with preferred cadence

−10% cadence → higher VO_2
−5% cadence → higher VO_2

+5% / +10% → no significant difference

Lower cadence reduced running economy
(= increased metabolic cost)



*Oxygen consumption during each SR condition. *Significantly different from preferred SR; P < .05. SR indicates step rate.*

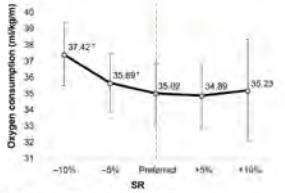
Interpretation: Preferred Cadence & Running Economy

Preferred stride frequency
= metabolically optimal frequency

Deviating from preferred cadence
→ increased metabolic cost
(Cavanagh & Williams 1982; Morgan 1994)

Our findings support this concept

Lower cadence
→ higher oxygen consumption
→ reduced running economy



*Oxygen consumption during each SR condition. *Significantly different from preferred SR; P < .05. SR indicates step rate.*

Clinical Implications



Cadence manipulation may help

- Modify foot strike behavior
- Redistribute joint loading
- Avoid metabolically inefficient running

As a practical gait-retraining strategy

But should be applied **selectively and gradually**

Cadence manipulation modifies running mechanics rather than enforcing a specific running style

Take-Home Message

1. **Step rate manipulation modifies foot strike behavior**
2. **Lower step rate increases metabolic cost and worsens running economy**
3. **Cadence manipulation is a practical gait-retraining strategy**
4. **It should be applied selectively, not universally**

Cadence manipulation may serve as a practical upstream strategy to influence running mechanics, including foot strike behavior and joint loading.

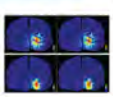
Thank You



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전형규

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연세대학교 일반대학원 체육학과 박사

주요 경력

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대한장애인축구협회 청각축구대표팀 트레이너

현재 소속 및 직위

동국대학교 스포츠과학융합연구소 연구초빙교수

대표논문

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달리기 부하와 하지 골관절염: 생체역학적 힘의 역할
Running Loads and Lower Limb Osteoarthritis: The Role of Biomechanical Forces

동국대학교
전형규

김 훈

학력

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University of Nebraska at Omaha, Athletic Trainnig 석사

Marquette University, Exercise and Rehabilitation Science 박사

주요 경력

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(2020.01-2020.12) [Exercise & Rehabilitation Science, Marquette University] Instructor

(2017.08-2021.01) [Exercise & Rehabilitation Science, Marquette University] Research Assistant

현재 소속 및 직위

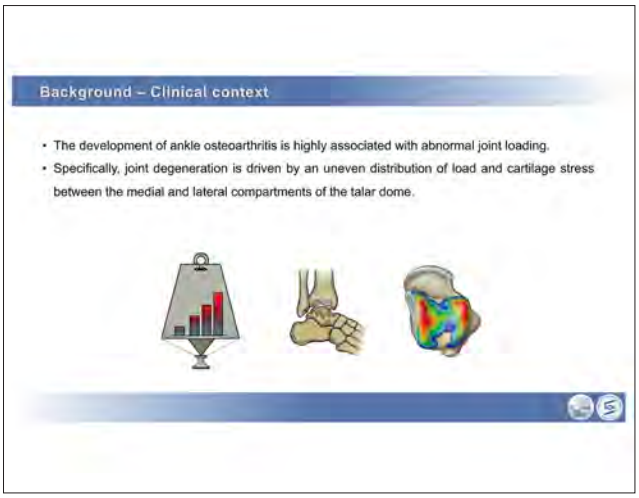
순천향대학교 스포츠의학과 조교수

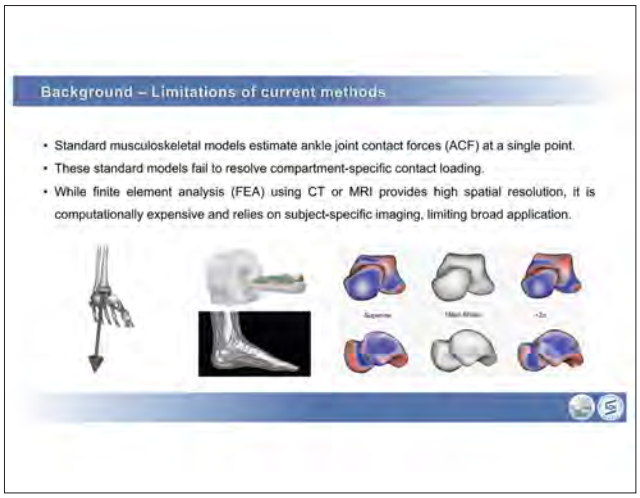
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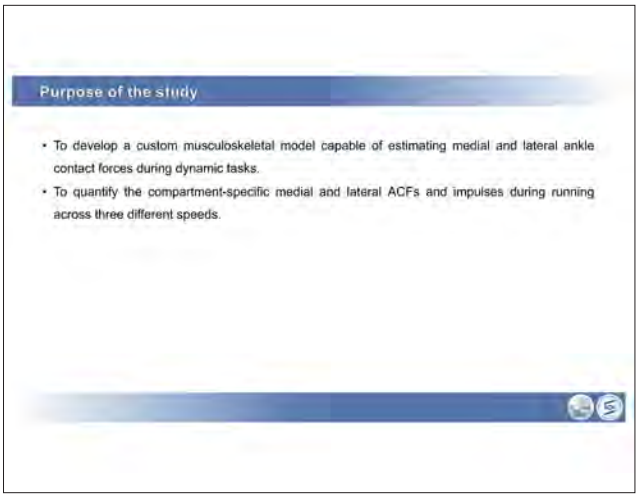
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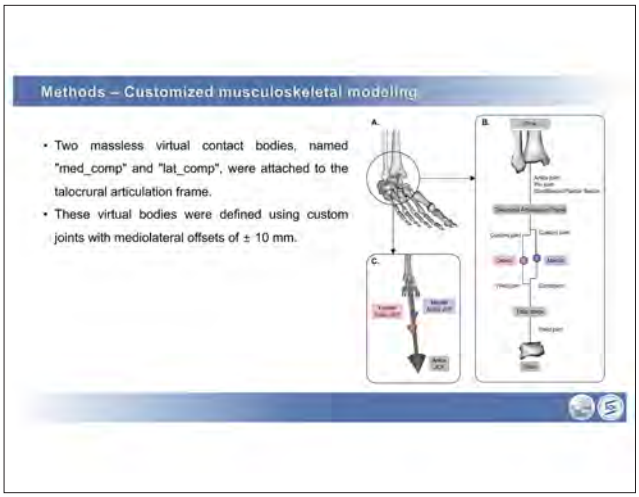
발목 내·외측 분리 모델 기반 러닝 중 발목 관절 부하 분석
Analysis of Ankle Joint Loading During Running Based on an Ankle Medial and Lateral Separation Model

순천향대학교
김 훈









Methods – Customized musculoskeletal modeling

- Two massless virtual contact bodies, named "med_comp" and "lat_comp", were attached to the talocrural articulation frame.
- These virtual bodies were defined using custom joints with mediolateral offsets of ± 10 mm.



Methods – Running data collection

- Dataset: Analyzed motion capture and ground reaction force data from the SimTK public dataset.
- Participants: 10 subjects.
- Task: Three cycles of running at speeds of 3, 4, and 5 m/s.



Results – Running data measurement

- Measurement: Motion capture, ground reaction forces.



Results – Running data analysis (OpenSim)

- Scale
- Inverse kinematics
- Residual reduction analysis
- Computed muscle control
- Joint reaction analysis

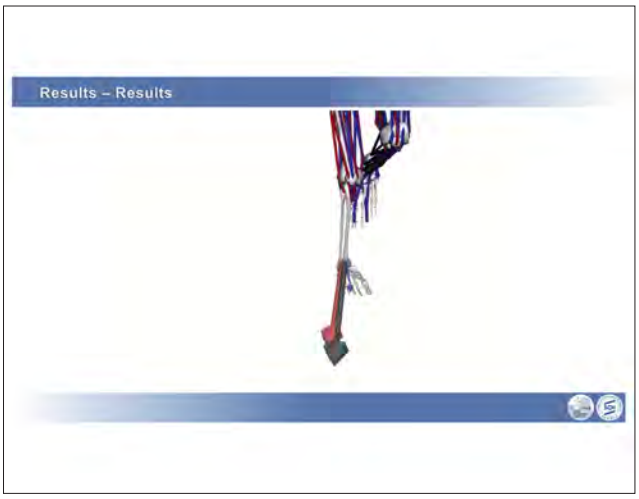
OpenSim

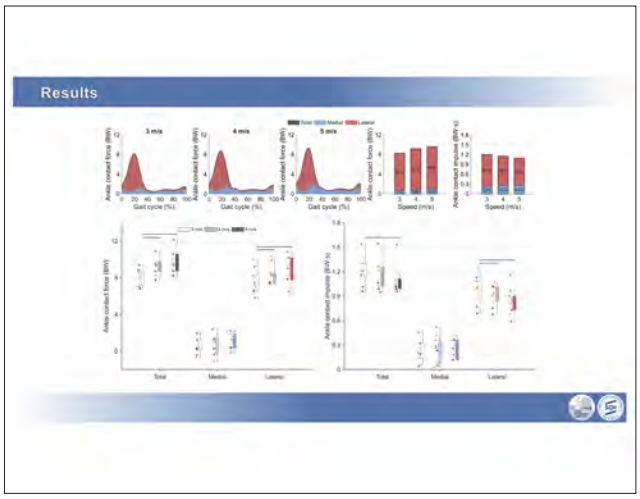
Results – Results

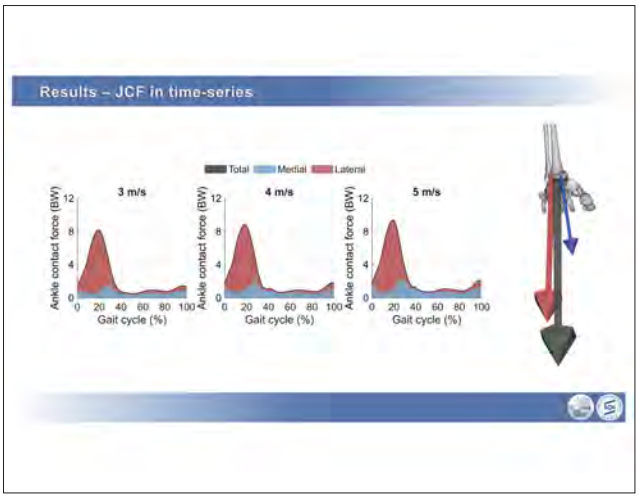


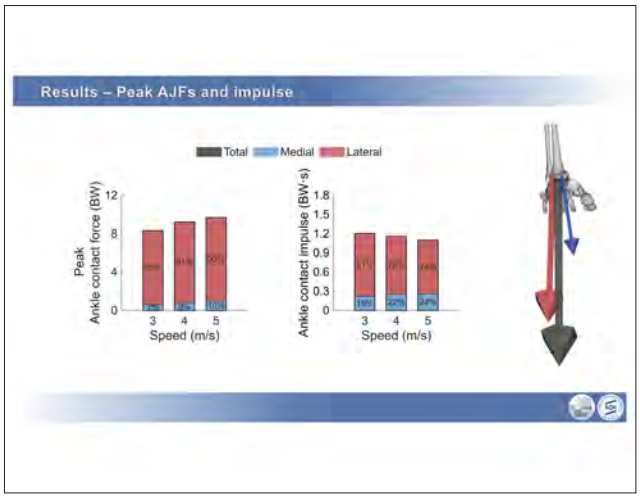
Results – Results

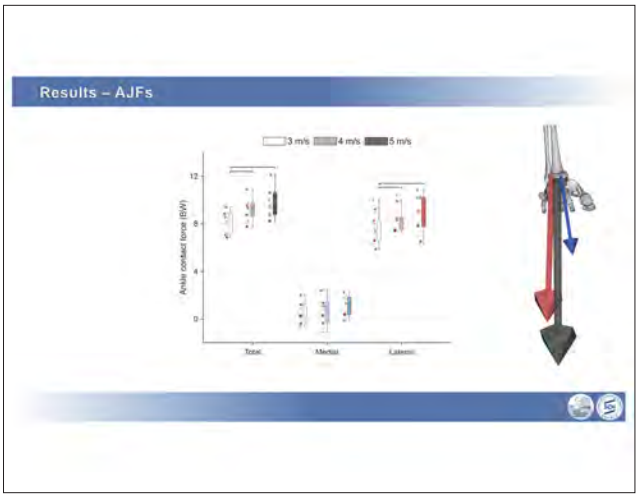


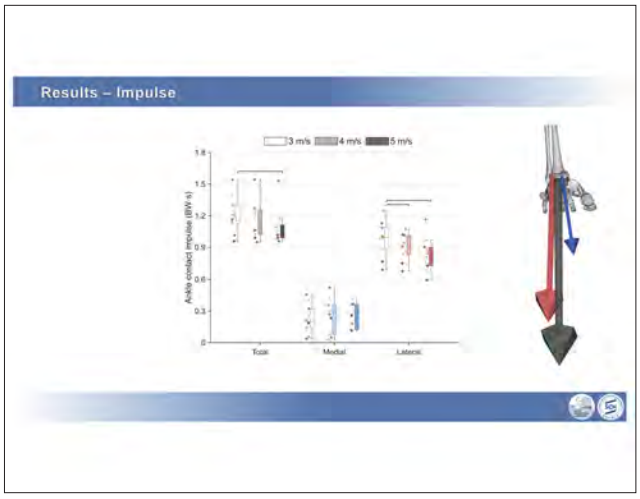

Results – Results


Results


Results – JCF in time-series
Total
Medial
Lateral
3 m/s
4 m/s
5 m/s
Ankle contact force (BW)
Gait cycle (%)


Results – Peak AJFs and impulse
Total
Medial
Lateral
Peak Ankle contact force (BW)
Ankle contact impulse (BW·s)
Speed (m/s)

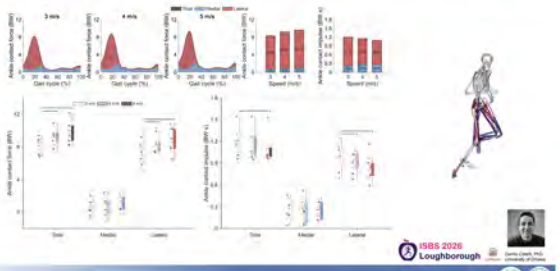

Results – AJFs
3 m/s
4 m/s
5 m/s
Ankle contact force (BW)


Results – Impulse
3 m/s
4 m/s
5 m/s
Ankle contact impulse (BW·s)

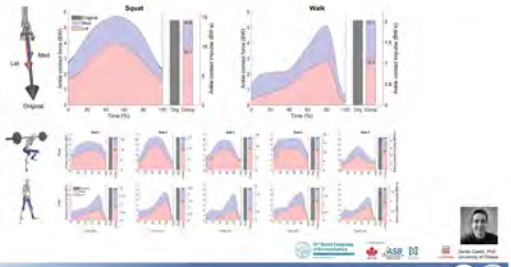
Conclusion

- Compartmentalizing the ankle joint allows for the resolution of side-specific loading patterns while preserving overall joint reaction force estimates and the integrity of the original model.
- AJFs of lateral compartment is greater than medial compartment during running and the magnitude increases as the running speed increases.
- The custom model provides a practical, computationally efficient tool for studying mediolateral ankle mechanics without the need for imaging-based simulations.

Will be presented in ...



Will be presented in ...



Kim H*, Kong T, Caleb D. (Ongoing)

Thank you!



The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

심포지엄 17: 러너를 위한 훈련 설계의 과학
The Science of Training Programs for Runners
(스포츠과학위원회 4)

좌장: 서울대학교 김연수, 계명대학교 안나영



양우휘

학력

German Sport University Cologne, Sport and Performance
German Sport University Cologne, Exercise Science and Coaching 석사
German Sport University Cologne, Exercise Science 박사

주요 경력

대한축구협회(KFA) 협력강사
Exercise Science (SCOPUS) 전문 편집위원
Physical Activity and Nutrition 편집위원
Frontiers in Physiology 편집위원
주식회사 론픽 자문교수
주식회사 뉴마핏 자문교수

현재 소속 및 직위

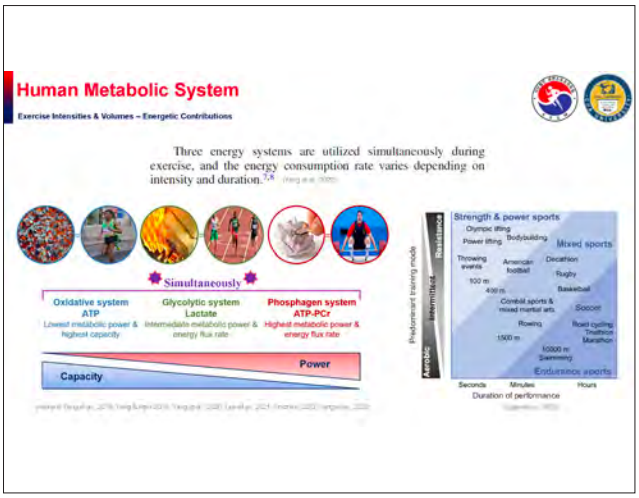
차 의과학대학교 스포츠의학대학원(부원장), 일반대학원 의학과 조교수

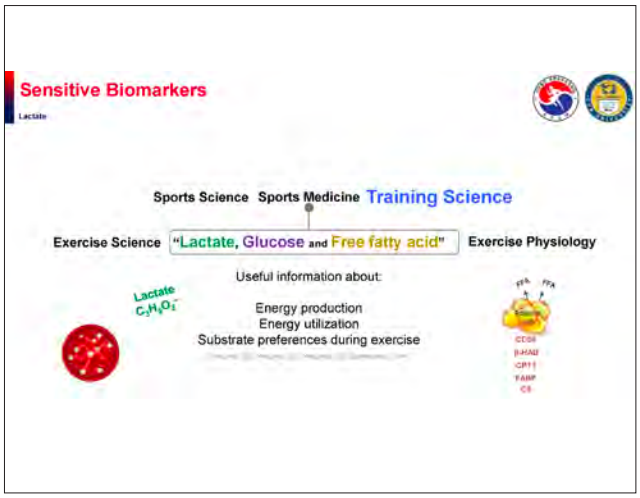
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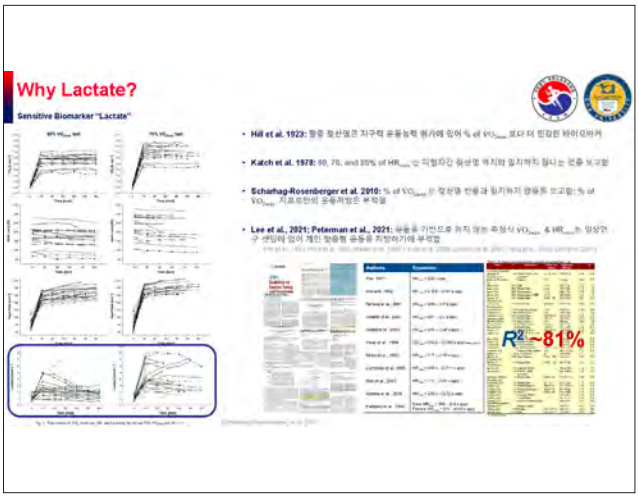
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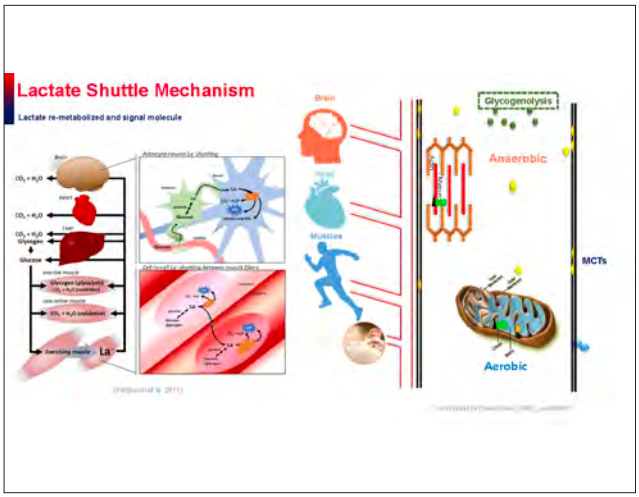
에너지대사에 기반한 맞춤형 러닝 훈련 강도 설정
Customized running training intensity setting based on energy metabolism

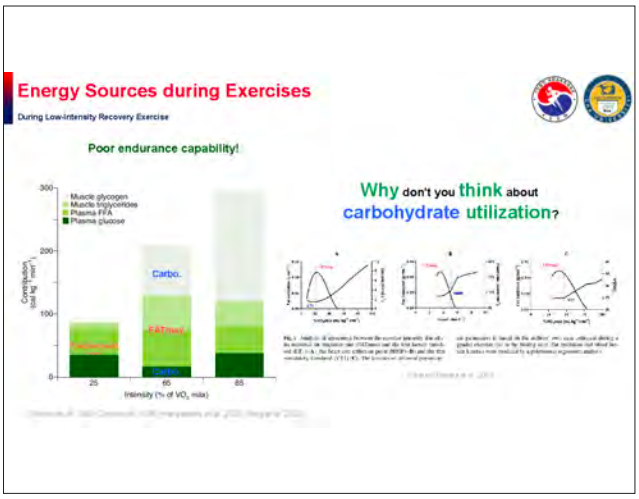
차의과학대학교 스포츠의학대학원
양우휘

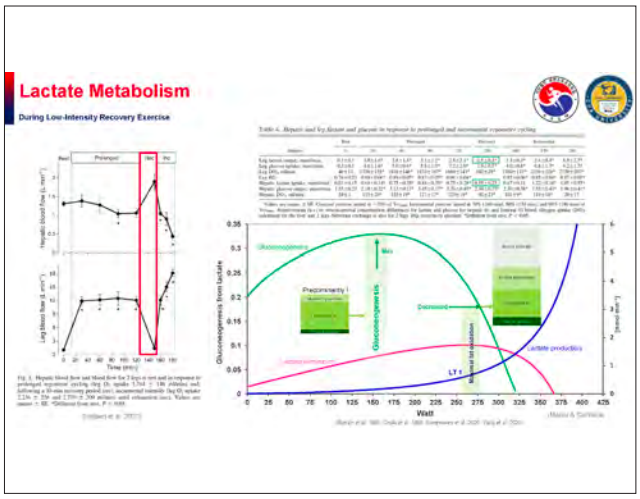


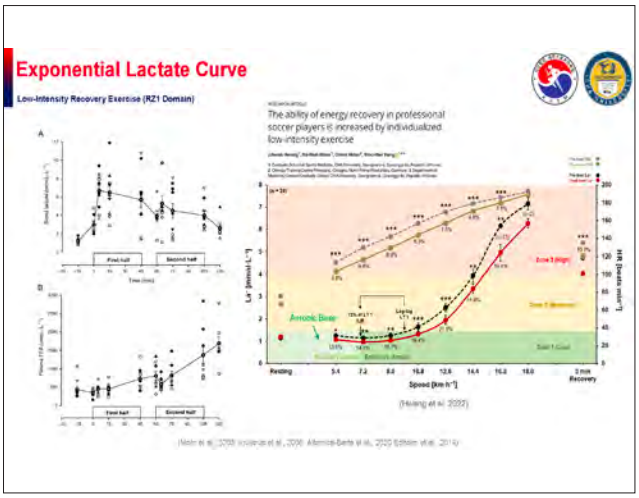


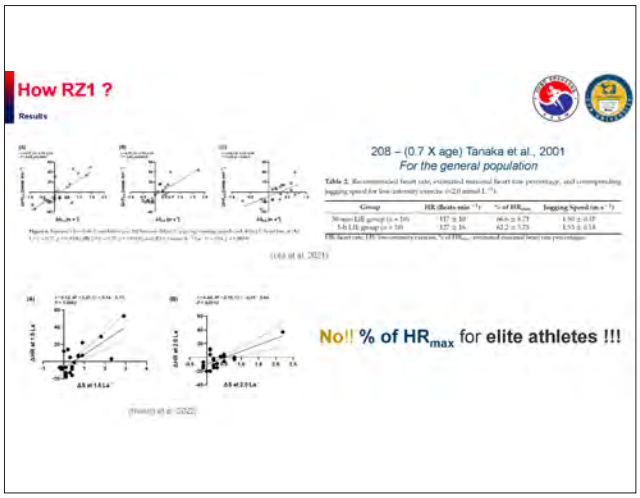


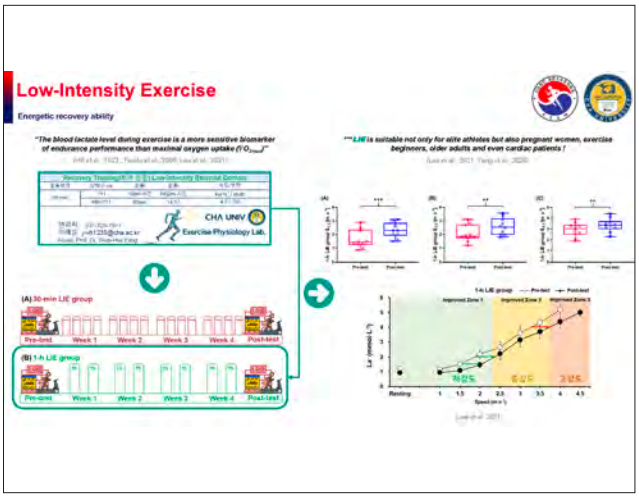


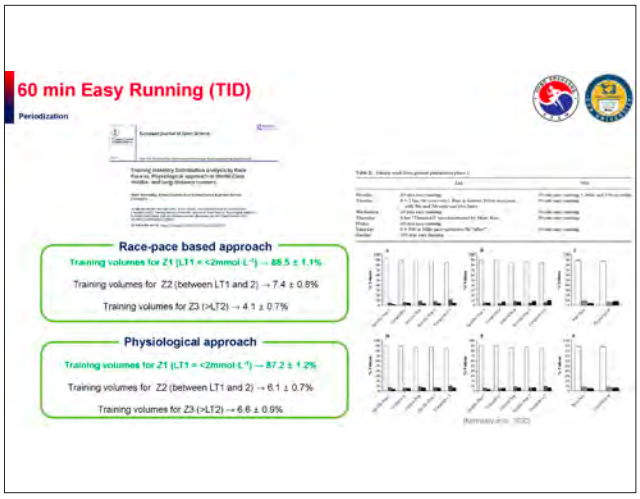

Energy Sources during Exercises
During Low-Intensity Recovery Exercise
Poor endurance capability!
Why don't you think about carbohydrate utilization?

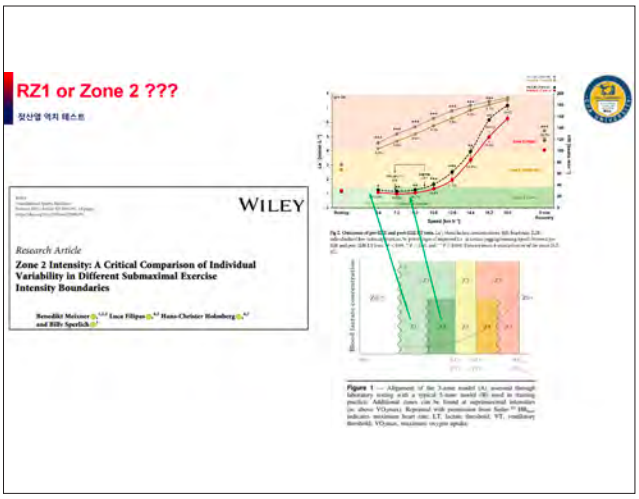

Lactate Metabolism
During Low-Intensity Recovery Exercise

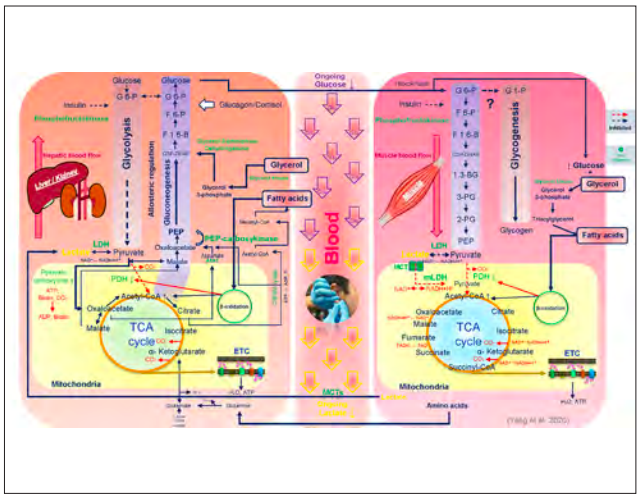

Exponential Lactate Curve
Low-Intensity Recovery Exercise (RZ1 Domain)
The ability of energy recovery in professional soccer players is increased by individualized low-intensity exercise

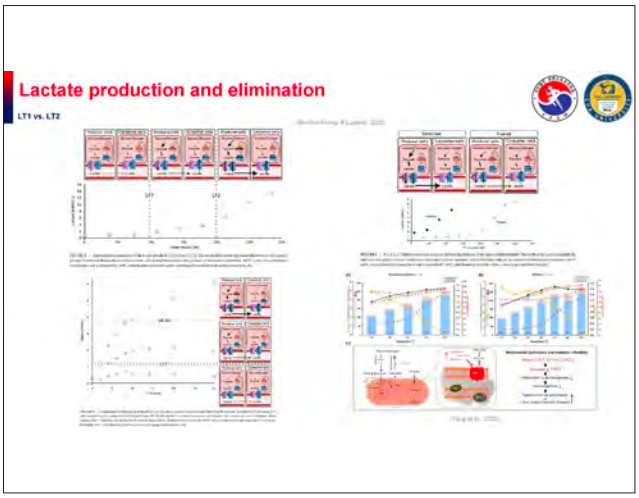

How RZ1 ?
Results
208 – (0.7 X age) Tanaka et al., 2001
For the general population
No!! % of HRmax for elite athletes !!!

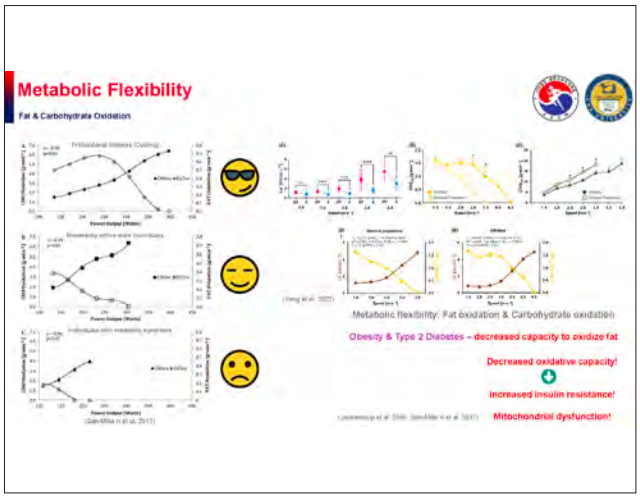

Low-Intensity Exercise
Energetic recovery ability
CHA UNIV
Exercise Physiology Lab.

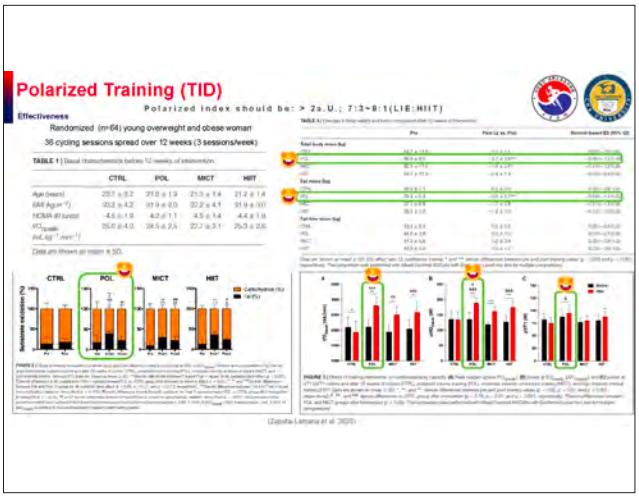

60 min Easy Running (TID)
Periodization
Race-pace based approach
Training volumes for Z1 (LT1 = <2mmol·L-1) → 88.5 ± 1.1%
Training volumes for Z2 (between LT1 and 2) → 7.4 ± 0.8%
Training volumes for Z3 (>LT2) → 4.1 ± 0.7%
Physiological approach
Training volumes for Z1 (LT1 = <2mmol·L-1) → 87.2 ± 1.2%
Training volumes for Z2 (between LT1 and 2) → 6.1 ± 0.7%
Training volumes for Z3 (>LT2) → 6.6 ± 0.9%

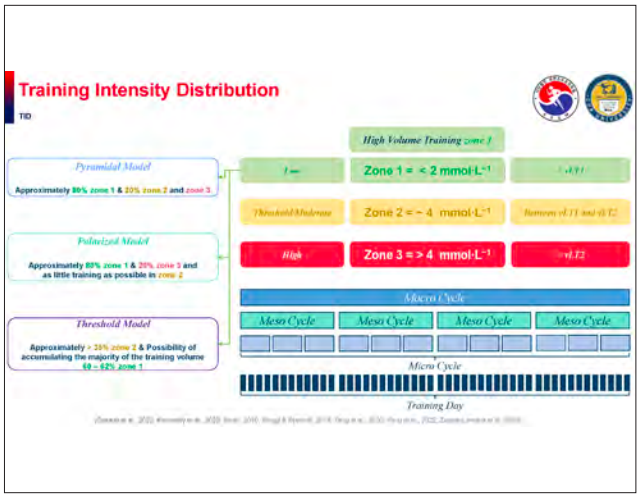

RZ1 or Zone 2 ???
젖산염 역치 테스트
WILEY
Research Article
Zone 2 Intensity: A Critical Comparison of Individual Variability in Different Submaximal Exercise Intensity Boundaries

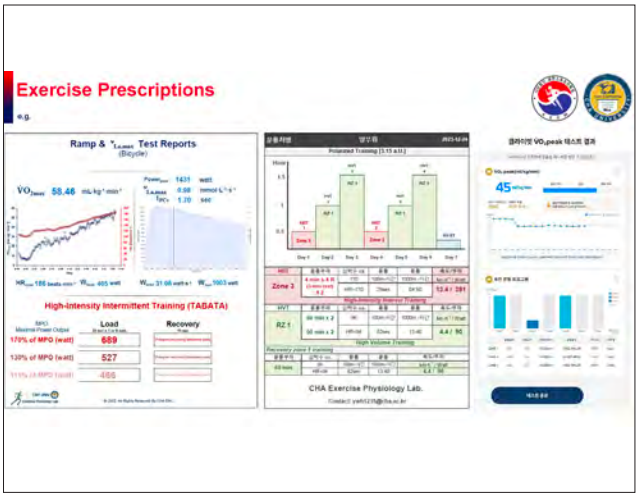

Glucose
Glycolysis
Glycogenesis
Glycerol
Fatty acids
Blood
Mitochondria
TCA cycle
ETC
Pyruvate
Lactate
Amino acids

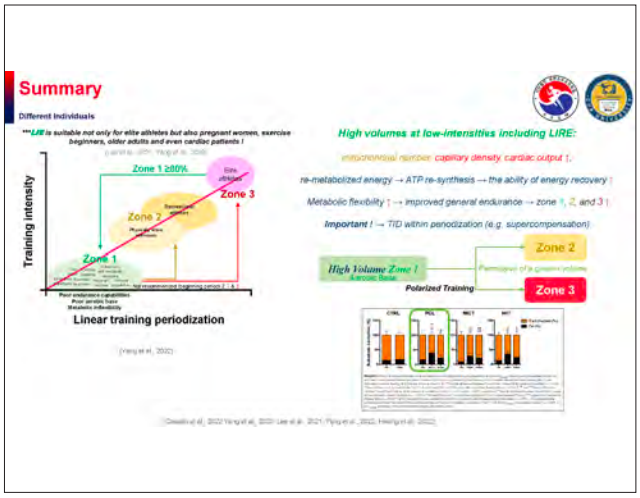

Lactate production and elimination
LT1 vs. LT2

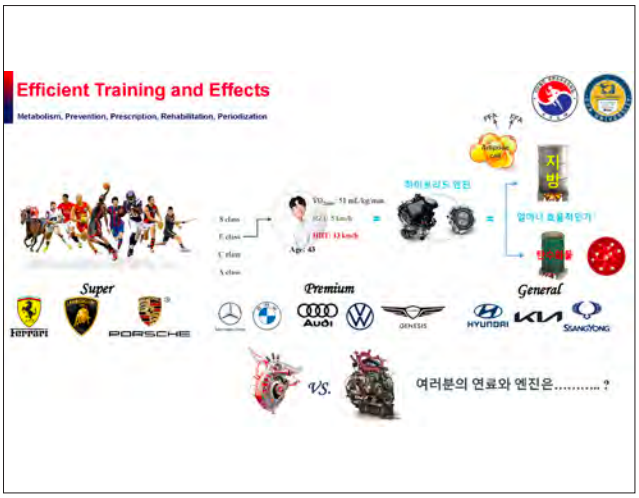

Metabolic Flexibility
Fat & Carbohydrate Oxidation
Metabolic flexibility: Fat oxidation & Carbohydrate oxidation
Obesity & Type 2 Diabetes – decreased capacity to oxidize fat
Decreased oxidative capacity!
Increased insulin resistance!
Mitochondrial dysfunction!


Polarized Training (TID)
Polarized Index should be: > 2a.U.; 7:3~8:1(LIE:HIIT)
Effectiveness
Randomized (n=64) young overweight and obese woman
36 cycling sessions spread over 12 weeks (3 sessions/week)
CTRL
POL
MICT
HIT


Training Intensity Distribution
TID
Pyramidal Model
Approximately 80% zone 1 & 20% zone 2 and zone 3
Polarized Model
Approximately 80% zone 1 & 20% zone 3 and as little training as possible in zone 2
Threshold Model
Approximately > 25% zone 2 & Possibility of accumulating the majority of the training volume 60 – 62% zone 1
High Volume Training zone 1
Zone 1 = < 2 mmol·L⁻¹
Zone 2 = ~ 4 mmol·L⁻¹
Zone 3 = > 4 mmol·L⁻¹
Micro Cycle
Meso Cycle
Micro Cycle
Training Day


Exercise Prescriptions
e.g.
Ramp & Test Reports
(Bicycle)
High-Intensity Intermittent Training (TABATA)
Load
Recovery
170% of MPO (watt)
689
120% of MPO (watt)
527
CHA Exercise Physiology Lab.


Summary
Different Individuals
Training intensity
Zone 1
Zone 2
Zone 3
Linear training periodization
High volumes at low-intensities including LIRE:
High Volume Zone 1
Polarized Training
Zone 2
Zone 3


Efficient Training and Effects
Metabolism, Prevention, Prescription, Rehabilitation, Periodization
Super
Premium
General
Ferrari
PORSCHE
AUDI
GENESIS
HYUNDAI
KIA
SSANGYONG
VS.
여러분의 연료와 엔진은..... ?


Our Scientists
What's our goal?
UNIVERSITÄT WÜRZBURG
Universidade de São Paulo
한국형 ARPA-H 프로젝트 사업단
Our Research Group
Thank you for your attention.

이승엽

학력

서울대학교 일반대학원 건강운동과학 스포츠의학 박사

주요 경력

현 보건복지부 국립재활원 자문위원

현 대한산학스키협회 경기력향상위원

전 부천FC프로축구단, 충주험멜프로축구단 의무위원

전 고양 오리온스 프로농구단 의무위원

현재 소속 및 직위

가톨릭관동대학교 스포츠재활의학과 교수

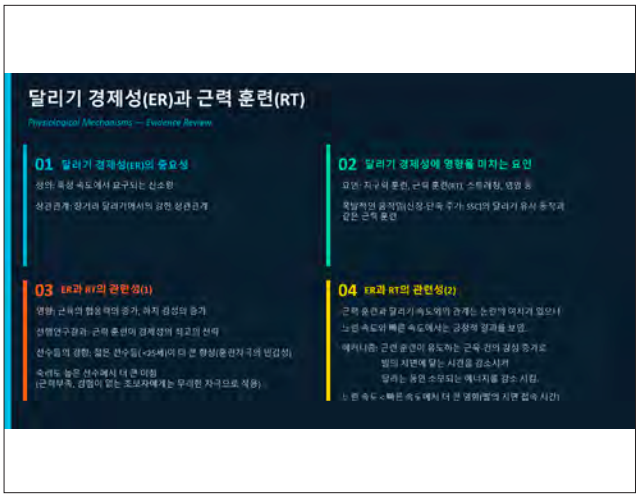
러너를 위한 근력 운동프로그램
Strength Training Program for Runners

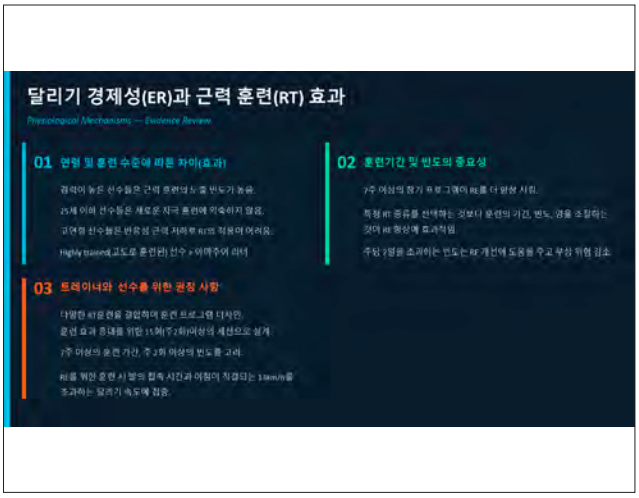
가톨릭관동대학교
이승엽



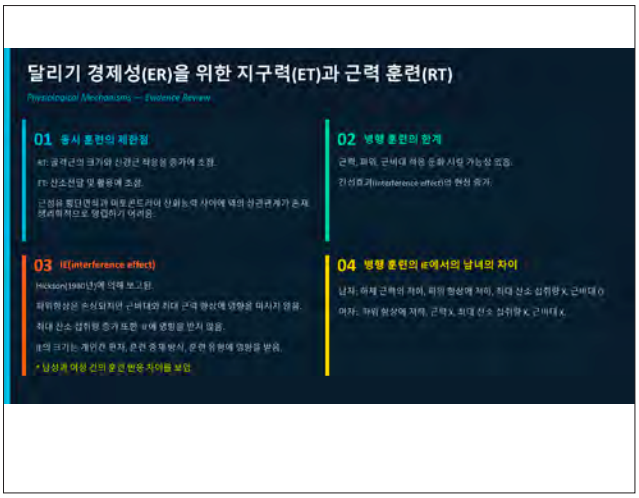






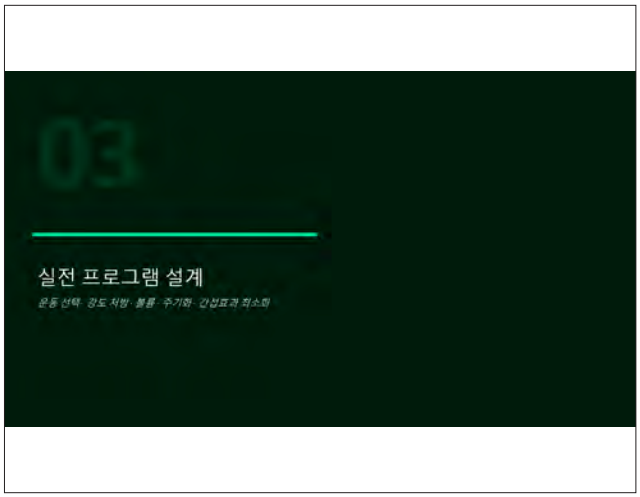

달리기 경제성(ER)과 근력 훈련(RT) 효과
Physiological Mechanisms — Evidence Review
01 연령 및 훈련 수준에 따른 차이(효과)
경력이 높은 선수들은 근력 훈련빈도 및 빈도가 높음.
25세 이하 선수들은 새로운 자극 훈련에 익숙하지 않음.
고연령 선수들은 반응성 근력 차이로 RTS 적용이 어려움.
Highly trained(고도로 훈련된) 선수 > 아마추어 러너
02 훈련기간 및 빈도의 중요성
7주 이상의 장기 프로그램이 8주로 더 효과 시킴.
특정 RT 종류를 선택하는 것보다 훈련의 기간, 빈도, 강도를 조절하는 것이 RE 향상에 효과적임
주당 2일을 초과하는 빈도는 RE 개선에 도움을 주고 부상 위험 감소
03 트레이너와 선수를 위한 권장 사항
다양한 RT운동을 결합하여 훈련 프로그램 디자인.
훈련 효과 극대화를 위한 15회(주 2회)이상의 세션으로 설계.
7주 이상의 훈련 기간, 주 2회 이상의 빈도를 고려.
RE를 위한 훈련 시 발의 접촉 시간과 이륙이 직결되는 13m/s를 초과하는 달리기 속도에 집중.


왜 러너들은 근력훈련을 안 하는가?
Common Misconceptions in Running Community
01
"근육이 커지면 무거워져서 느려진다"
현실: 근비대 없는 신경근 적응의 목표
고강도 저반복(≥6RM) 훈련은 근비대 없이 RFD 및 RE 개선
02
"유산소 훈련만 해도 충분하다"
현실: VO2max는 훈련 한계 요인 있음.
근력훈련은 러닝 이코노미를 독립적으로 개선 — 유산소성 훈련과 근력 훈련은 완전히 다른 메커니즘
03
"근력훈련은 부상 위험을 높인다"
현실: 근력 훈련을 참여한 대상자들은 부상 위험이 낮은 경향을 보임.
(Desai et al., 2023; Leppänen et al., 2024)


달리기 경제성(ER)을 위한 지구력(ET)과 근력 훈련(RT)
Physiological Mechanisms — Evidence Review
01 동시 훈련의 제한점
AT: 골격근의 크기와 신경근 적응성 증가에 초점.
ET: 산소전달 및 활용에 초점.
근섬유 횡단면적과 미토콘드리아 산화능력 사이에 역의 상관관계가 존재. 생리학적으로 양립하기 어려움.
02 병행 훈련의 한계
근력, 파워, 근비대 적응 둔화 시킬 가능성 있음.
간섭효과(interference effect)의 현실 증거.
03 IE(interference effect)
Hickson(1980년)에 역학 보고됨.
파워향상은 손상되지만 근비대와 최대 근력 향상에 영향을 미치지 않음.
최대 산소 섭취량 증가도 RE에 영향을 받지 않음.
IE의 크기는 개인간 편차, 훈련 중재방식, 훈련 유형에 영향을 받음.
* 남성과 여성 간의 훈련반응 차이를 보임
04 병행 훈련의 RE에서의 남녀의 차이
남자: 하체 근력의 차이, 파워 향상에 차이, 최대 산소 섭취량 X, 근비대 O
여자: 파워 향상에 차이, 근력 X, 최대 산소 섭취량 X, 근비대 X


02
생리학적 기전
근력트레이닝이 러닝 퍼포먼스를 향상시키는 과학적 메커니즘


근력트레이닝의 4가지 핵심 기전
Physiological Mechanisms — Evidence Review
01 건(Tendon) Stiffness 증가
탄성에너지 저장·반환 효율 증가
→ 추진력 개선, 산소비용 감소
(Achilles tendon stiffness ↑)
02 신경근 효율 향상
운동단위 동원 패턴 최적화
RFD (Rate of Force Development) ↑
지근 속근 협응 개선
03 근섬유 유형 전환 억제
느린 피로 유발 섬유 유지
Type IIx → IIa 전환
(지구력 근섬유 보존)
04 보행 역학 최적화
착지 충격 흡수 능력 ↑
Ground Contact Time ↓
Vertical oscillation ↓


03
실전 프로그램 설계
운동 선택 · 강도 처방 · 볼륨 · 주기화 · 간섭효과 최소화

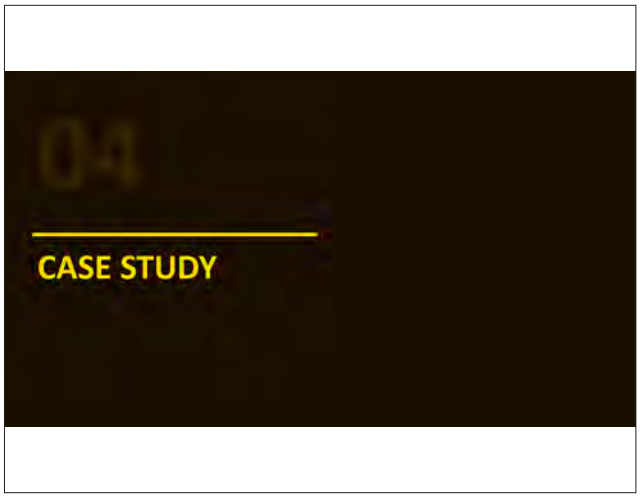

트레이닝 방법 선택 원칙
Training Modality Selection — Evidence-Based Priority
★★★
Heavy Resistance Training
Protocol
85-95% 1RM
2-4 Sets × 2-5 Rep
RFD 극대화 목표
효과
RE 향상 효과 최대
신경근 효율 증심
근비대 최소화
★★★
Plyometric Training
Protocol
체중~부가중
Jump/Hop/Bound
탄성 사이클 중심
효과
건 강성 개선 탁월
보행역학 향상
입문자 부상주의
★★
Submaximal Strength
Protocol
60-80% 1RM
3-4 Sets × 8-12 Rep
근지구력 목표
효과
RE 향상 효과 제한적
기초 근력 단계에 유효
비시즌 초반 적합
★★
Isometric Training
Protocol
최대 자의적 수축
벽 스쿼트/힐레이즈
건 병변 재활 적합
효과
부상 회복 국면 유용
통증 억제 효과
기능적 전이 확인 필요


훈련설계 가이드라인
Prescription Guidelines — Intensity, Volume, Frequency, Timing etc.
강도 (Intensity)
85–95% 1RM
RIR 0–2
24RM 초과 시 효과 ↓
(Elhara et al. 2022)
볼륨 (Volume)
2–4 Sets
주 2–3세션
강도와 볼륨 = 피로 누적
러닝 간섭효과 주의
기간 (Duration)
최소 8–12주
최적 12–16주
6주 미만 효과 불명확
유지기 전환 필요
타이밍 (Timing)
러닝 후 6–8시간
또는 non-running day
동일 세션 시
러닝 선행 권장
빈도 (Frequency)
주 2회 (비시즌)
주 1–2회 (시즌 중)
시즌 중 최소 주 1회
유지로도 효과 보존
점진성 (Progression)
4주 단위 부하 증가
Deload 1주 삽입
통증 자극 지속 × 악화 징후

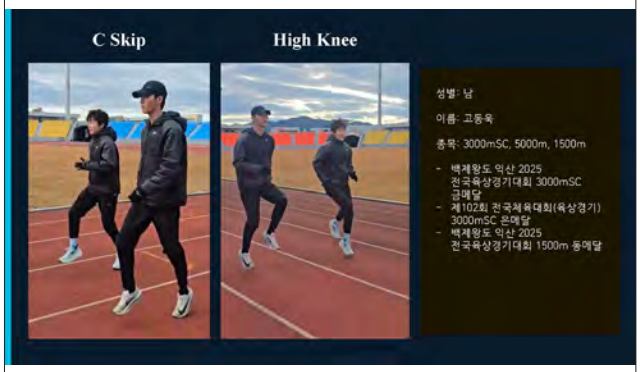

주기화 (Periodization)
Annual Plan — Aligning Strength with Running Training Cycle
OFF-SEASON
비시즌
• 목표: 기초 근력 구축
• 방법: Submaximal + Hypertrophy
• 강도: 60–80% 1RM
• 볼륨: 높음 (3–4 Sets × 8–12)
• 러닝: 낮은 훈련량
PRE-SEASON
준비기
• 목표: 최대 근력 → RFD 전환
• 방법: Heavy Resistance
• 강도: 85–95% 1RM
• 볼륨: 중간 (3 Sets × 3–5)
• 러닝: 증가 시작
IN-SEASON
시즌 중
• 목표: 근력 파워 유지
• 방법: Plyometric + Heavy 유지
• 강도: ≥85% 1RM
• 볼륨: 낮음 (2 Sets × 3–5)
• 러닝: 최고 훈련량
TAPER
테이퍼
• 목표: 신경근 각성 유지
• 방법: Explosive / 점프
• 강도: 유지 (감소 ×)
• 볼륨: 최소 (1–2 Sets)
• 러닝: 대폭 감소
Taper: 대회나 테스트 직전 훈련량을 의도적으로 줄여서 컨디션을 최고로 끌어올리는 단계

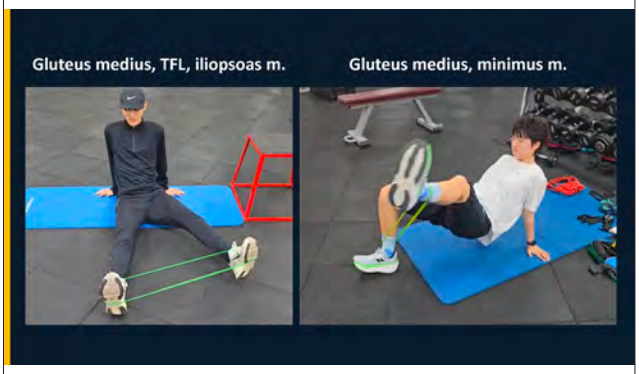

운동 선택 가이드
Exercise Selection by Running-Specific Demand
Hip & Knee Extension 엉덩이·무릎 신전
Back Squat / Front Squat
Deadlift / Romanian DL
Leg Press (입문자)
Bulgarian Split Squat
→ 추진 국면 지면 반력 생성
Ankle / Calf Complex 발목·종아리
Single-leg Calf Raise
Seated Calf Raise
Plyometric Ankle Hop
Pogo Jump
→ Achilles tendon stiffness 향상
Hip / Glute Stability 고관절 안정화
Hip Thrust / Glute Bridge
Lateral Band Walk
Single-leg RDL
Clamshell (Hip abduction)
→ 골반 안정화 진균인대 보호
Core / Anti-Rotation 코어 강화
Plank (RKC 변형)
Pallof Press
Dead Bug
Copenhagen Adduction
→ 에너지 누출 방지, 자세 유지


간섭효과 (Interference Effect) 최소화 전략
Concurrent Training Optimization
간섭효과란?
유산소 지구력 + 근력 동시 훈련 시, 분자 신호 경로(AMPK ↔ mTOR) 경쟁으로 인해 근력 적응이 억제될 수 있음.
그러나 러너에게는 근비대가 목표가 아니므로
신경근 적응 수준에서의 간섭효과는 임상적으로 크지 않음.
타이밍 분리
러닝과 근력운동 사이 최소 6–8시간 확보
불가시: 러닝 → 근력 순서 권장(예순 대비 피로 감소)
요일 분리
고강도 러닝 세션과 근력 세션은 다른 날 배치
특히 장거리 LSD 후 근력 세션 금지
시즌 조정
시즌 중: 볼륨 40–50% 감소, 강도 유지
완전 중단 시 6주 내 신경근 적응 소실
영양 전략
근력 세션 후 단백질 0.3 g/kg 즉시 섭취
탄수화물 공동 섭취로 mTOR 경로 자원

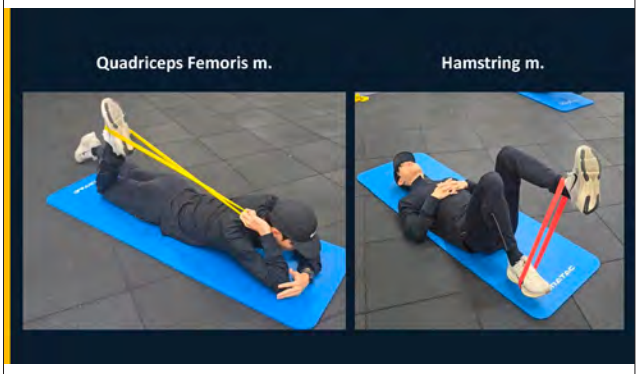

04
CASE STUDY

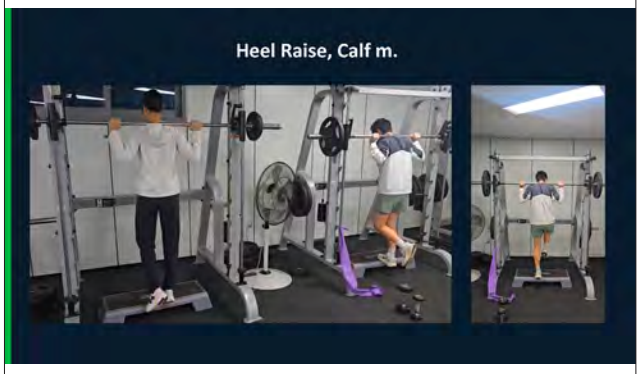

A Skip
B Skip
성별:여
이름: 최수아 선수
종목: 3000mSC
- 105회 전국체육대회 3위
- 제 26회 아시아육상선수권대회 3000mSC 국가대표 선수
- 2025 구미아시아 육상선수권대회 최종 선발 대회 2위
- 제 79회 전국육상선수권대회 1위
*부상이 많은 선수였으나 컨디셔닝으로 부상을 극복한 후 최고기록을 냄.


C Skip
High Knee
성별: 남
이름: 고동욱
종목: 3000mSC, 5000m, 1500m
- 백제왕도 익산 2025 전국육상경기대회 3000mSC 금메달
- 제102회 전국체육대회(육상경기) 3000mSC 은메달
- 백제왕도 익산 2025 전국육상경기대회 1500m 동메달

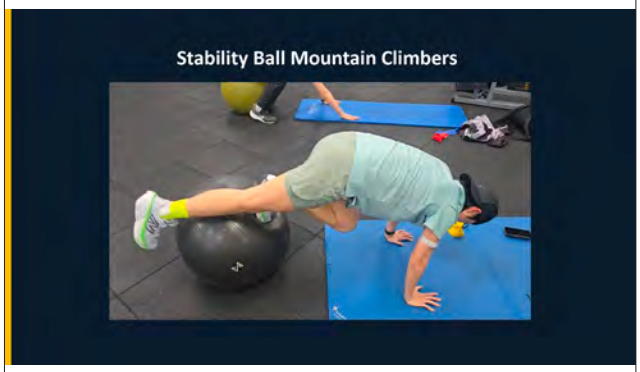

Gluteus medius, TFL, iliopsoas m.
Gluteus medius, minimus m.

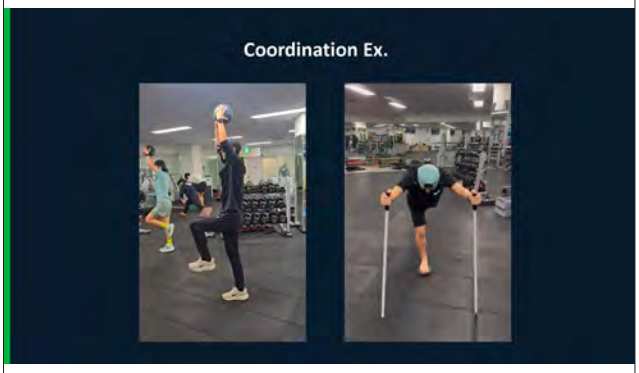

Gluteus medius, TFL m.


Quadriceps Femoris m.
Hamstring m.


Heel Raise, Calf m.

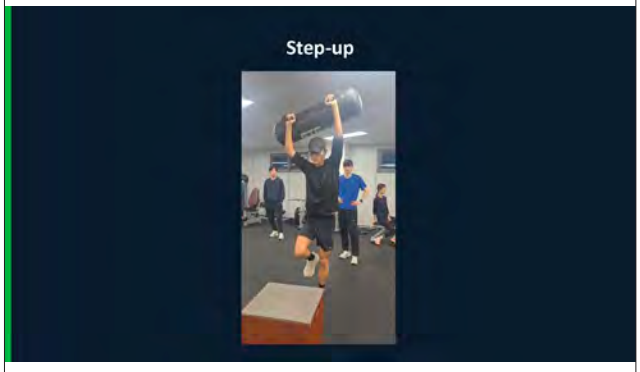

Quadriceps & Hamstring

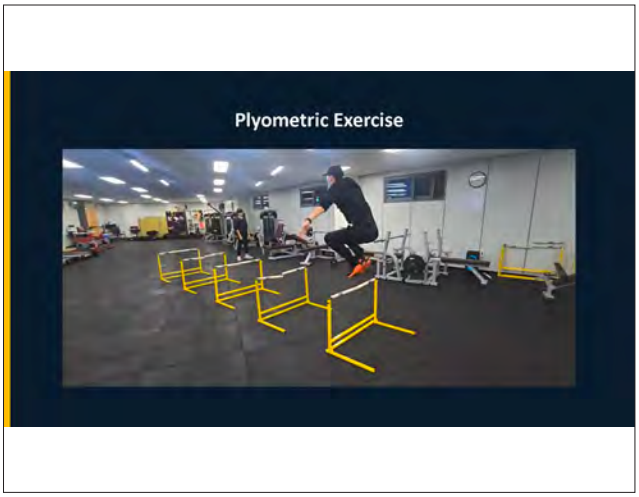

Stability Ball Mountain Climbers

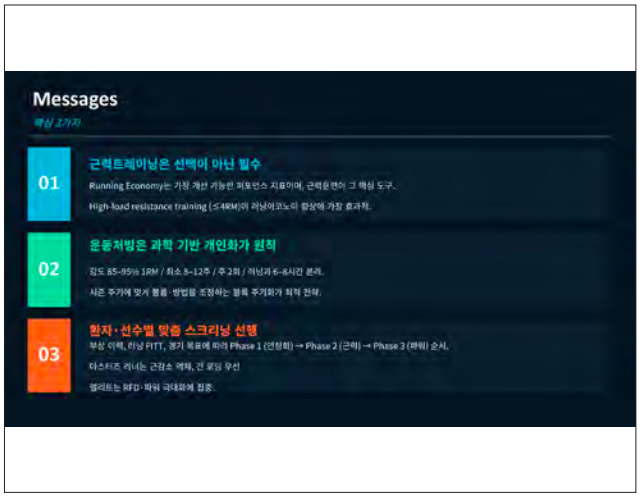

Coordination Ex.

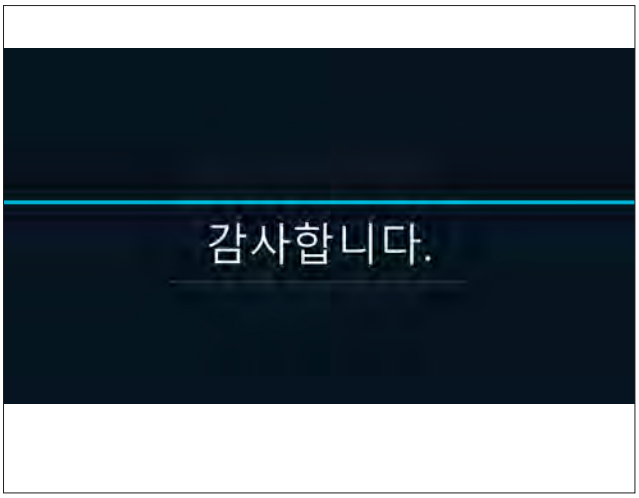

Coordination Ex.


Coordination Ex.


Step-up


Plyometric Exercise


Messages
01
02
03


감사합니다.

김희재

학력

아주대학교 공과대학 생명공학과 학사

아주대학교 의과대학 의학과 신경생리학 석사

서울대학교 사범대학 체육교육과 운동생리학 박사

주요 경력

현, 광운대학교 스포츠융합과학과 겸임교수

현, LPGA, KLPGA 프로골프 선수 영양 컨설팅

현, AI 기반 선수 컨디션 분석 플랫폼 개발

전, 프로야구/프로축구 선수단 영양 교육 및 컨설팅

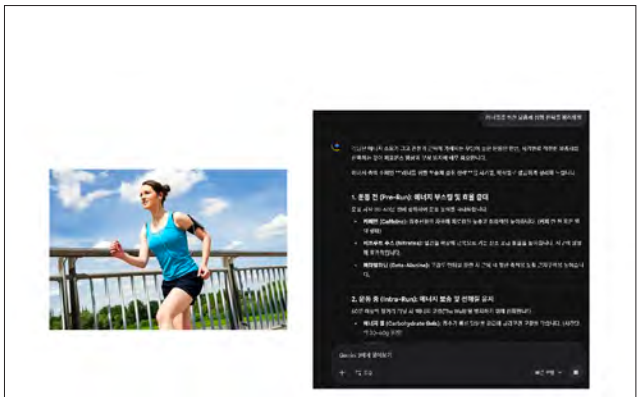
현재 소속 및 직위

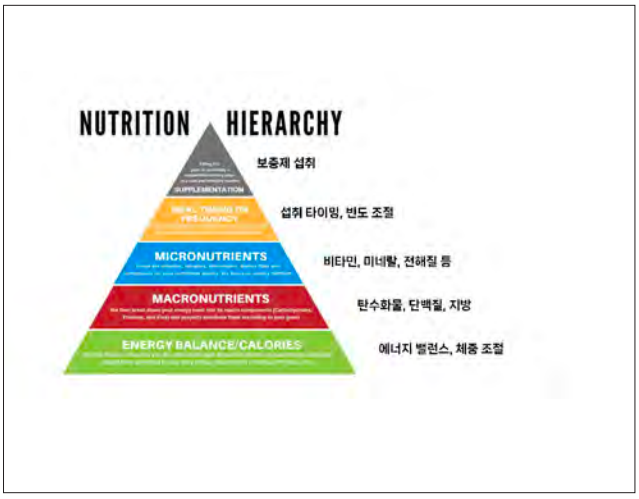
현, ㈜엔루틴 대표이사

러너를 위한 보충제 섭취 전략
Supplement Intake Strategy for Runners

엔루틴연구소
김희재

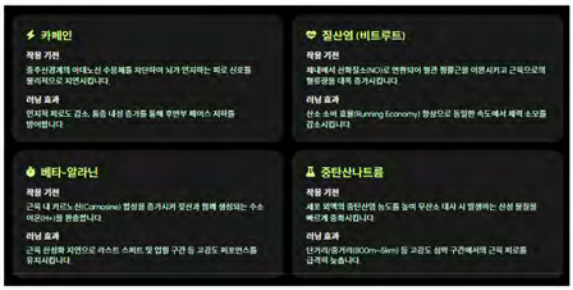






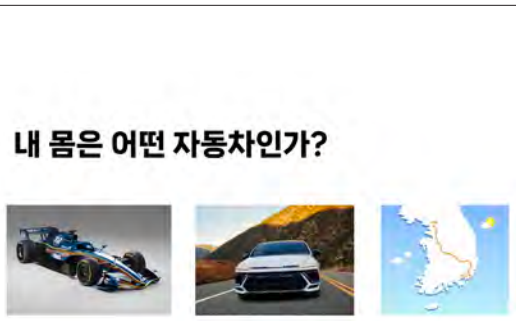



Level A
검증
보충제
수많은 임상 연구들 통해 그 효과와
안전성이 확실하게 입증된 퍼포먼스 향상
핵심 성분 4가지입니다.
카페인
Caffeine
인지적 피로 감소 및 통증 지각 완화
운동 30~60분 전 체중 1kg당 3~6mg
섭취를 권장합니다.
질산염
Nitrate / Beetroot
혈관 확장으로 산소 공급 효율 증가
운동 2~3시간 전 비트 주스/질산염
310~560mg을 섭취하세요.
베타-알라닌
Beta-Alanine
근육 산성화 지연 및 고강도 스피트
향상 예상 3.2~6.4g씩 2~4주 이상
꾸준한 로딩이 필수적입니다.
중탄산나트륨
Sodium Bicarbonate
혈액 완충 능력 향상으로 산성 물질
증폭. 5km 이내 고강도에 탁월하나
위장 장애에 주의해야 합니다.


카페인
작용 기전
중추신경계의 아데노신 수용체를 차단하여 뇌가 인지하는 피로 신호를
둔화적으로 지연시킵니다.
리뷰 효과
인지적 피로도 감소, 통증 내성 증가를 통해 후반부 페이스 저하를
방어합니다.
질산염 (비트루트)
작용 기전
체내에서 산화질소(NO)로 변환되어 혈관 평활근을 이완시키고 근육으로의
혈류량을 대폭 증가시킵니다.
리뷰 효과
산소 소비 효율(Running Economy) 향상으로 동일한 속도에서 체감 소모를
감소시킵니다.
베타-알라닌
작용 기전
근육 내 카르노신(Carnosine) 합성을 증가시켜 젖산과 함께 생성되는 수소
이온(H+)을 완충합니다.
리뷰 효과
근육 산성화 지연으로 랙스트 스피트 및 업힐 구간 등 고강도 퍼포먼스를
유지시킵니다.
중탄산나트륨
작용 기전
세포 외액의 중탄산염 농도를 높여 무산소 대사 시 발생하는 산성 물질을
빠르게 중화시킵니다.
리뷰 효과
단거리(중거리(800m~5km) 등 고강도 심박 구간에서의 근육 피로를
급격히 늦춥니다.


필수 영양 보충 (Sports Foods)
성능을 직접적으로 향상시키는 부스터는 아니지만, 지구력 운동 선수에게 반드시 기본적으로 채워져야 하는 필수
리스트입니다. 균형 잡힌 식단과 함께 적절한 타이밍에 섭취하세요.
성분
주요 역할
권장 섭취 타이밍
탄수화물 (Carbohydrates)
근육 글리코겐 고갈 방지 및 지속적인 에너지 유지
운동 중 (시간당 30~60g 보충)
전해질 (Electrolytes)
체내 수분 균형 유지 및 땀 배출로 인한 근육 경련 방지
1시간 이상 장거리 주행 및 고온 환경 시
단백질 (Protein)
미세한 근육 손상 회복 및 운동 후 신체 적응 촉진
운동 종료 후 1시간 이내 (기회의 창)
철분 (Iron)
산소 운반(헤모글로빈) 핵심 성분 (특히 여성 러너 필수 체크)
평상시 꾸준한 식단 및 필요 시 보충제

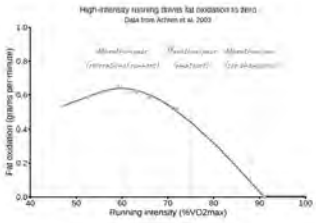

GU
CLIF
ION
토레타


내 몸은 어떤 자동차인가?


내 몸은 어떤 연료를 쓰고 있나?
구분
저장 위치
에너지 보유량
특징
탄수화물
근육 · 간
(글리코겐)
약 <3,000 kcal
한계 명확, 고갈 시
퍼포먼스 급락
탄수화물
지방
체지방
(조직)
100,000 kcal 이상
대용량 저장,
저장도/장거리의 핵심
지방

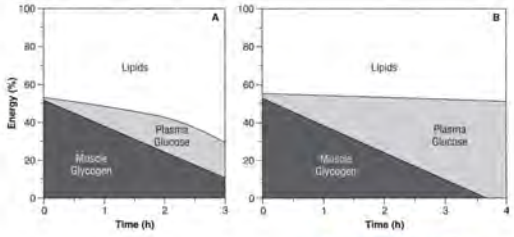
▶ **Table 13.2** Energy Sources in Running Events

Distance (m)	Time (s)[a]	Speed ($m \cdot s^{-1}$)	Contribution of energy systems (%)[b]		
			ATP-CP	Lactate	Oxygen
100	9.77	10.24	39	56	5
200	19.32	10.35	30	55	15
400	43.18	9.26	17	48	35
800	101.11	7.91	9	33	58
1,500	206	7.28	4	20	76
5,000	759.36	6.58	1	6	93
10,000	1,582.75	6.32	1	3	96
42,195	7,538	5.60	0	1	99

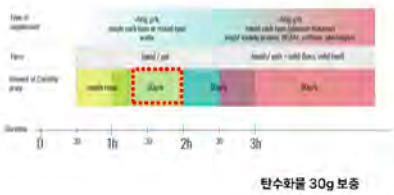




훈련/영양 섭취의 전략은 무엇일까요?

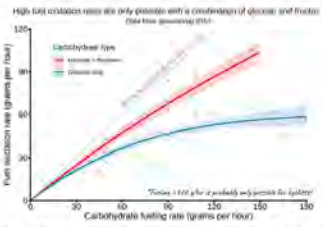


Carbohydrate loading



탄수화물 30g 보충

- 바나나 중간 크기 (120g) 1개 정도
- 스포츠음료 500 ml
- 에너지 젤 1포~1포 반



- 이는 동일한 양의 탄수화물을 먹더라도 포도당과 과당 복합 섭취가 몸에서 실제로 연료로 사용하는 양을 훨씬 더 많게 만든다는 것을 의미합니다.
- Glucose-fructose mix는 분당 1g(시간당 60g)의 섭취량을 초과해도 곡선이 계속 상승하여, 분당 1.5g(시간당 90g) 이상의 더 높은 연료 산화 속도를 달성합니다.

에너지 젤 섭취 시 주의할 점

섭취법 현상 방지

반드시 수분과 함께 섭취

- 에너지 젤은 농도가 매우 높은 '고장성' 액체에 해당
- 물 없이 먹으면 위장이 농도를 맞추기 위해 체내 수분을 오히려 장으로 끌어당겨 탈수와 위장 경련을 유발 합니다.
- 반드시 종이컵 1-2잔의 물과 함께 섭취

탄수화물 수송체 한계

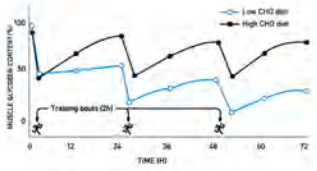
사전 위장 적응 훈련

- 장에서 당분을 흡수하는 수송체의 개수는 한정되어 있음
- 평소 러닝 중 젤을 먹어보지 않으면, 흡수되지 못한 당분이 장에 남아 방귀 (복부팽만, 설사 등)
- 사전 훈련을 통해 장을 적응한 후 적응해야 함
- 다른 업로도 흡수되는 다중 수송 탄수화물 제품은 위장 부담을 줄이는데 도움

카페인 포함 에너지 젤

카페인 누적 용량 확인

- 카페인은 체내 3-5시간 이상 작용
- 카페인이 포함된 젤을 반복적으로 섭취하면 체내 과다 축적 가능성 있음
- 심박수 급증, 불안, 두근거림이 발생 할 수 있음





요약 및 정리

보충제 섭취 이전에 명확한 목적 설정이 우선입니다.

- 모두에게 똑같이 적용되는 만병한 정답은 없습니다.
- 단순한 유행, 엘리트 선수의 가이드를 맹목적으로 따라하기 보단,
  자신의 체력 상태와 명확한 훈련 목적 (기록, 건강체력향상, 지방대사 촉진 등)을 명확히 파악하고
  그에 맞는 훈련/영양 전략을 유연하게 수립해야 합니다.
- 기본을 간과한 보충제는 일빠진 독에 물 붓기 입니다.
- 칼로리 밸런스, 3대영양소, 미세영양소를 잘 채우기 위한 식사/간식이 우선입니다.

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

3월 22일(일요일)

Room B



The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

우수구연

좌장: 동아대학교 이종화, 동아병원 심상돈



초기 급성 외측 발목 염좌 후 보존적 치료 실패의 위험 인자: 전향적 코호트 연구

Risk Factors for Failed Conservative Treatment After First-Time Acute Lateral Ankle Sprain: A Prospective Cohort Study

분당차병원

이성현

목적

The open modified Broström-Gould procedure is widely accepted as the reference standard for lateral ankle stabilization. However, there is a lack of research comparing the outcomes of arthroscopic repair and open repair procedures for chronic ankle instability (CAI), despite the increasing number of publications on arthroscopic repair of the anterior talofibular ligament (ATFL).

대상 및 방법

We prospectively randomized 64 patients who underwent ligament repair surgery for CAI into two groups: arthroscopic LLC repair (group A, 33 patients) and open modified Broström-Gould procedure (group O, 31 patients). High-demand patients, as determined by a Tegner Activity level ≥ 6, with CAI were included. Subjective outcomes were measured using the pain visual analog scale, American Orthopaedic Foot & Ankle Society score, Foot and Ankle Outcome Score, and the Karlsson Ankle Function Score. Posturographic analysis was performed using a Tetrax device as an objective outcome. Radiologic evaluations were conducted preoperatively and at 2 years postoperatively using stress radiographs and axial view magnetic resonance imaging (MRI). A subgroup analysis was also performed according to arthroscopic ligament quality (excellent to fair vs. poor).

결과

Both groups showed significant improvements in all clinical scores, objective posturography results, and stress radiographs at 2 years postoperatively (all p < 0> 0.05). Additionally, we identified 5 cases of retear (7.8%) based on postoperative MRI evaluation (9.1% [3/33] in group A and 6.5% [2/31] in group O). One patient in group O experienced postoperative soft tissue infection. However, there were no significant

differences between the two groups ($p > 0.05$). There was no difference in clinical results between each group in subgroup analysis according to ligament quality ($p > 0.05$).

결론

Arthroscopic LLC repair produced similarly favorable outcomes when compared with open lateral ankle ligament repair. In addition, arthroscopic LLC repair, as a minimally invasive technique, provide comparable outcomes to open procedure, even when the ligament tissue was poor.

외측주를 침범한 소두 박리성 골연골염에서 보존적 치료 후 조기 투구 복귀 전략의 임상적 결과

Clinical Outcomes of an Early Return-to-Throwing Strategy Following Conservative Treatment for Capitellar Osteochondritis Dissecans Involving the Lateral Column

좋은삼선병원

조형래, 허태영, 구정회, 박진호

목적

Capitellar osteochondritis dissecans (OCD) involving the lateral column has a relatively poorer prognosis than centrally located lesions. It requires a prolonged healing time and often results in extended time away from play. This study aimed to investigate the clinical outcomes of patients who underwent conservative treatment for stable OCD involving the lateral column and returned to throwing early after lateral column healing.

대상 및 방법

Twenty-three male adolescent baseball players (mean age: 12.6 years; right: left = 22:1; pitcher: fielder = 8:15) diagnosed with stable OCD involving the lateral column between 2017 and 2024 were enrolled. The coronal width of the lesion was measured using plain radiographs, and lesion stability was assessed by magnetic resonance imaging (MRI), range of motion, and assessment of physeal maturity of the capitellum and radial head. Lesions were categorized as either localized lateral (n=6) or extended lateral (n=17), with a mean lesion width of 10.6 mm (52% of the radial head width, RHW). Three patients were in the radiolucent stage and 20 in the fragmentation stage. Return to throwing was permitted once lateral column healing was confirmed following rest and kinetic chain rehabilitation. We analyzed time to throwing resumption, radiographic healing of the entire lesion, and factors associated with poor outcomes or incomplete healing. The mean follow-up period was 24.8 months.

결과

The average time to return to throwing was 4.3 months after the initial diagnosis. Fifteen patients (65%) demonstrated complete radiographic healing of the lesion at a mean of 8.1 months (localized lateral type: 3.8 months; extended lateral type: 10.8 months). At the time of return to throwing, the mean lesion width had decreased to 4.8 mm (23% of RHW). Eight patients (35%) had incomplete healing with a central defect averaging 7.9 mm (36.8% of RHW); five of these (22%) were able to throw without pain, while three (13%) progressed to unstable lesions and required arthroscopic fragment excision. No player quit baseball during the follow-up period. Factors significantly associated with incomplete central healing included age (p=0.03), lesion size (p=0.02), skeletal maturity of the radial head (p=0.03), and patient compliance (p=0.03).

결론

In patients with stable capitellar OCD involving the lateral column, an early return to throwing was possible without pain in 87% of cases following lateral column healing. Even in the presence of incomplete central lesion healing, pain-free throwing was often achievable. This strategy may serve as a viable alternative to prolonged rest while awaiting complete lesion resolution.

만성 발목 불안정증 환자에서 보존적 치료 및 modified Broström operation 후 성공적인 스포츠 복귀 예측 위하여 Side hop test는 중요하다: Ankle-GO 점수 기반 연구

Side hop test is a predictor of successful return to sports after conservative treatment or modified Broström operation in patients with chronic ankle instability: Based on Ankle-GO score

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목적

The Ankle-GO score is an objective evaluation battery for return to sports (RTS) decisions after conservative or surgical treatment in patient with chronic ankle instability (CAI). However, there are few data directly comparing Ankle-GO scores or subscales between patients who achieved successful RTS and those who did not. In addition, no study has identified the specific subscales that predict successful RTS following conservative or surgical treatment. Therefore, to directly compare the Ankle-GO subscales between patients with and without successful RTS after conservative treatment and modified Broström operation (MBO). The secondary aim was to explore which Ankle-GO subscales are significantly associated with successful RTS.

대상 및 방법

One hundred patients (100 ankles) with CAI were enrolled. 52 ankles underwent conservative treatment (31 with successful RTS and 21 without) and 48 ankles underwent MBO (26 with successful RTS and 22 without). Successful RTS was defined as return to preinjury sport level with a Tegner activity score ≥ 6. The Ankle-GO, which consists of six subscales, was compared between patients with and without successful RTS: the single-leg stance test, modified star excursion balance test, side hop test (SHT), figure-of-8 test (F8T), Foot and Ankle Ability Measure, and Ankle Ligament Reconstruction-Return to

Sport after Injury. Statistical analyses were performed using independent t-tests and multivariable binary logistic regression analyses with ROC curve analysis.

결과

In the conservative treatment group, CAI patients with successful RTS demonstrated superior Ankle-GO scores, SHT, and F8T compared with those without successful RTS (all p<0.001). In the MBO group, CAI patients with successful RTS demonstrated superior Ankle-GO scores, SHT, F8T, and ALR-RSI scores compared with those without successful RTS (all p<0.001). Furthermore, SHT was a significant predictor of RTS in both the conservative treatment (OR=18.03 and 95% CI=2.8 to 36.8) and MBO (OR=4.59 and 95% CI=2.0 to 10.7) groups.

결론

Our study demonstrated that in both the conservative treatment and MBO groups, SHT and F8T were key factors distinguishing patients with CAI who had successful RTS from those who did not. In addition, SHT was the strongest independent predictor of RTS in both the conservative treatment and MBO groups. Clinicians and therapists should consider these findings when planning rehabilitation and RTS strategies.

6주간의 Weighted Ball 훈련이 청소년 엘리트 야구 선수의 구속 및 운동학적 변인에 미치는 영향

Effects of a 6-Week Weighted Ball Training Program on Pitch Velocity and Kinematic Variables in Youth Elite Baseball Players

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목적

본 연구의 목적은 중학교 야구 투수들을 대상으로 두 그룹(LB 그룹, WB 그룹)으로 분류하고 6주간 가벼운 공 훈련과 무거운 공 훈련을 각각 적용한 후 구속 증가와 운동학 및 운동역학에 미치는 영향을 비교 분석하여 중학교 야구 투수들에게 구속 향상에 효과적인 훈련프로그램을 제공하고자 하였다.

대상 및 방법

중학교 야구 투수 20명을 대상으로 LB 그룹(n=10)과 WB 그룹(n=10)으로 무작위로 분류하였다. 6주간 각 훈련프로그램을 적용하여 훈련프로그램 적용 전보다 후에 구속, 관절가동범위(어깨관절 굽힘, 벌림, 가쪽돌림, 안쪽돌림 팔꿈치 굽힘), 근력(어깨관절 굽힘, 벌림, 가쪽돌림, 안쪽돌림), 운동역학(팔스윙속도, 팔꿈치 안굽이 토크, 암 슬롯), 시점 별 각도(풋 컨택, 최대가쪽돌림, 볼 릴리즈)를 확인하였다.

결과

1. 6주간 훈련프로그램 적용에 따른 구속을 확인한 결과, LB 그룹과 WB 그룹에서 훈련프로그램 적용 전보다 후에 유의하게 증가하였다.
2. 6주간 훈련프로그램 적용에 따른 어깨관절 가동범위를 확인한 결과, WB 그룹에서 어깨관절 가쪽돌림은 훈련프로그램 적용 전보다 후에 유의하게 향상되었고, 어깨관절 안쪽돌림은 훈련프로그램 적용 전보다 후에 유의하게 감소하였다.
3. 6주간 훈련프로그램 적용에 따른 어깨관절 근력을 확인한 결과, WB 그룹에서 어깨관절 벌림 근력이 훈련프로그램 적용 전보다 후에 유의하게 향상되었다.
4. 6주간 훈련프로그램 적용에 따른 팔 스윙 속도를 확인한 결과, LB 그룹은 훈련프로그램 적용 전보다 후에 유의하게 향상되었고, WB 그룹은 훈련프로그램 적용 전보다 후에 유의하게 감소되었으며, 집단 간 유의한 차이가 나타났으며, 상호작용 효과가

나타났다.

5. 6주간 훈련프로그램 적용에 따른 팔꿈치 안굽이 토크를 확인한 결과, LB 그룹은 훈련프로그램 적용 전보다 후에 유의하게 향상되었으며, 상호작용 효과가 나타났다. 훈련프로그램 적용 후에 LB 그룹이 WB 그룹에 비해 더 큰 감소를 확인하였다.
6. 6주간 훈련프로그램 적용에 따른 풋 컨택 시점의 각도를 확인한 결과, WB 그룹의 어깨관절 벌림 각도는 훈련프로그램 적용 전보다 후에 유의하게 감소하였으며, 그룹 간 차이가 나타났다. 또한 WB 그룹의 엉덩관절 굽힘 각도는 훈련프로그램 적용 전보다 후에 유의하게 감소하였다.
7. 6주간 훈련프로그램 적용에 따른 최대가쪽돌림 시점의 각도를 확인한 결과, WB 그룹의 어깨관절 벌림 각도는 훈련프로그램 적용 전보다 후에 유의하게 감소하였다. 또한 LB 그룹의 엉덩관절 굽힘 각도는 훈련프로그램 적용 전보다 후에 유의하게 감소하였으며, 그룹 간 차이가 나타났다.
8. 6주간 훈련프로그램 적용에 따른 볼 릴리즈 시점의 각도를 확인한 결과, WB 그룹의 무릎관절 굽힘 각도는 훈련프로그램 적용 전보다 후에 유의하게 증가하였다.

결론

위와 같은 연구 결과를 통해 중학교 엘리트 야구 투수를 대상으로 6주간 LB 훈련과 WB 훈련을 적용하여 구속의 증가에 대해 긍정적인 영향을 확인할 수 있었다. 하지만 신체가 성숙하지 않은 청소년임을 고려하였을 때 상지의 운동학적 변화의 차이가 없고, 팔 스윙 속도 증가, 팔꿈치 안굽이 토크를 낮추며 구속을 증가시킨 LB 훈련이 청소년 투수들에게 효과적인 훈련프로그램으로 제공될 수 있을 것으로 보여진다.

한국 청소년의 신체활동 및 수면시간과 심리적 웰빙의 공동 연관성: 2021년 NYPI 횡단면 연구 Joint associations of physical activity and sleep duration with psychological well-being in Korean adolescents: 2021 NYPI cross-sectional study

서울대학교

홍지원

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

초청세션 4: 대한정형외과스포츠의학회 KOSSM

흔한 달리기 부상: 수술 시기와 방법

Common Running Injuries: When and How to Operate

좌장: 경희대병원 정비오, 천안국가대표정형외과의원 유중진



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아킬레스건을 포함한 족부족관절 손상
Foot and Ankle Injuries including Achilles tendon

영남의대
박철현

1. 서론 (Introduction)

- 발생 현황: 발과 발목 부상은 전체 러닝 부상의 약 31%를 차지하며, 아킬레스 건병증, 족저근막병증, 발목 염좌는 러너에게 가장 흔한 5대 부상에 포함됨.
- 핵심 원칙: 대부분의 부상은 활동 수정(Activity modification)과 근력 및 기능 회복을 위한 교정 운동 등 보수적 관리로 호전됨.

2. 주요 건병증 (Tendinopathies)

2.1 아킬레스 건병증 (Achilles Tendinopathy)

- 진단: 건 중부(비혈관 구역) 또는 부착부의 통증 확인. 실버 스키올드 테스트로 장딴지근 긴장도 평가.
- 치료 및 관리:
  - 초기: 활동 수정, 얼음찜질, 단기적인 뒤꿈치 리프트(Heel lifts) 사용.
  - 재활(Gold Standard): Alfredson 편심성 로딩(Eccentric loading) 프로그램. 무릎을 편 상태와 굽힌 상태에서 각각 15회 3세트, 하루 2회, 12주간 실시.
  - 주의: 스테로이드 주사는 파열 위험으로 권장되지 않음.

2.2 후경골근 및 비골건 질환

- 후경골근 (PTTD): 내측 아치 지지 기능 저하 시 발생. 아치 서포트 교정기 사용 및 고반복 뒤꿈치 들기 운동 실시.
- 비골건 (Peroneal): 만성 발목 불안정성과 관련. 외측 뒤꿈치 쐐기(Lateral heel wedge) 및 신경근 훈련 병행.

3. 인대 및 근막 질환 (Ligament and Fascia)

3.1 족저근막병증 (Plantar Fasciopathy)

- 진단: 아침 첫 발 통증, 윈드라스(Windlass) 테스트 시 통증 유발.
- 치료 및 관리:
  - 스트레칭: 엄지발가락을 정강이 쪽으로 당기는 특화 스트레칭 (10초 유지, 10회 반복).

o 강화 운동: 수건을 이용한 **고부하 근력 훈련(High-load strength training)**이 장기적 효과가 큼.

o 기타: 맞춤형 보조기, 야간 부목(Night splints), 체외충격파(ESWT) 고려.

3.2 발목 염좌 (Ankle Sprains)

• 진단: 주로 외측(내번) 염좌. 인대 손상 정도에 따라 1~3도로 분류.

• 치료 및 관리 (PRICE):

o 초기 보호, 휴식, 냉찜질, 압박, 거상 실시.

o 통증이 심할 경우 7~10일간 워킹 부트 착용 후 기능적 보조기로 전환.

o 재활: 자세 제어를 위한 균형 및 고유수용성 감각 훈련 필수.

4. 신경 및 기타 질환 (Nerve and Other Conditions)

• 지간신경종 (Morton's Neuroma): 제3-4 중족골 사이 통증. 볼이 넓은 신발 착용 및 중족골 패드 사용.

• 무지강직증 (Hallux Rigidus): 엄지발가락 관절염. 딱딱한 밑창이나 탄소 섬유 보조기로 관절 움직임 제한.

• 족근관 증후군: 내측 발목 신경 압박. 보수적 관리와 함께 러닝 생체역학 평가 병행.

5. 결론 및 예방 전략 (Conclusion & Prevention)

1. 운동 역학의 교정: 발목뿐 아니라 엉덩이(중둔근/대둔근), 무릎을 포함한 **전체 운동 사슬(Kinetic Chain)**의 강화가 필수적임.
2. 발 코어(Foot Core) 강화: 발 내재근 훈련을 통해 충격 흡수 능력을 향상시킴.
3. 훈련 부하 조절: 부상의 주원인인 과사용을 방지하기 위해 훈련 강도와 거리를 단계적으로 조절할 것을 권고함.

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주요경력

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대한축구협회 의무위원

서울이랜드FC, SK Nights 농구단 주치의

현재 소속 및 직위

세종스포츠정형외과 원장

대표논문

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골 손상 (스트레스 골절 등)
Bone Injuries (stress fx. Etc)

세종스포츠정형외과
김진수

스트레스 골절(stress fracture)은 반복적인 기계적 부하에 의해 발생하는 피로 손상으로, 달리기와 같은 반복적 충격이 가해지는 스포츠에서 흔히 발생한다. 특히 장거리 달리기 선수, 군인, 그리고 다양한 엘리트 스포츠 종목에서 높은 발생률이 보고되어 있으며, 대부분의 스트레스 골절은 활동 제한과 점진적 재활을 통한 보존적 치료로 회복된다. 그러나 일부 부위의 스트레스 골절은 치유 지연(delayed union), 불유합(nonunion), 혹은 완전 골절로 진행될 위험이 높아 수술적 치료가 필요할 수 있다. 국제 스포츠의학 및 정형외과 문헌에서는 이러한 병변을 high-risk stress fracture로 분류하며 조기 수술적 치료를 고려할 수 있다고 보고하고 있다.

스트레스 골절의 수술적 치료를 고려해야 하는 대표적인 부위로는 대퇴 경부(superior femoral neck), 전방 경골 피질(anterior tibial cortex), 주상골(navicular), 제5중족골 기저부(proximal fifth metatarsal), 슬개골, 그리고 내측 복사(medial malleolus) 등이 있다. 이러한 부위는 해부학적 특성상 혈류 공급이 제한적이거나 반복적인 장력이 작용하는 구조적 환경 때문에 보존적 치료만으로는 치유가 지연되거나 불유합이 발생할 가능성이 높다. 특히 달리기 선수에서는 발과 하퇴에 집중되는 반복적 부하로 인해 주상골 스트레스 골절과 제5중족골 스트레스 골절이 중요한 임상적 문제로 보고된다.

수술적 치료의 결정에서 중요한 요소는 병변의 위치, 영상학적 단계, 통증 지속 기간, 그리고 선수의 경기 복귀 필요성이다. MRI나 CT를 통한 영상 평가에서 골절선이 명확하게 관찰되거나 피질 결손이 존재하는 경우, 혹은 일정 기간의 보존적 치료에도 불구하고 통증이 지속되는 경우 수술적 치료가 고려될 수 있다. 특히 대퇴 경부의 장력측(tension-side) 스트레스 골절이나 전방 경골 피질 스트레스 골절과 같이 완전 골절로 진행될 위험이 높은 병변에서는 조기 수술이 권고되기도 한다. 또한 엘리트 선수의 경우 장기간의 활동 제한이 경기력에 미치는 영향을 고려하여 초기 단계에서도 수술적 치료가 선택되는 경우가 있다.

수술 방법은 병변의 위치와 골절 형태에 따라 다양하게 선택된다. 대퇴 경부 스트레스 골절의 경우 일반적으로 cannulated screw를 이용한 내고정이 사용되며, 주상골 스트레스 골절에서는 percutaneous screw fixation이 널리 시행된다. 제5중족골 근위부 스트레스 골절에서는 intramedullary screw fixation이 표준적인 치료 방법으로 보고되어 있으며, 전방 경골 피질 스트레스 골절에서는 경우에 따라 plate fixation이나 intramedullary nailing이 고려될 수 있다. 일부 만성 병변이나 불유합

에서는 골이식(bone graft)이 병행되기도 한다. 이러한 수술적 치료는 골절 안정성을 확보하고 골 치유를 촉진하며 조기 재활을 가능하게 하는 것을 목표로 한다.

수술 시기의 결정은 스트레스 골절 치료에서 중요한 요소이다. 일반적으로 초기 단계의 스트레스 반응이나 불완전 골절은 보존적 치료가 우선되지만, high-risk 부위에서 골절선이 명확히 확인되거나 통증이 지속되는 경우에는 조기 수술적 치료가 고려된다. 특히 주상골이나 제5중족골 스트레스 골절에서 조기 수술은 선수의 경기 복귀 기간을 단축시키는 것으로 보고된 바 있다. 반면 일부 부위에서는 일정 기간의 보존적 치료 후 치유가 이루어지지 않을 때 수술을 시행하는 전략이 사용되기도 한다.

결론적으로 달리기 관련 스트레스 골절에서 수술적 치료의 결정은 병변 위치와 위험도, 영상학적 단계, 그리고 선수의 활동 수준을 종합적으로 고려하여 이루어져야 한다. 특히 high-risk 부위의 스트레스 골절에서는 조기 진단과 적절한 수술 시기 결정이 완전 골절의 진행을 예방하고 선수의 안전한 스포츠 복귀를 가능하게 하는 중요한 요소이다. 본 발표에서는 달리기 관련 스트레스 골절 중 수술적 치료가 필요한 병변을 중심으로, 각 병변의 수술 적응증, 수술 시기, 그리고 주요 수술 방법에 대해 최신 문헌과 임상 경험을 바탕으로 정리하고자 한다.

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김동휘

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무릎관절 주위 손상
Around Knee Injuries

조선의대
김동휘

1. Running-related Knee Injuries

- **Epidemiology**
  - Running injuries 중 **30–50%가 무릎 주변 손상**
  - Overuse injury가 대부분
  - 수술이 필요한 경우는 **10% 미만**
- **Common Pathologies**
  - Patellofemoral pain syndrome
  - Iliotibial band syndrome
  - Meniscus tear
  - Patellar tendinopathy
  - Focal cartilage injury

2. Surgical Indication in Running-related Knee Injury

- **Conservative treatment first**
  - Activity modification
  - Physical therapy
  - NSAIDs
  - Injection therapy
- **Surgery considered when**
  - **Persistent symptoms >3–6 months**
  - **Mechanical symptoms (locking / catching)**
  - **Structural lesion on MRI**
  - **Failure of rehabilitation**

3. Patellofemoral Pain Syndrome

- **Etiology**
  - Patellar maltracking
  - Quadriceps imbalance
  - Overuse
- **Surgical indication**
  - Rare (<5%)
  - Severe malalignment
  - Cartilage lesion
- **Procedure**
  - Arthroscopic lateral release
  - Tibial tubercle osteotomy
  - Cartilage restoration procedure

5. Meniscus Injury in Runners

- **Mechanism**
  - Repetitive loading + rotational stress
- **Surgical indication**
  - Mechanical symptoms
  - Unstable tear
  - Root tear
- **Procedure**
  - Arthroscopic meniscus repair
  - Partial meniscectomy
  - Meniscus root repair
- **Trend**
  - → **Meniscus preservation**

5. Meniscus Injury in Runners

- **Mechanism**
  - Repetitive loading + rotational stress
- **Surgical indication**
  - Mechanical symptoms
  - Unstable tear
  - Root tear
- **Procedure**
  - Arthroscopic meniscus repair
  - Partial meniscectomy
  - Meniscus root repair
- **Trend**
  - → **Meniscus preservation**

6. Patellar Tendinopathy

- **Typical lesion**
  - Degenerative change at inferior pole of patella
- **Indication**
  - Failure of conservative treatment (> 6–12 months)
- **Procedure**
  - Arthroscopic tendon debridement
  - Open debridement
  - Inferior pole excision

7. Cartilage Injury

- **Running-induced repetitive impact**
- **Procedure selection**



8. Key Surgical Principles in Runners

1. **Tissue preservation**
   Meniscus repair preferred over meniscectomy
2. **Early rehabilitation**
3. **Return-to-running protocol**
   - Typical return to running
   - Meniscus repair: **4–6 months**
   - Cartilage procedure: **6–12 months**
   - Tendon surgery: **3–5 months**

9. Key Messages

- 대부분의 달리기 관련 무릎 손상은 **비수술 치료 가능**
- 수술은 **mechanical pathology가 있는 경우 선택**
- 최근 트렌드는 **joint preservation surgery**

The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

심포지엄 18: 부위별 스포츠 관련 발목 손상: 전방 및 외측 인대 손상, 후방-내측 병변

Sports-Related Ankle Injuries by Region: Anterior and Lateral Ligament Injuries, and Posterior-Medial Conditions

좌장: 서울의료원 김기천, 고려의대 강 석



여의동

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주요 경력

대한스포츠의학회전문의

대한스포츠의학회 2023년 한일travelling fellowship

2018년 평창동계올림픽 의무지원단

현재 소속 및 직위

중앙보훈병원 정형외과 여의동

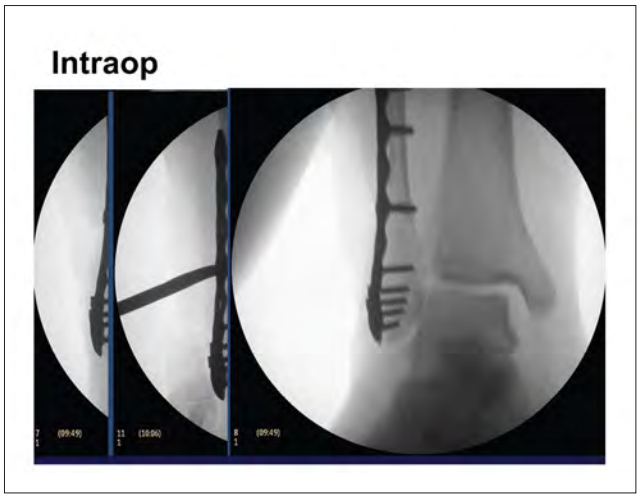
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스포츠 상황에서의 내측 발목 병변: 삼각 인대 손상의 진단 및 치료
Medial Ankle Injuries in Sports: Diagnosis and Treatment of Deltoid Ligament Injuries

중앙보훈병원
여의동









Int Orthop (SICOT) (2020) 44:341–347
https://doi.org/10.1007/s00264-019-04416-9

REVIEW ARTICLE

Outcome of primary deltoid ligament repair in acute ankle fractures: a meta-analysis of comparative studies

Motasem Salameh[1] · Abduljabbar Alhammoud[1] · Nedal Alkhatib[1] · Ahmed K. Attia[1] · Mohamed M. Mekhaimar[1] · Pieter D'Hooghe[2] · Karim Mahmoud[1]

Received: 14 June 2019 / Accepted: 13 September 2019 / Published online: 27 November 2019
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Abstract

Purpose The indications of deltoid ligament repair in ankle injuries with widened medial clear space in the absence of medial malleolus fracture remain controversial. Many authors reported no difference in long-term functional outcomes, while others stated that persistent medial clear space widening and malreduction are higher when deltoid ligaments went without repair. This meta-analysis aims to report the current published evidence about the outcomes of deltoid ligament repair in ankle fractures.

Methods Several databases were searched through May 2018 for comparative studies. The primary outcome was the medial clear space correction; while secondary outcomes included maintenance of medial clear space reduction, pain scores, functional outcome, and total complications if any. Three comparative studies met the inclusion criteria for the meta-analysis. The analysis included a total of 192 patients, 81 in the deltoid ligament repair group and 111 in the non-repair group.

Results The medial clear space correction and maintenance of the said correction on final follow-up radiographs were superior in the deltoid ligament repair group. Although the pain scores were better in the repair group at the final follow-up, this did not result in a better functional outcome, with similar total complication rates.

Conclusion In conclusion, those who had their deltoid ligament repaired had superior early and late radiological correction of the medial clear space, an indirect of the quality of ankle reduction with better pain scores. However, no differences in the functional outcome and complications rate were reported.

Original Article

Repair of Deltoid Ligament Disruption in Bimalleolar Equivalent Fractures: A Cadaveric Study

Young Koo Lee, MD, Darryl D'Lima, MD*, Woo Jong Kim, MD†, Hong Seop Lee, MD†, Whi Ie Cho, MD†, Tae Dong Yoo, MD‡§¶

Background: The effectiveness of deltoid ligament complex repair in bimalleolar equivalent fracture remains controversial. While direct repair of the superficial ligamentous attachment is feasible, the necessity of primary repair for the deep component and the optimal approach for achieving this remain unclear. This study aimed to determine whether anterior deltoid ligament repair (ADLR), transmalleolar and clamping ligamentoplasty can stabilize the ankle joint following a complete deltoid ligament rupture (cDLR).

Methods: Seventeen ankles from nine fresh frozen cadavers were dissected from the knee downward and divided into 3 groups: normal (intact ankle ligaments), cDLR, and ADLR. The medial clear spaces and torque failure after ADLR were evaluated. Medial clear spaces were measured under non-weight-bearing conditions and during 5 ft-lb (26 N) external rotation and gravity stress tests across the 3 groups. The medial clear spaces were measured using Adobe Photoshop's length measurement function.

Results: Significant differences ($p < 0.001$) were observed in the medial clear space measurements across the normal, cDLR, and ADLR groups during all test conditions. Torque failure occurred after ADLR at a mean of 71.3 ft-lb (standard deviation, 25.5).

Conclusions: The stability observed in stress tests following ADLR and the results of torque failure testing suggest that ADLR alone is sufficient to restore ankle stability. Distal stability was achieved using ADLR, which can be performed relatively easily even in cases of cDLR.

Keywords: Ankle injury, Ankle fracture, Articular ligament, Biomechanical phenomena

Received February 4, 2021; Revised March 18, 2021;
Accepted April 20, 2021

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Rupture of the deltoid ligament is a common occurrence in ankle fractures, with up to 69% of such fractures reported to involve deltoid ligament injury.[1] The ligament is typically torn due to eversion or external rotation forces. In cases of bimalleolar equivalent fractures, the decision between conservative management and surgical repair of the deltoid ligament complex remains debated.[2] Previous studies have shown that conservative treatment of deltoid ligament ruptures generally yields satisfactory outcomes.[3,4] However, some patients continue to experience pain, and up to 20% have reported poor results.[5,6] Shino et al.[7] re-

Veterans Health

73세 여자
자전거를 타다 넘어져 ER 내원



Does Medial Tenderness Predict Deep Deltoid Ligament Incompetence in Supination-External Rotation Type Ankle Fractures?

Nicola A. DeAngelis, MD, Mark S. Eskander, MD,* and Bruce G. French, MD†*

J Orthop Trauma • Volume 21, Number 4, April 2007

Results: Thirteen patients (23.6%) were tender medially and had a positive external rotation stress radiograph. Thirteen patients (23.6%) were tender medially and had a negative external rotation stress radiograph. Nineteen patients (34.5%) were nontender medially and had a negative external rotation stress radiograph. Ten patients (18.2%) were nontender medially and had a positive external rotation stress radiograph. We calculated a χ^2 statistic of 2.37 as well as the associated P value of 0.12. Medial tenderness as a measure of deep deltoid ligament incompetence had a sensitivity of 57%, a specificity of 59%, a positive predictive value of 50%, a negative predictive value of 66%, and an accuracy of 42%.

Vet

Simple Radiography



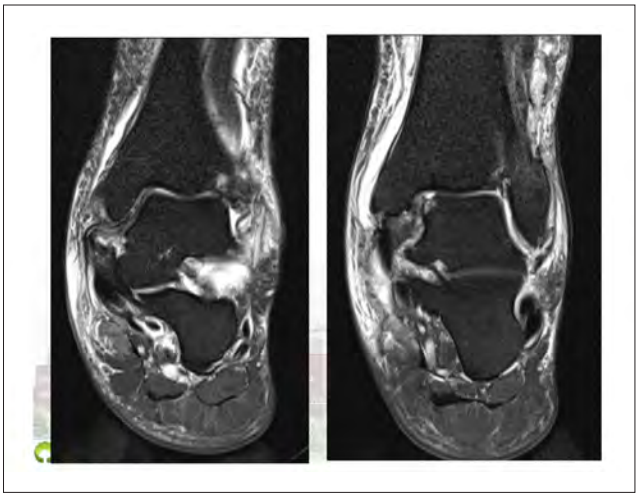
Deltoid Ligament Integrity in Lateral Malleolar Fractures: A Comparative Analysis of Arthroscopic and Radiographic Assessments

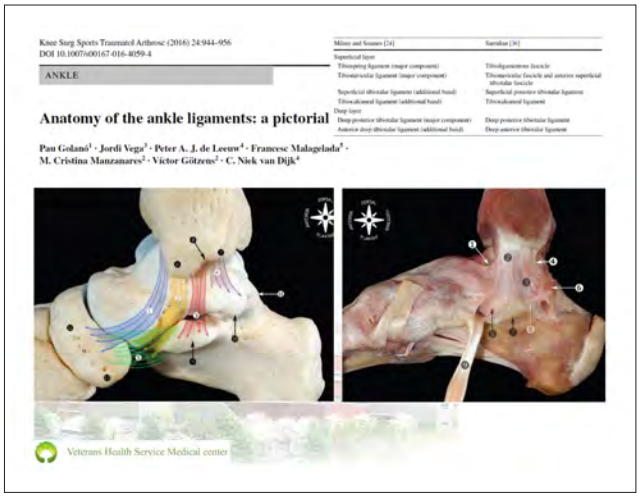
John M. Schuberth, DPM, FACFAS,[1] David R. Collman, DPM,[2] Shannon M. Rush, DPM,[3] and Lawrence A. Ford, DPM[4]

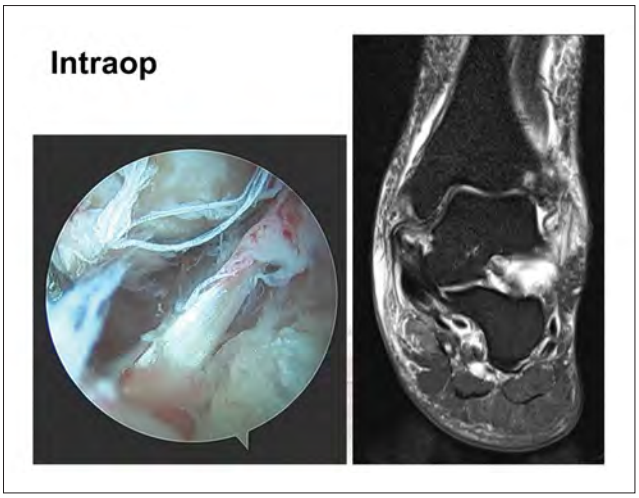
THE JOURNAL OF FOOT & ANKLE SURGERY

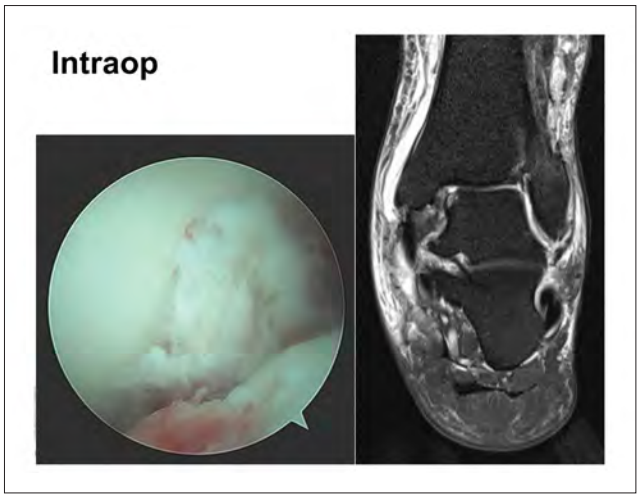


where widening can be found: 4 mm in a nonstressed mortise view and/or a superior tibiotalar clear space greater than 1 mm are considered pathologic. Moreover, normal values are reported to vary from 1 to 5 mm.[14] An MCS of more than 4 mm, with that value being at least 1 mm greater than the superior tibiotalar space, is accepted to represent a deep deltoid ligament rupture. On stressed mortise views, an MCS greater than 5 mm is considered pathologic.[14] Indications for surgery have been an MCS

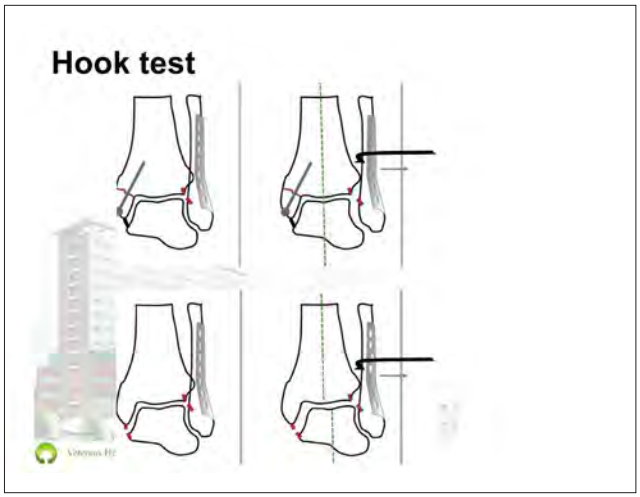



Knee Surg Sports Traumatol Arthrosc (2016) 24:944–956
DOI 10.1007/s00167-016-4059-4
ANKLE
Anatomy of the ankle ligaments: a pictorial
Pau Golanó · Jordi Vega · Peter A. J. de Leeuw · Francesc Malagelada · M. Cristina Manzanares · Víctor Götzens · C. Niek van Dijk
Veterans Health Service Medical center

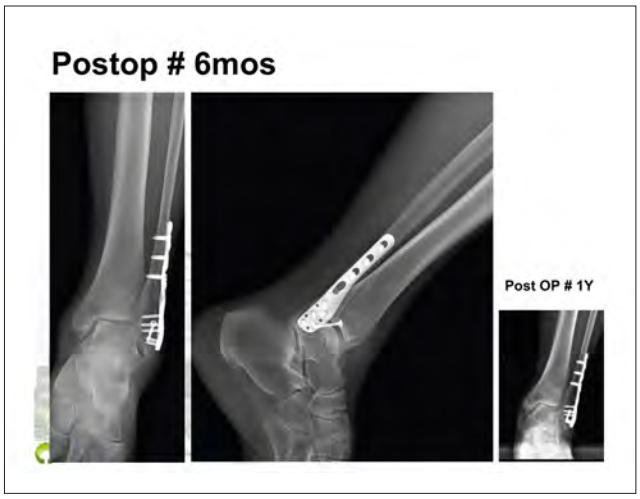

Intraop


Intraop

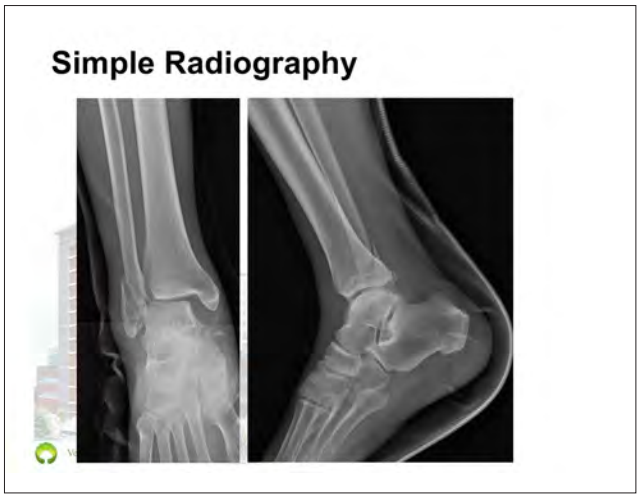

Intraop


Hook test

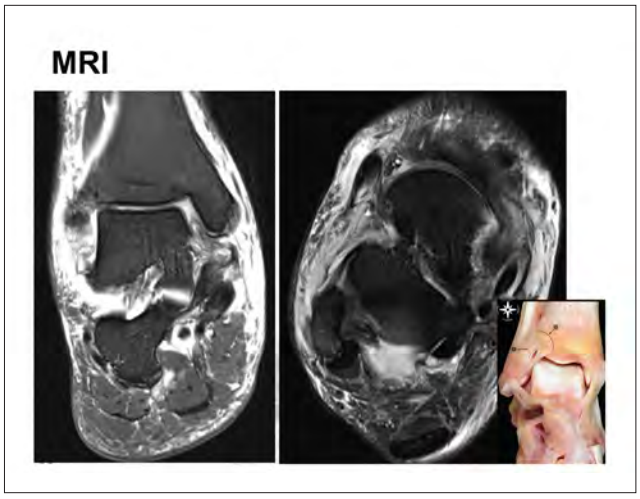

Postop
L
L


Postop # 6mos
Post OP # 1Y

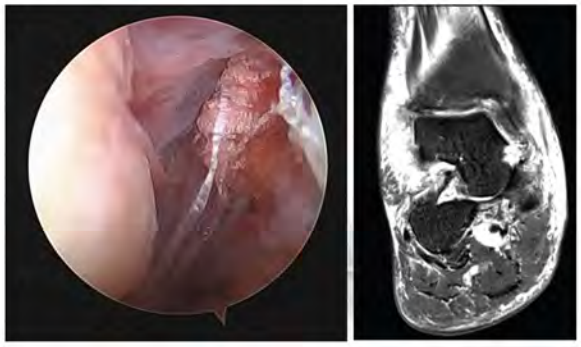

68세 남자
아령을 밟으며 미끌어진후 발생한 우측 발목
통증으로 내원


Simple Radiography

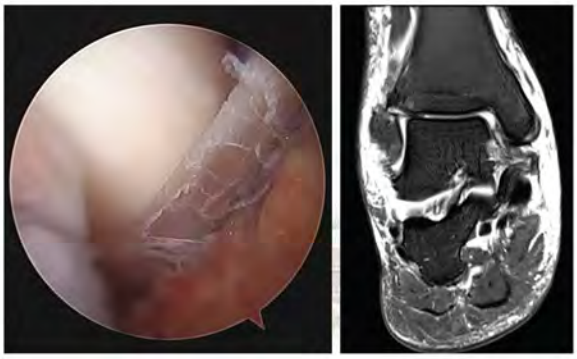

CT
Veterans Health Service Medical center


MRI

Intraop



Intraop





Intraop



Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

The contribution of anterior deltoid ligament to ankle stability in isolated lateral malleolar fractures

Tae Hoon Lee [a,1], Kyu Sun Jang [a,1], Gi Won Choi [b,2], Chan Dong Jeong [a,3], Suk Joo Hong [c,3], Min A. Yoon [c], Hak Jun Kim [a,*]

[a] Departments of Orthopaedic Surgery, Guro Hospital, College of Medicine, Korea University, Seoul, Korea
[b] Department of Orthopaedic Surgery, Ansan Hospital, College of Medicine, Korea University, Gyeonggido, Korea
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ARTICLE INFO

Article history:
Accepted 9 March 2016

Keywords:
Superficial deltoid ligament
Anterior deltoid ligament
Medial ankle instability
Isolated lateral malleolus fracture

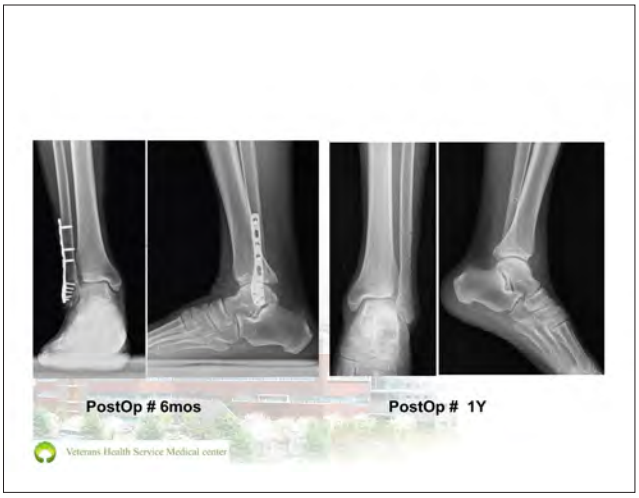
ABSTRACT

The treatment of isolated lateral malleolar fractures with deltoid ligament rupture remains controversial. We prospectively analysed 35 patients with isolated lateral malleolar fractures during 2006–2013. Radiography and magnetic resonance imaging (MRI) were performed to assess the degree of reduction, ligament damage, and stability. Internal fixation was performed for all unstable valgus fractures with unacceptable fracture parameters. Fractures with residual valgus instability after fixation underwent anterior deltoid repair. The mean anterior deltoid ligament grade based on MRI was significantly different between the high-grade unstable group and the stable and low-grade unstable groups ($p = 0.037$ and 0.004, respectively). Postoperative medial clear space measurements were not significantly different between groups. MRI was shown to be a useful tool in the preoperative identification of isolated lateral malleolus fractures prone to valgus instability. In the case of high-grade unstable fractures of the lateral malleolus, repair of the anterior deltoid ligament is adequate for restoring medial stability.

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Postop

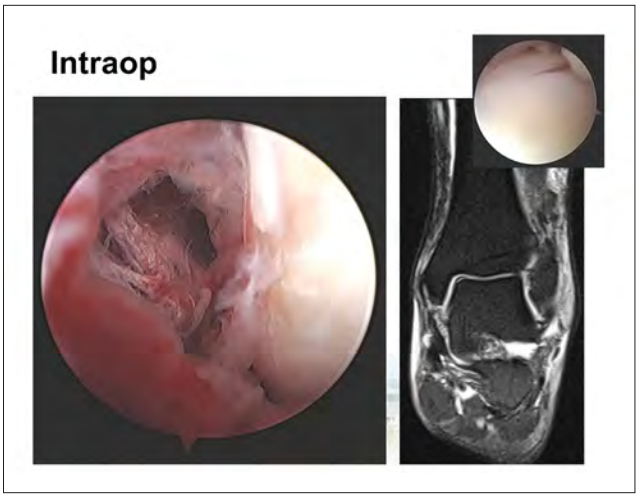



PostOp # 6mos
PostOp # 1Y
Veterans Health Service Medical center


54세 남자
축구중 발목을 접질린후 통증으로 ER 내원


Simple Radiography

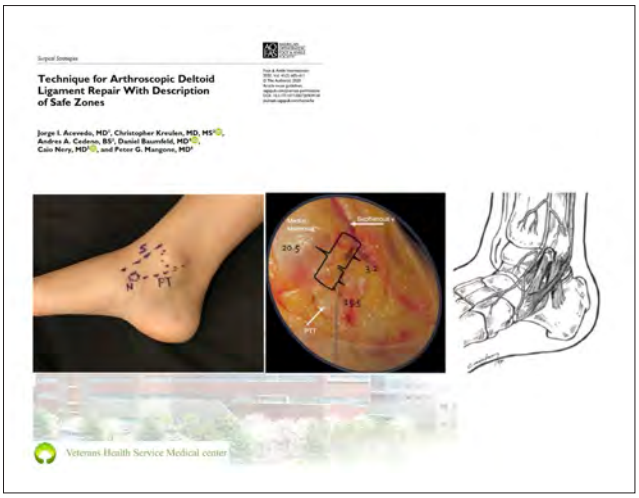

MRI


Intraop


59 kVp
2.5 mA
60 kVp
1.6 mA
62 kVp
1.8 mA
OEC




Before tie
After tie


Technique for Arthroscopic Deltoid Ligament Repair With Description of Safe Zones


Postop


Postop # 1Y


75세 남자
하산 하는 중 나뭇가지에 걸려 넘어지면서 발생한
우측 발목 통증

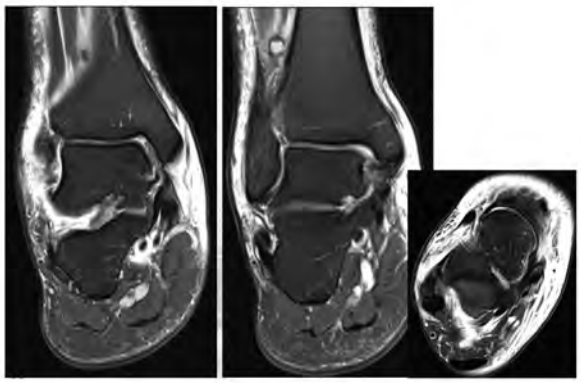
Simple Radiography



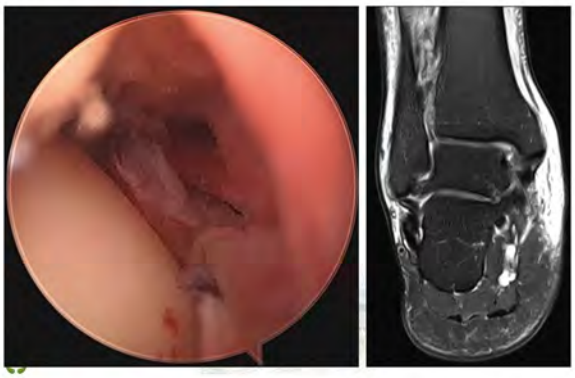
Simple Radiography



MRI



Intraop



Intraop



Before eversion stress

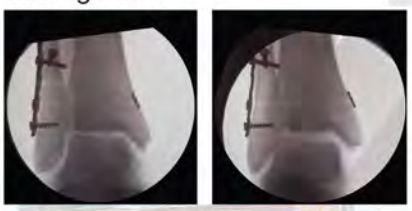
After eversion stress

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Review Article

Deltoid Ligament Rupture in Ankle Fracture: Diagnosis and Management

J Am Acad Orthop Surg 2019;27: e648-e658



graphic features of the talus. ≥7° of talar tilt is used as the cutoff to declare a positive intraoperative eversion stress test. This value was arrived

Intraop



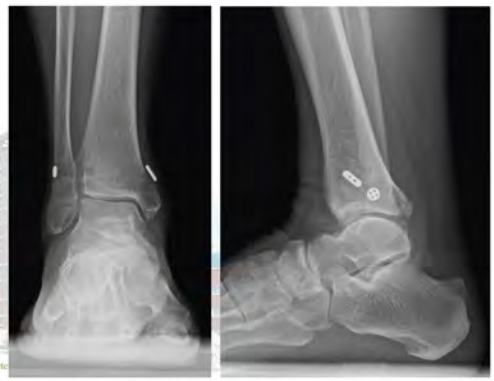
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Postop



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Postop #1Y



Take Home message

1) Stress test:

cotton or hook for syndesmosis injury
external rotation or eversion for deltoid injury : gap >5mm or tilt >7°

2) Op sequence

fibular fixation → syndesmosis fixation → deltoid ligament repair

3) repair technique

Ant. Deltoid ligament repair

Veterans Health Service Medical center



Thank you for your attention

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Veterans Health Service Medical center

김우종

학력

순천향대학교 의학과 학사

순천향대학교 의과대학원 정형외과학 석사

순천향대학교 의과대학원 정형외과학 박사

주요 경력

복싱 M 커미션 링닥터2020~

서울 이랜드 FC 팀닥터 2019~2020

대한 스포츠의학회 인증 전문의 관리 위원회 위원 2023~

대한정형외과 스포츠학회 의무지원위원2021~

현재 소속 및 직위

순천향 대학교 천안 병원 정형외과 족부족관절, 정교수

대표논문

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2. Yoon SJ, Yoe ED, Hong YC, Hong CH, Won SH, Jung KJ, Lee KJ, Ji JY, Byeon JY, Lee DW, ★Kim WJ: Evaluating the Efficacy of Tension Band Wiring Fixation for Chaput Tubercle Fractures: JCM, 2023, Aug 24;12(17):5490
3. Lee YK, Park WS, Lee HR, Choi YS, Kim SH, Yoe ED, Lee HS, Jung KJ, Lee BR, Lee MJ, ★Kim WJ: Is There a Difference in the Distribution of Mechanoreceptors among the Three Sections of the Anterior Talofibular Ligament?: Medicina, 2023, Aug 18;59(9):1510

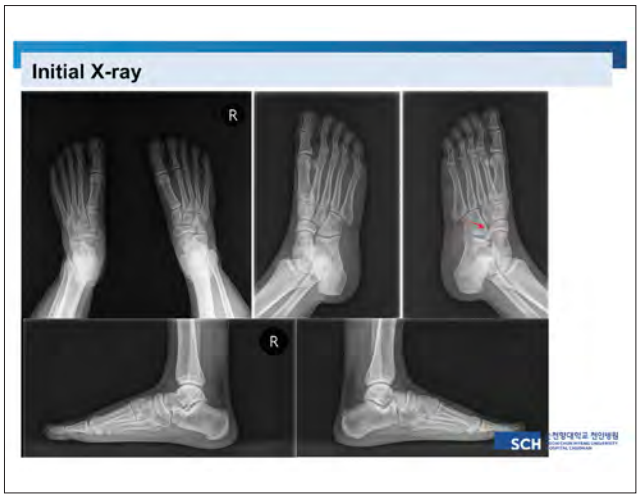
스포츠 상황에서의 전후방 발목 손상: 경비인대결합 손상 및 전방 불안정성 후방 FHL 병변의 정형진단과 치료 전략

Anterior and posterior Ankle Injuries in Sports: Syndesmosis Injuries, Posterior (FHL) Lesions

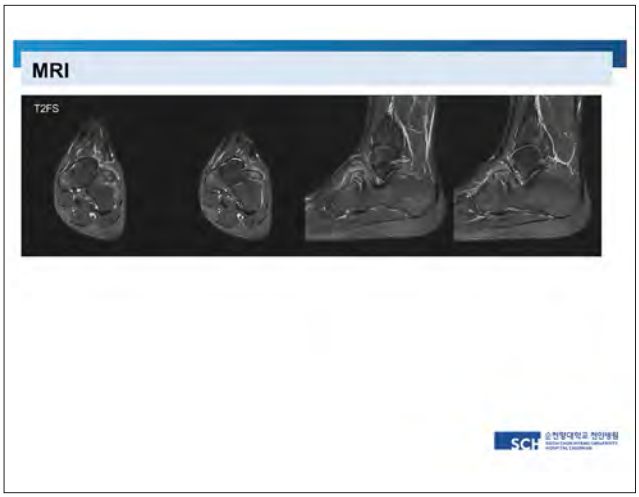
천안순천향병원

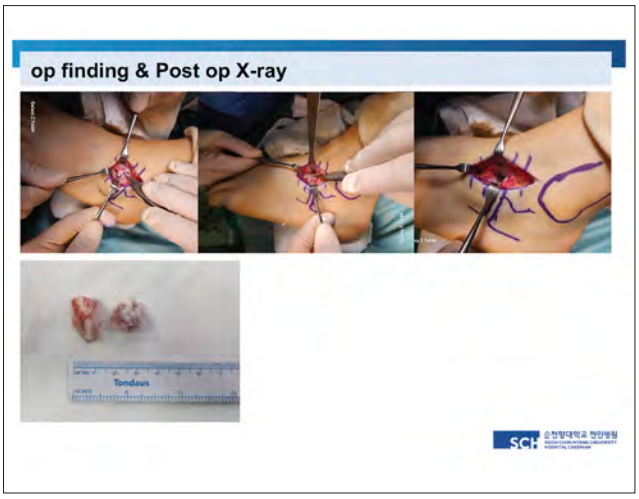
김우종

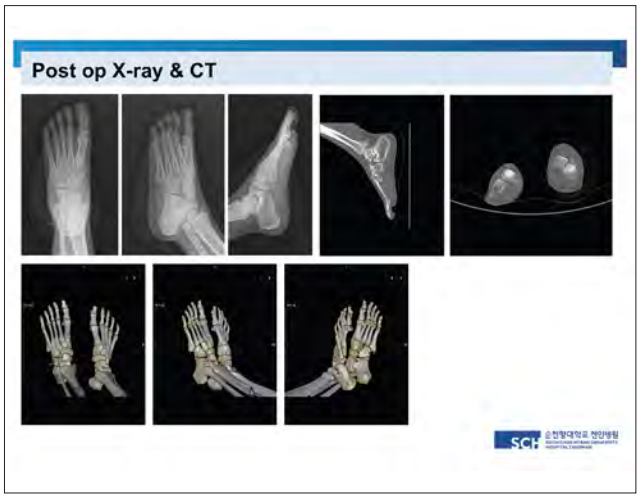









op finding & Post op X-ray
Tondaus


Post op X-ray & CT


Post-operative progress
Histopathologic examination
Findings: cartilage-covered bone with intervening fibrous tissue
and no bony continuity at the specimen margins.
Postoperatively
• pain and tenderness resolved immediately
• allowed weight-bearing as tolerated.
At the 1-year follow-up
• AOFAS mid-foot score: 84 ➡ 90 points.
• VAS score: 8 ➡ 0-1

스포츠 상황에서의 외측 발목 인대 손상: 급성 염좌부터 만성 외측 불안정성까지
Lateral Ankle Ligament Injuries in Sports: From Acute Sprains to Chronic Lateral Instability

분당차병원
이성현

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

심포지엄 19: 야구선수에서 발생하는 회전근 힘줄 및 근육파열
Rotator cuff tendon and muscle tears occurring in baseball players (KBO 주치의 협의회)

좌장: 네온정형외과 박진영, 문영래정형외과병원 문영래



이제형

학력

한림대학교 의학과 학사

주요 경력

두산베어스 프로야구단 수석 주치의

KB손해보험 스타즈 프로 배구단 주치의

한국 여자 야구 대표팀 주치의

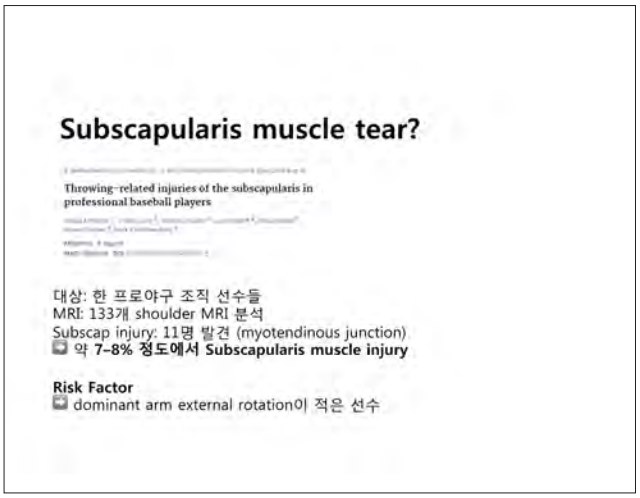
현재 소속 및 직위

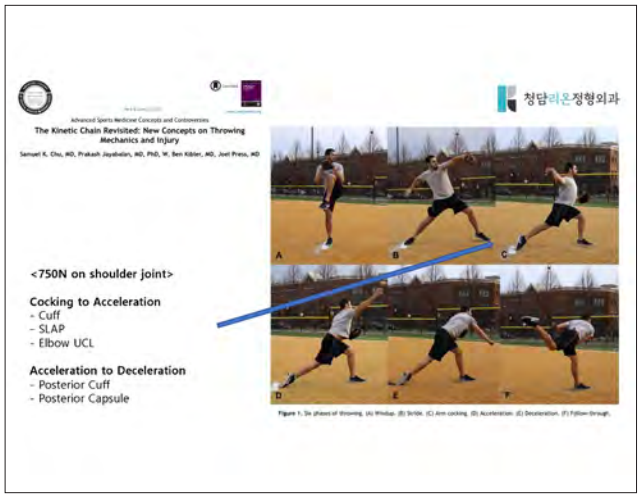
청담리온정형외과 원장

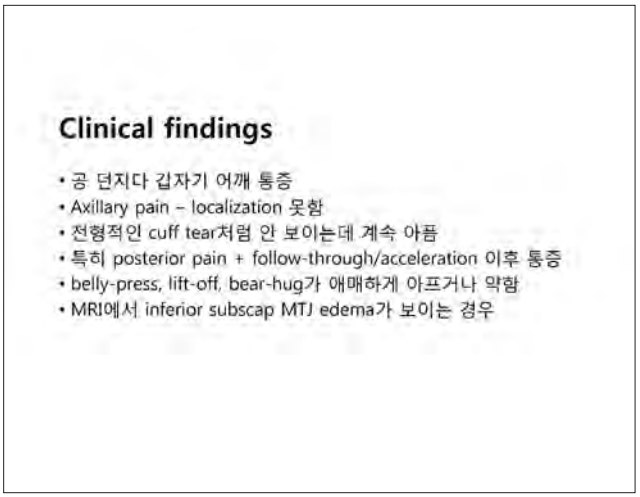
야구선수에서 발생하는 견갑하건 근육 파열
Subscapularis muscle tear occurring in baseball players

청담리온정형외과
이제형









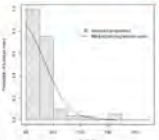
Throwing-Related Injuries of the Subscapularis in Professional Baseball Players

청담리온정형외과



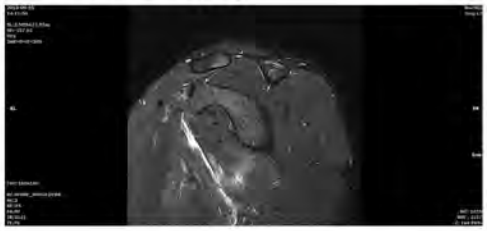
OJSM, 2015

- All SC injury located on inferior half, myotendinous junction
- At 90 degrees of AB-ER,
→ SC inf. fiber aligns in the transverse plane across the G-H joint
- Greatest stretch during the late cocking and early acceleration
- Increased risk with lower levels of external rotation
(shorter arc requires greater force production by the subscapularis muscle)



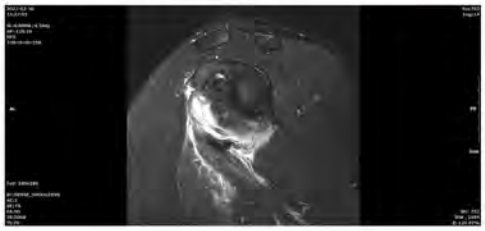
청담리온정형외과

29세 / Pro baseball pitcher
2018.09.05. / 1st injury



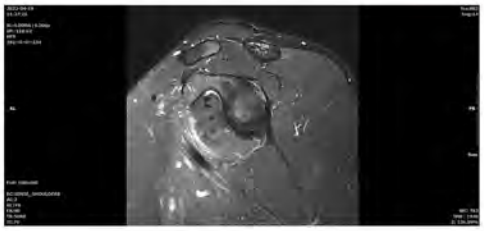
청담리온정형외과

2022.03.30. / 2nd injury



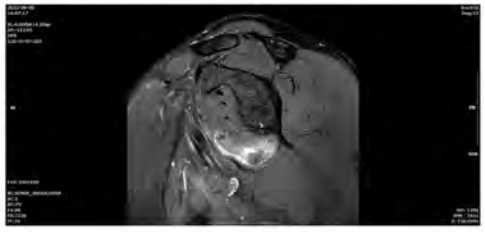
청담리온정형외과

2022.04.19. / recovered



청담리온정형외과

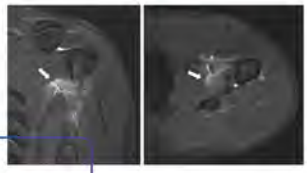
2022.08.05. / 3rd injury



Research Square

Characteristics of subscapularis muscle strain in professional baseball players: A case series

청담리온정형외과



SC muscle strain

2/83 fielder (3.6%)
5/108 pitcher (4.6%)

Most injury located at myotendinous junction and in inferior half

Mean RTP in 55.3days (7-120)

[Orthopaedic Surgery]

청담리온정형외과

Subscapularis Strain From Swinging a Baseball Bat in an Adolescent With Closed Physis





Batting injury for SC

- Upper half of SC
- Pain on dominant AB-ER

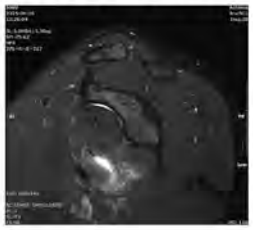
So, SC injury for batter can happen, also!

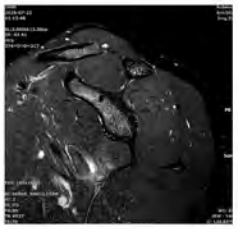
청담리온정형외과

Options for treatment

- Rest
- Ice
- Physical therapy
- ESWT
- Injection (collagen, PDRN, prolotherapy, PRP)
- Exercise

2024년도8월7일 MCL recon후 2025년도 2월에 ITP 시작...









SC수상 4개월 뒤 ITP 다시 시작...



6주뒤... 재손상....





청담리온정형외과

Summary

- Be aware of SC injury in baseball players
- SC injury occurs on myotendinous junction
- SC injury occurs mostly on inferior half



Thank you for kind attention !

금정섭

학력

건국대학교 의과대학 학사

건국대학교 의과대학원 석사

건국대학교 의과대학원 박사 수료

KERLAN-JOBE CLINIC 연수

주요 경력

LG 트윈스 필드닥터

2026 WBC 국가대표야구팀 주치의

대한육상연맹 의무위원

대한장애인농구협회 이사

현재 소속 및 직위

세종스포츠정형외과 병원장

야구선수에서 발생하는 극상근 근육 파열
Supraspinatus muscle tear occurring in baseball players

세종스포츠정형외과
금정섭

야구 선수에서 어깨 통증의 흔한 원인은 관절와순 손상이나 회전근개 힘줄 손상으로 알려져 있으며, 특히 극상건의 관절측 병변은 반복적인 투구 동작과 관련하여 Internal Impingement syndrome의 일환으로 비교적 흔하게 보고된다. 반면 극상근의 근육 부위(muscle belly) 또는 근건이행부(musculotendinous junction) 손상은 상대적으로 드물게 보고되며 대규모 역학 연구에서도 별도의 진단군으로 분류되는 경우가 거의 없다. 그러나 실제 임상에서는 극상건의 명확한 파열이 관찰되지 않음에도 불구하고 투구 시 통증과 기능 저하를 호소하는 선수들이 존재하며, 이러한 경우 극상근 근육 손상이 잠재적인 원인이 될 수 있다. 본 발표에서는 throwing athlete에서 보고된 극상근 근육 및 근건이행부 손상에 대한 기존 문헌 및 저자의 증례들을 바탕으로 손상의 발생 기전, 임상적 특징, 영상학적 소견 및 치료 전략을 정리하였다.

극상근은 투구 동작에서 상완골두의 안정화와 관절 중심화를 유지하는 중요한 역할을 수행하며, 특히 late cocking에서 acceleration 단계로 이어지는 과정에서 반복적인 편심성 부하를 받는다. 이러한 반복적 부하와 근육 피로의 누적은 극상근 근육 또는 근건이행부 손상의 발생과 관련이 있는 것으로 보고되고 있다. 영상학적으로는 MRI에서 극상건의 연속성은 유지되면서 극상근 근육 또는 근건이행부 부위의 부종 및 고신호 변화가 관찰되는 것이 특징적이다.

대부분의 경우 보존적 치료와 단계적 재활 프로그램을 통해 좋은 임상 결과를 보이며, 일부 구조적 손상이 동반된 근건이행부 병변에서는 수술적 치료가 고려될 수 있다.

결론적으로 극상근 근육 손상은 드물지만 투구 선수에서 발생하는 어깨 통증의 감별 진단에서 고려되어야 할 중요한 병변이며, 정확한 진단을 위해서는 임상 양상과 함께 영상학적 평가에 대한 이해가 필요하다. 향후 투구 선수에서 회전근개 근육 손상을 보다 체계적으로 분석하기 위한 추가적인 연구가 필요할 것으로 생각된다.

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학력

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야구선수에서 발생하는 회전근 힘줄 파열
Rotator cuff tendon tears in baseball players

좋은삼선병원
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서론

회전근개 손상은 야구 선수에게 흔한 통증 및 기능 장애의 원인이다. 이는 반복적인 가속, 감속, 그리고 투구 동작의 overhead 움직임으로 인해 어깨의 동적 안정 구조물에 상당한 스트레스가 가해지기 때문이다. 진단 방법과 수술적 치료의 발전에도 불구하고, 회전근개 파열이 있는 투수의 성공적인 치료는 여전히 쉽지 않다. 회전근개 병변이 있는 일부 오버헤드 운동선수에서는 변연 절제술이 효과적인 것으로 입증되었지만, 심각한 부분층 파열 및 전층 파열에 대한 수술적 봉합은 이전의 투구 수준으로 회복과 복귀가 어려울 수 있다. 야구선수에서 회전근개 손상의 성공적인 치료를 위해서는 근본적인 병리 해부학, 증상, 치료 방법에 대한 포괄적인 이해가 필요하며, 이와 함께 shoulder girdle, 견갑골, 운동 사슬, 그리고 투구 동작에 대한 철저한 평가가 이루어져야 한다.

병리 해부학

투구의 각 단계에서 회전근개는 구심성 및 편심성 스트레스를 모두 받는다. 와인드업 단계에서는 회전근개의 활동이 거의 없지만, 투수가 초기 코킹에서 후기 코킹 단계로 진행하면서 후상부 회전근개는 구심성으로 수축하여 팔을 외회전 위치로 가져간다. 이후 가속 단계에서는 견갑하근과 다른 어깨 내회전근들이 구심성으로 활성화되어 수축한다. 팔이 내회전된 상태에서 투수는 follow-through 단계를 마무리하며, 이때 후상부 회전근개가 편심성으로 수축하여 팔을 감속시키는 역할을 한다.[1)]

투수에서 회전근개 손상이 발생하는 기전에 대해서는 여러 가지 이론이 있는데, 여기에는 internal impingement, 후방 관절낭 구축, 그리고 적응성 변화(adaptive changes)가 포함된다. 투구하는 어깨는 반대측 비투구 어깨와 비교했을 때 생체역학적으로 변화를 초래하는 독특한 적응 능력을 지닌다. 예를 들어, 프로 투수는 반대측 어깨에 비해 평균 약 17도의 상완골 후염전 증가를 보이며 전방 관절낭은 이완이 증가되어 있다. 반면, 후방 관절낭의 비후 또는 구축은 내회전을 제한하며, 이를 GIRD(glenohumeral internal rotation deficit)라고 한다. 생체역학적 연구에 따르면, 후방 관절낭 구축은 오구견봉인대와 회전근개 사이의 부하를 증가시키는 것으로 나타났다.[2-4)]

Gilles Walch등 의해 관찰된 관절 내부 충돌(internal impingement)이라는 용어는, 상지 90도 외전 및 90도 외회전 위치에

서 후상방 관절와를 따라 극상근 후방과 극하근 전방의 관절면측이 접촉하는 것을 말한다.[5] Burkhart 등은 내부 충돌은 생리적인 것이며 후방 관절낭 구축으로 인해 회전근개에 가해지는 전단력과 비틀림력의 결과로 변형된 충돌이 발생하는 것으로 보고하였다.6) 이는 비정상적인 상완골두의 움직임과, 팔이 과도한 외회전 위치에 놓였을 때 회전 중심이 후상방으로 이동하는 현상을 초래한다. GIRD에서는 총 운동 범위가 유지될 수 있으나, 투구 동작이 최대 외전 및 외회전 위치로 진행되면 구축된 후방 관절낭이 병리적 연쇄 반응을 시작하게 된다. 이 연쇄 반응은 상완골두의 상대적인 후상방 전위, 전하방 관절와 상완인대의 이완, 그리고 후방 극상근 및 전방 극하근의 관절면이 후상방 관절와와 접촉하는 현상을 초래한다. 중요한 점은, 무증상 회전근개 파열이 야구 선수에서 흔하며 내부 충돌에 대한 적응적 변화로 간주된다는 것이다. 야구 투수에서 부분층 회전근개 파열은 이러한 적응성 변화로 인해 무증상일 수 있다. 반면, 전층 파열은 비교적 드물며, 대개 접촉성 스포츠 선수에서 흔히 보이는 단일 외상 사건과 더 관련이 있다. 실제로 연구에 따르면 프로 투수의 40% 이상에서 무증상의 관절면측 부분 병변이 보고되고 있다.[7] 따라서 무증상 선수에서 영상검사상 양성 소견이 존재하더라도, 반드시 중재나 치료가 필요한 것은 아닐 수 있다.

선수 평가

(1) 병력

평가는 병력 청취, 신체 진찰, 그리고 영상 검사를 통해 시작된다. 선수들의 병변은 흔히 경기력 저하와 함께 오버헤드 동작 시 발생하는 깊은 어깨 통증으로 나타난다. 특히 투수의 경우, 치료를 찾게 되는 주요 계기는 구속, 근력, 그리고 제구력의 감소와 관련되는 경우가 많다. 증상에 앞서 특정 사건이 있었는지를 확인하여, 외상성 또는 병적 파열과 적응성 변화를 구별하는 것이 중요하다.

(2) 이학적 검사

상의를 벗은 상태에서 어깨 전체를 시진하는 것에서 시작한다. 이때 어깨, 흉추, 견갑골의 좌우 차이와 근위축 여부를 중점적으로 평가한다. 또한 투구 선수에서 견갑골 운동을 주의 깊게 관찰하는 것은 견갑골 운동이상을 평가하는 데 매우 중요하다. 이는 관절 가동 범위 동안 견갑골의 비대칭적 위치 또는 과도한 전인(protraction)으로 나타난다. 이후 압통이 있을 수 있는 부위인 견봉쇄골관절, 흉쇄관절, 그리고 상완이두건을 촉진한다. 시진 후에는 가능하면 앙와위에서 좌우 비교를 통해 관절 가동 범위를 평가한다. GIRD는 투구 어깨에서 외전 상태의 내회전이 반대측에 비해 감소하지만, 양측 모두에서 총 회전 범위(total arc of rotation)는 유지되는 것이 특징이다. 이러한 각 운동 평면에서 근력 또한 동시에 평가하며, 비대칭 여부를 확인한다. 회전근개 병변은 Neer, Hawkin 충돌 유발 검사로 평가할 수 있으며, 오버헤드 운동선수에서의 회전근개 손상은 일반적으로 크기가 크지 않아 뚜렷한 근력 약화를 유발하지는 않지만, 경미한 약화는 나타날 수 있고 이러한 손상은 충돌 증상으로 나타난다.

(3) 영상의학적 검사

단순 방사선 검사 상 어깨의 Grashey view, outlet view, axillary view를 포함해야 하며, 이를 통해 초기 퇴행성 변화, 유리체, 또는 반응성 골병변을 평가할 수 있다. 초음파는 외래에서 회전근개 파열이나 상완이두건 아탈구를 진단하는 데 유용한 도구가 될 수 있다. 대부분의 경우, 선수가 이전의 경기력 수준으로 복귀하지 못할 때 병변 부위를 명확히 규명하기 위해 정밀 영상 검사가 필요하다. noncontrast MRI가 가장 흔히 시행되며, 이를 통해 상완 이두건 병변뿐 아니라 회전근개, 관절와순, 관절낭, 관절면 연골의 손상 여부를 평가할 수 있다. 다만, 야구 선수에서는 관절 내 어깨 병변에 대한 위양성 비율이 높기

때문에, 영상 소견은 반드시 철저한 병력 청취와 신체 진찰 결과와 연관 지어 해석하는 것이 중요하다.[7]

치료적 접근

야구 투수에서 회전근개 병변의 초기 치료의 기본 원칙은 비수술적 치료이다. 부분층 회전근개 파열에 대한 비수술적 치료에는 GIRD를 교정하기 위한 후방 관절낭 스트레칭, 회전근개 강화 프로그램, 견갑 주위 근육 강화, 코어 및 하지 운동, 유연성 결손 개선, 훈련 프로그램의 최적화(예: 투구 수 관리), 올바른 투구 기전 회복, 그리고 주사 치료가 포함된다.[1] 훈련 프로그램의 최적화에는 일반적으로 약 6주간의 투구 중단 후 추가로 6주간 점진적인 투구 복귀 프로그램이 포함된다. 주사의 위치와 종류(스테로이드 또는 생물학적 제제)는 기저 병변에 따라 결정된다. 견봉하 스테로이드 주사는 외부 충돌이나 점액낭 측 병변이 있는 투수에서 통증 완화, 염증 감소, 정상적인 투구 동작 회복 환경 조성을 목적으로 도움이 될 수 있다. 관절 내 스테로이드 주사는 관절면 측 병변에 더 적합하다. 혈소판 풍부 혈장과 같은 생물학적 주사도 관절 내 병변에서 고려될 수 있으나, 관련 문헌은 아직 제한적이다. 회전근개 손상(재손상 포함)의 예방을 위한 체계적인 프로그램 또한 매우 중요하다. 예방은 적절한 워밍업과 코어 및 운동 사슬 강화, 그리고 구조화된 유지 프로그램에서 시작된다. Throwers Ten 운동 프로그램은 투구에 필요한 어깨 복합체의 주요 근육을 단련하도록 구성된 체계적이고 간결한 프로그램으로, 지구력, 근력, 그리고 파워 향상에 초점을 둔다.

수술적 치료는 비수술적 치료에 실패했거나 투구 복귀 프로그램을 적절히 진행하지 못한 투수에게 시행된다. 야구 선수에서 회전근개를 봉합할 때에는 중요한 고려사항이 있다. 수술의 목표는 투구와 관련된 적응성 해부학적 변화를 고려하는 것이며, 건을 과도하게 긴장시키지 않도록 해야 하는데, 과긴장은 외전과 외회전을 제한할 수 있다. 관절면 측 부분 파열로 footprint의 50% 미만을 침범하는 경우에는 관절경적 변연 절제술이 적응증이다. 이 병변은 Partial-thickness Articular Supraspinatus Tendon Avulsion(PASTA) 병변이라고 하는데, PASTA 병변에서 전통적인 봉합술의 문제점은, 비투구 선수의 회전근개 손상에서 나타나는 현상과 달리, 주로 조직 결손에 의한 병변이기 때문에 과긴장을 유발할 수 있다는 점이다.[8] 관절면 측과 점액낭 측 회전근개가 분리되는 delamination을 동반한 부분층 파열은 부분층 관절면측 건내 파열(Partial-thickness Articular surface Intratendinous Tear, PAINT) 병변이라고 한다. 이러한 병변은 조직을 대결절에 고정하지 않고 side-to-side 봉합으로 치료한다. 견봉하 공간의 관찰도 필요하며 경우에 따라 변연절제를 시행할 수 있으나, 점액낭 측 회전근개 병변이 없는 경우가 많다. 보다 깊거나 거의 전층에 가까운 파열의 경우에는 전통적인 회전근개 봉합술로 대결절에 고정할 수 있으며 회전근개 케이블을 침범하는 전방 또는 후방 파열은 footprint에 대한 봉합이 도움이 된다.

야구 선수의 회전근개 봉합술후 복귀율은 연구마다 차이가 있다. Tibone 등은 mini-open 봉합술과 전방 견봉 성형술을 받은 프로 또는 대학 선수(부분층 30건, 전층 15건)에서 이전 수준으로 복귀한 비율이 32%라고 보고하였다.[9] Mazoue 등은 12명의 투수에서 mini-open 봉합술 후 이전 수준으로 복귀한 경우가 단 1명(약 8%)에 불과하다고 보고하여 결과가 더욱 저조했다.[10] 최근에는 Erickson 등이 메이저리그선수들을 대상으로 한 사례 시리즈를 발표했는데, 21명의 선수에서 회전근개 봉합술 후 33.3%가 투구 복귀, 그중 14.3%는 동일 수준 또는 그 이상의 수준으로 복귀했다고 보고하였다.[11] 또한 130명의 선수에서 변연 절제술 후에는 50% 이상의 복귀율, 그 중 42.3%가 동일 수준 또는 그 이상의 수준으로 복귀한 것으로 나타났다.[12] 반면 일부 연구에서는 보다 긍정적인 결과가 보고되었는데, Dines and Altchek의 소규모 사례 시리즈에서는, lateralized footprint 기법을 이용한 봉합술 후 6명의 MLB 투수 중 5명이 최소 1시즌 동안 투구 복귀에 성공했는데, 이 기법은 건의 긴장을 줄이고 투구 자세에서 봉합 공

간을 확보할 수 있도록 설계되었다.[13] 유사하게 Altintas 등은 메타분석에서 43명의 야구/소프트볼 선수를 포함한 4개의 연구를 분석했으며, 투구 복귀율 79%, 그중 38%는 동일 수준 또는 그 이상의 수준으로 복귀했다고 보고하였다.[14]

요약

회전근개 손상은 야구 선수에서 흔한 통증과 기능 장애의 원인이다. 고수준 투구에서 견관절과 그 동적 안정 구조물에 가해지는 스트레스는 적응성 해부학적 변화를 초래하며, 이러한 변화는 치료 시 반드시 고려해야 한다. 비수술적 치료가 1차 치료로 권장되며, 회전근개와 견갑 주위 근육 강화, 운동사슬 최적화, 투구 기전 개선, 다양한 물리치료적 방법에 중점을 둔다. 회전근개 봉합술을 시행할 경우, 과도한 긴장을 피하는 것이 매우 중요하며, 과긴장은 관절 가동 범위 손실과 투구 복귀율 감소로 이어질 수 있고, 연구에 따르면 MLB 투수의 투구 복귀율은 약 33.3% 정도로 보고된다.

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The 68th Spring Conference of Korean Society of Sports Medicine
사단법인 대한스포츠의학회
제68차 춘계학술대회

초청세션 5: 대한체력코치협회
무릎 스포츠 손상 후 현장 복귀를 위한 통합 전략: 기능적 통합 트레이닝
An Integrated Approach to Return to Play (RTP) After Knee Sports Injuries: Functional Integrated Training (FIT)

좌장: SRC병원 김은국, 순천향대학교 김철현



김태규

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주요 경력

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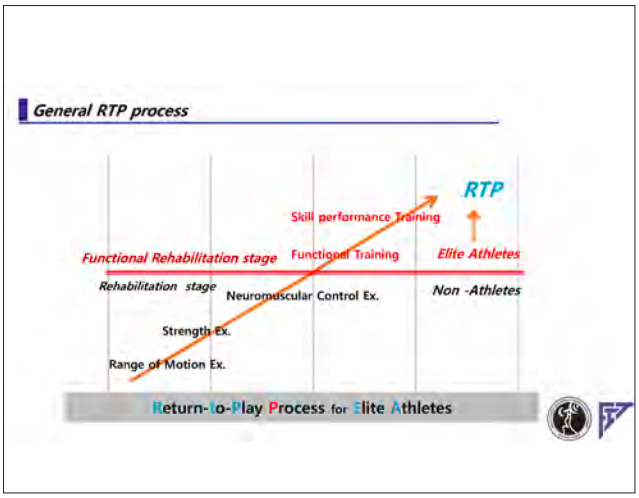
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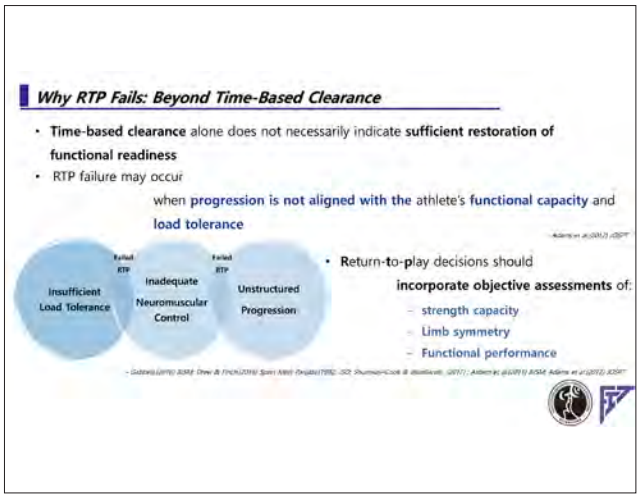
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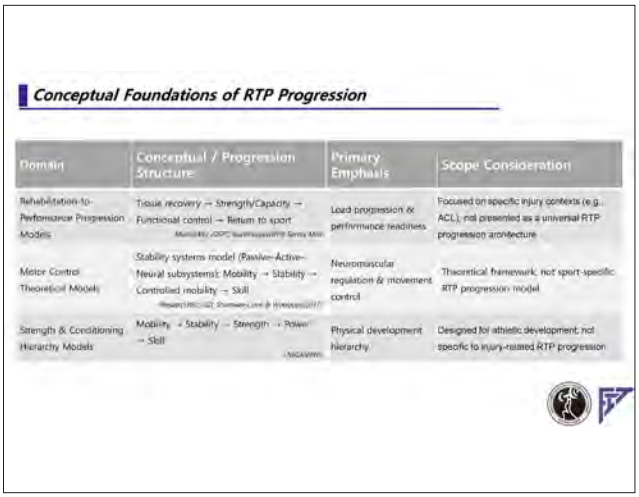
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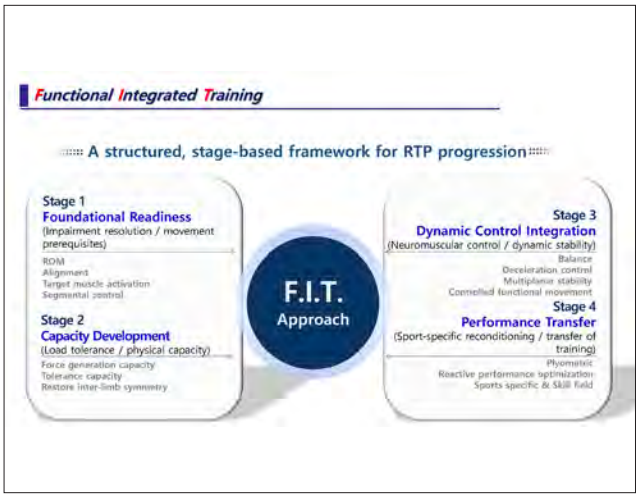
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F.I.T Strategies for RTP

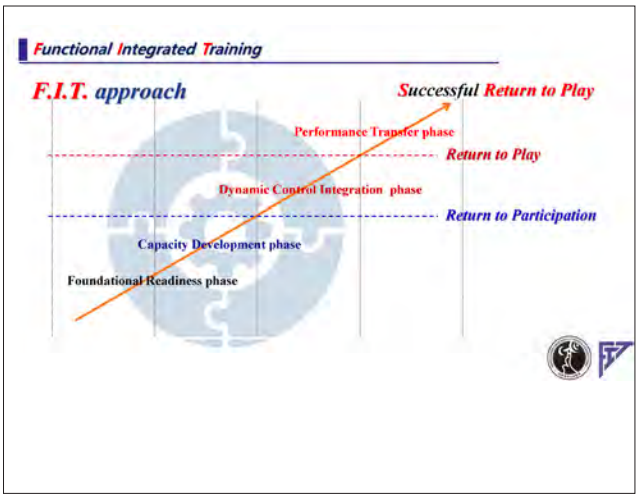
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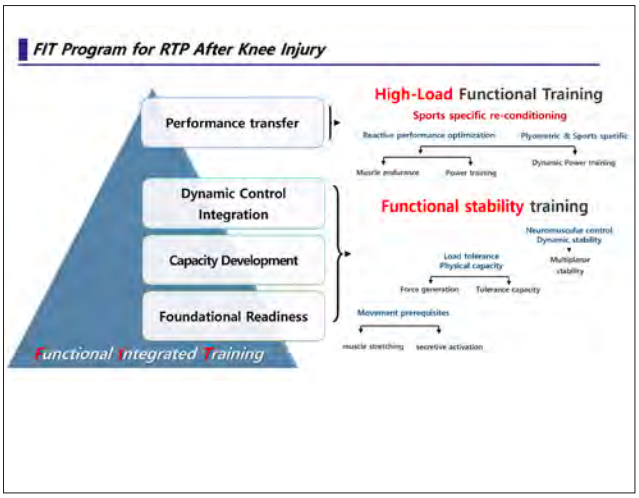







Functional Integrated Training
F.I.T. approach
Successful Return to Play
Performance Transfer phase
Return to Play
Dynamic Control Integration phase
Return to Participation
Capacity Development phase
Foundational Readiness phase


Knee Injury: Incidence and Mechanisms
Knee injury
The most prevalent and clinically significant musculoskeletal problems in athletes
→ represent over 40% of sports-related musculoskeletal injuries
Mechanisms of knee injury
Contact injury
Non-contact injury
Overuse injury
Common risk factors
Knee muscle force control imbalance (H:Q)ratio
Impact loading ↑
Knee abduction moment ↑ (valgus loading)
Frontal-plane & hip kinematics
→ Pelvic drop / hip adduction / IR ↑
Hip abductor strength ↓
Contribute to..
Dynamic Knee Valgus


FIT Program for RTP After Knee Injury
Performance transfer
Dynamic Control Integration
Capacity Development
Foundational Readiness
Functional Integrated Training
High-Load Functional Training
Sports specific re-conditioning
Functional stability training
Movement prerequisites

김수용

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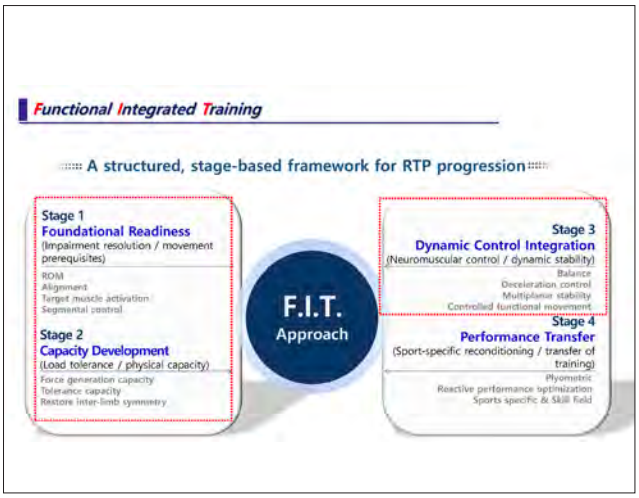
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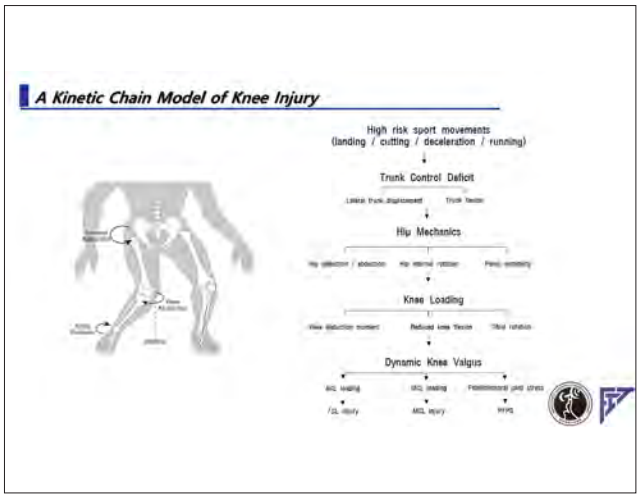
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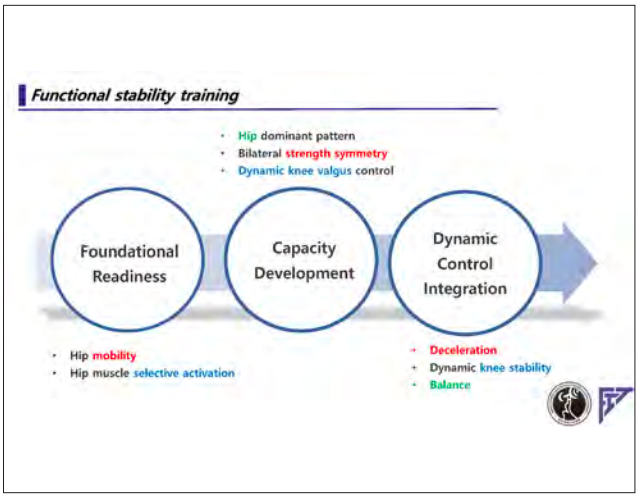
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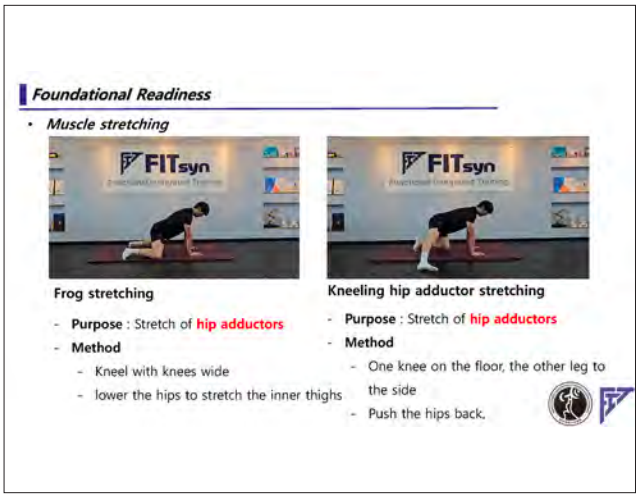
스포츠 손상 후 현장 복귀를 위한 기능적 안정성 트레이닝
Functional Stability Training for RTP

양산부산대병원
김수용









Foundational Readiness

- *Selective activation of Gmed & Gmax*



Sidelying hip abduction

- **Purpose** : Selective activation of **Gmed**
- **Method**
  - Sidelying position
  - Hip **extension** + **ER** + **abduction**



Prone hip extension

- **Purpose** : Selective activation of **Gmax**
- **Method**
  - Prone position + Bend the **knee** to **90°**
  - **Hip extension**

Capacity Development

- *Bridge exercise*



Bridge exercise

- **Purpose** : **Gmax strength**
- **Method**
  - Supine position+ Bend the knee to 90°
  - Hip extension



Bridge exercise with ball

- **Purpose** : **Hip extensor strength**
- **Method**
  - Bridge on ball
  - Hip & knee flexion

Capacity Development

- *Squat*

- **Purpose** : **Gluteal muscle & Q-muscle** strength
  Hip strategy
  Knee dynamic stability
- **Method**
  - Stand shoulder-width apart
  - **Hip hinge** + Knee flexion
- **Clinical tips** :
  - Alignment
    - Lumbopelvic neutral position
    - **Dynamic knee valgus**(DKV)



Capacity Development

- *Monster gait*

- **Purpose** : **Gluteal muscle & Q-muscle** strength
  Lateral knee stability
  hip-knee-ankle **coordination**
- **Method**
  - Place a band around the ankles.
  - Slightly bend the hips and knees.
  - Step forward while keeping tension on the band.
  - Keep the knees aligned with the toes.
- **Clinical tips** :
  - Alignment (Lumbopelvic neutral position), **DKV**



Capacity Development

- *Lateral step up down*

- **Purpose**: **Lateral pelvic stability**
  Controlled **single-leg loading**
- **Method**
  - Stand beside the step box.
  - Place the exercise leg on the step box.
  - Push through the step to lift the body.
  - Slowly lower the opposite leg to the floor.
- **Clinical tips**
  - Maintain **pelvic level**: **GMed**
  - Control **DKV**



Dynamic Control Integration

- *Single leg squat*

- **Purpose** : **Single leg knee stability**
  Deceleration control
  Hip-knee-ankle coordination
- **Method**
  - Place one foot on the step box.
  - Perform a single-leg squat.
- **Clinical tips** :
  - Alignment
    - Lumbopelvic neutral position
    - **DKV**



Dynamic Control Integration

- *Side Lunge with aqua bag*



- **Purpose** : Lateral deceleration control
  Dynamic lateral knee stability
- **Method** :
  - Shift the weight outward in a lowered position.
  - Keep the knee aligned with the toes
- **Clinical tips** :
  - Alignment
    - Lumbopelvic neutral position
    - Control DKV

Dynamic Control Integration

- *Aqua Bag Lunge Hold (Shaking)*



- **Purpose** : Reactive neuromuscular control
  dynamic rotation knee stability
- **Method** :
  - Hold an aqua bag and maintain a lunge
  - Swing the aqua bag side to side.
- **Clinical tips** :
  - Alignment
    - Lumbopelvic neutral position
    - Control DKV

Functional stability training

Return to Participation



Return to Play



천우호

학력

한국체육대학교 체육학과 학사

한국체육대학교 사회체육대학원 생활체육학과 석사

순천향대학교 일반대학원 체육학과 박사

주요 경력

현) 대육체육회 진천선수촌 체력전문위원

현) 대한스포츠과학 운동의학회 이사

전) 서울시 역도연맹 이사

전) 국민대학교 겸임교수

현재 소속 및 직위

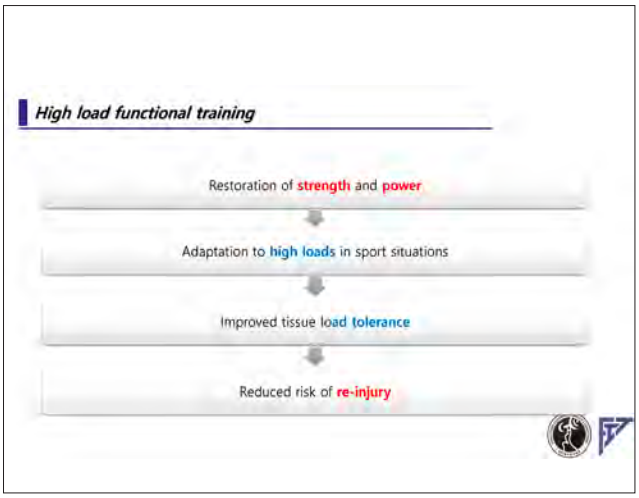
대한체육회 진천선수촌 체력전문위원

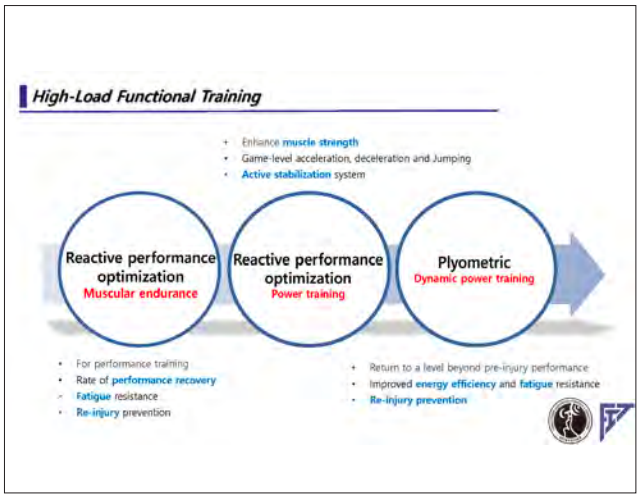
대표논문

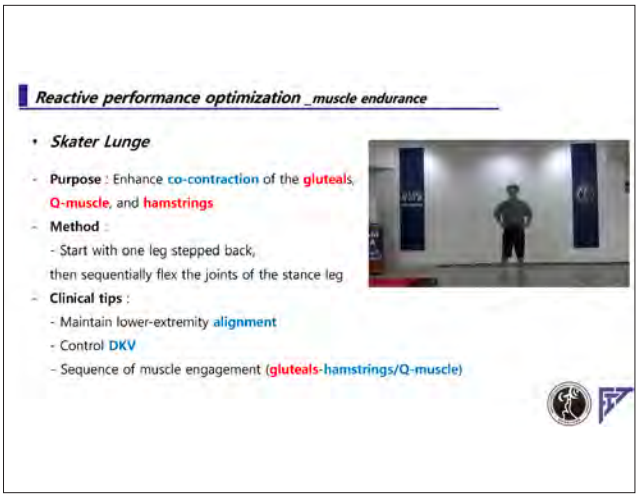
1. Lee JB, Chun Wh, Lee KH. Comparison of One-Repetition Maximum (1RM) Strength across Sports among Male National-LevelAthletes in Korea. International Journal of Human Movement and Sports Sciences. 2025;13(1):235-242.
2. 이동률, 이규림, 천우호, 성준영. Functional Movement Screen을 통한 성인 엘리트 선수들의 기능성 동작 및 좌우 비대칭성 분석. 한국 스포츠학회지. 2021;19(3):761-771
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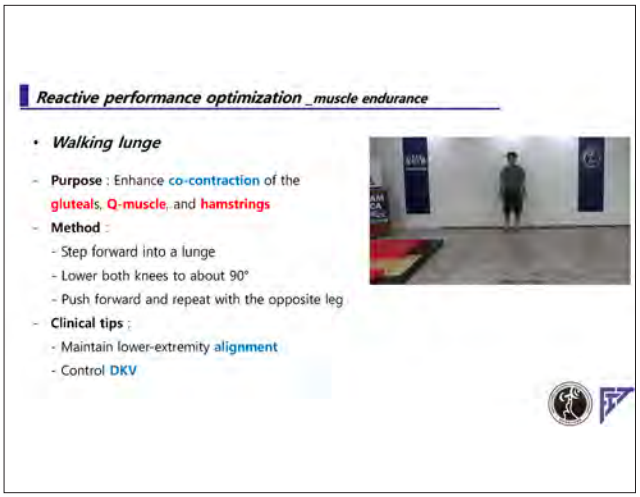
스포츠 손상 후 현장 복귀를 위한 고강도 기능적 트레이닝
High-Load Functional Training for RTP

진천선수촌
천우호









Reactive performance optimization _muscle endurance

- **Bosu Squat / Wobble**



- **Purpose** : Enhance **co-contraction** of the **gluteals** and **Q-muscle**
- **Method** :
  - Maintain a neutral lumbopelvic position on the BOSU
  - Rapidly tap both feet in a squat position
- **Clinical tips** :
  - Maintain **spinal** and **lower-extremity** alignment
  - Tap the feet as quickly as possible

Reactive performance optimization _muscle endurance

- **Bent Over Squat**



- **Purpose** : Strengthen the **gluteals** and **hamstrings**
- **Method** :
  - Hinge at the hips with your torso slightly forward
  - bend the knees to perform a squat
- **Clinical tips** :
  - Maintain a neutral spine
  - **Extend** the **trunk** through the hip joint

Reactive performance optimization _Power training

- **Backward Lunge to Box Step Up**



- **Purpose** : Enhance **co-contraction** of the **gluteals**, **Q-muscle**, and **hamstrings**
- **Method**:
  - From the box
  - Perform a lunge(with **barbell**) while stepping one leg back
- **Clinical tips**:
  - Maintain **spinal** alignment
  - Control **DKV**

Reactive performance optimization _Power training

- **Back Squat**



- **Purpose** : Enhance **co-contraction** of the **gluteals**, **Q-muscle**, and **hamstrings**
- **Method** :
  - Maintain intra-abdominal pressure
  - Flex the hip, knee, and ankle in the same movement pattern
- **Clinical tips** :
  - **Spinal** alignment
  - **Muscle recruitment** changes according to lower-extremity position

Reactive performance optimization _Power training

- **Box Squat**



- **Purpose** : Enhance **co-contraction** of the **gluteals**, **Q-muscle**, and **hamstrings**
- **Method**:
  - From the starting squat position
  - Sit down on the box and stand back up
- **Clinical tips**:
  - Maintain **spinal** alignment
  - Control **DKV**
  - Use explosive contraction

Reactive performance optimization _Power training

- **Seated Squat**



- **Purpose** : **Strengthen** the **gluteals**, **Q-muscle**, and **hamstrings**
- **Method** :
  - Perform the movement from a seated position while forcefully driving off the floor
  - Flex and extend the hip and knee in the same movement pattern
- **Clinical tips**:
  - Maintain **squat alignment** when driving off the floor
  - Use **explosive contraction**

Plyometric & Sports specific _Dynamic power training

- *Skater Jump*



- **Purpose** : Strengthen the gluteals, Q-muscle, and hamstrings and improve power
- **Method** :
  - Perform the movement by jumping side to side in a Skater Lunge
- **Clinical tips** :
  - Maintain a neutral trunk and stance leg
  - Control DKV
  - Stabilize the position after landing

Plyometric & Sports specific _Dynamic power training

- *Single Leg Lateral Step up Jump*



- **Purpose** : Strengthen the gluteals, Q-muscle, and hamstrings and improve power
- **Method**:
  - Place one leg on the box, then jump and land
- **Clinical tips**:
  - Maintain upper-body and landing-leg alignment
  - Explosive extension of the hip, knee, and ankle

Plyometric & Sports specific _Dynamic power training

- *Alternating Lateral Step up Jump*



- **Purpose** : Enhance co-contraction of the gluteals, Q-muscle, and hamstrings
- **Method**:
  - With the box in the center, repeatedly jump and land from side to side
- **Clinical tips**:
  - Maintain lower-extremity alignment
  - Keep the head level and switch legs side to side quickly

Plyometric & Sports specific _Dynamic power training

- *Squat Jump*



- **Purpose** : Strengthen the gluteals, Q-muscle, and hamstrings and improve power
- **Method**:
  - Flex the hip, knee, and ankle in the same movement pattern, then extend rapidly into a jump
- **Clinical tips**:
  - Maintain upper-body and lower-extremity alignment
  - Pay attention to knee valgus during jump and landing

Functional Integrated Training



Return to Play in knee injuries is achieved through F.I.T.

The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

3월 22일(일요일)

Room C



The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회

제68차 춘계학술대회

심포지엄 14: 좋은 논문, 좋은 저널: KJSM와 함께 성장하기

Better Papers, Better Journal: Growing with KJSM

(편집위원회)

좌장: 서울시립대 제세영, 순천향대부천병원 이영구



학력

중앙대학교 의학과 학사, 석사, 박사
방송통신대학교 정보통계학과 학사
고려대학교 보건대학원 역학보건정보학과 석사
고려대학교 대학원 역학과 박사 수료

주요 경력

Anesthesia and Pain Medicine-Editor in Chief
Journal of Evidence Based Practice-Editor in Chief
CardioMetabolic Syndrome Journal-Editor in Chief
Korean Journal of Pain-Section Editor
Systematic Reviews – Associate Editor

현재 소속 및 직위

중앙대학교 의과대학 마취통증의학과, 교수

대표논문

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AI 시대 의학논문출판 실전
Practical Guide to Publishing Medical Papers in the AI Era

중앙의대
강 현

Conflict of Interest Disclosure

Responsible use of large language models in manuscript authorship, peer review, and editorial processes: a Delphi consensus among editors-in-chief of anaesthesia and pain medicine journals (RULE-AP)

I am one of authors of this publication.

I used ChatGPT (GPT-5.3, accessed March 2026) and Gemini 3 Flash (accessed March 2026) for language editing and reference search.

Why This Topic Is Urgent

● AI는 이미 우리 주변에 와 있습니다

- 전공의, 학생들은 이미 사용 중
- 연구자, 저자, 리뷰어, 에디터도 사용 중
- 문제는 "사용 여부"가 아님
- 문제는 "누가, 무엇을, 어떻게 통제할 것인가?"임
- 이는 Academic Ownership(학문적 주권)을 어떻게 지킬 것인가?와도 연관이 됨

Introduction

● AI는 이미 우리 주변에 와 있습니다

- 대규모 언어 모델(LLM)은 일반적으로 트랜스포머(Transformer) 신경망 구조와 자연어 처리 기술에 기반한 고급 딥러닝 아키텍처임.
- LLM은 별도의 작업 특화된 학습(Task-specific supervision) 없이도 이해, 생성, 번역, 요약, 추론을 포함한 광범위한 언어 관련 업무들을 수행할 수 있는 역량을 갖추고 있음.

Introduction

● AI는 이미 우리 주변에 와 있습니다

- LLM은 일상생활에 빠르게 자리 잡았음.
- 또한, 과학적 글쓰기, 문헌 및 데이터베이스 검색, 정보 정리, 초안 작성, 교정 등 광범위한 학술적 목적으로 활용되면서 과학계 전반에 침투하였음.
- LLM이 비원어민 연구자들의 영어 학술 글쓰기 능력을 크게 향상할 수 있음을 입증하였음.

Introduction

● **AI는 이미 우리 주변에 와 있습니다**

- LLM은 반복적인 업무를 자동화함으로써 연구자의 인지적 부하(Cognitive load)를 줄여주어, 연구자가 고차원적인 추론과 분석에 더 집중할 수 있게 해 줄 수 있음
- LLM은 실시간 피드백을 제공함으로써 학술 텍스트의 구조, 명확성, 그리고 일관성을 개선할 수 있음.

Introduction

● **AI의 부작용과 윤리적 위험성**

- LLM이 가공의 데이터(fabricated data), 정형화된 이미지(stereotyped imagery), 존재하지 않는 참고문헌(non-existent reference), 혹은 '비문(Tortured language)'과 같은 허위 사실(흔히 '환각(hallucination)'이라 불리는 현상)을 생성할 수 있다는 점은 입증되고 있음.

Introduction

● **AI의 부작용과 윤리적 위험성**

- 이러한 오류가 LLM에만 국한된 것은 아니고, 인간이 작성한 원고에서도 발견되지만, 이를 감지하지 못한 채 자동화된 방식으로 대량 생산하는 것은 학술적 진실성(Academic integrity)에 위협이 될 수 있음!

Introduction

● **AI의 부작용과 윤리적 위험성**

- 과학적 글쓰기에 LLM을 사용하는 것은 더 빠르지만 잠재적으로 정확성이 떨어지는 결과물을 만들어내는 '지름길'을 택하는 것에 비유되기도 함!
- 저자가 LLM 사용 여부를 밝히지 않을 경우, 인간이 쓴 글과 LLM이 작성한 글을 구분하는 것은 매우 어려움!

Introduction

● **지금, 편집자들은 무엇을 직면하고 있을까요?**

- 존재하지 않거나, 잘못 인용된 참고문헌 (Fabricated references)
- 너무 매끄러워서 의심스러운 discussion (AI-written discussion sections)
- 유사한 구조의 낮은 질의 원고 폭증 (Explosion of low-quality submissions)
- AI 미공개 사용 (Undisclosed AI use)

Introduction

● **이 Consensus의 목적**

- 저자, 편집자, 심사위원, 출판업자들에게 과학 출판의 진실성을 보존하면서도 LLM을 학술 과정에 안전하고 효과적으로 통합할 수 있는 실무적 체계(framework)를 제공하는 것

Consensus

● **세계 주요 편집장들의 합의**

- 전세계 Anesthesia and Pain Medicine 영역의 주요 53명의 Editors-in-Chief 가 참여
- Delphi consensus

Consensus

● **General**

1. 지속적인 업데이트 (Living Document)

- 이 합의안은 **유동적인 문서(Living document)**로 취급되어야 하며, 새롭게 등장하는 증거, 기술 및 윤리적 발전을 반영하기 위해 정기적으로 업데이트되어야 한다.

2. 투명한 사용의 가치 인정 (Permitted & Disclosed Use)

- 각 학술지의 정책에 따라 **허용**되고, **공개**되었으며, **감독**하에 사용된 LLM은 원고의 과학적 질이나 진실성을 훼손하지 않는다.
- 따라서 저자, 심사위원, 편집자는 이러한 사용을 **부정적으로 인식해서는 안 된다.**

Consensus

● **Author**

저자권과 책임 (Authorship & Responsibility)

3. LLM은 저자로 등재될 수 없다.
4. AI를 썼더라도 내용의 정확성, 진실성, 독창성에 대한 모든 **책임**은 사람 저자에게 있다.
5. 제출 전 모든 AI 생성물은 저자가 직접 **검토**하고 **승인**(Endorse)해야 합니다
11,12. 생성 AI로 만든 이미지의 저작권 침해 여부와 정확성, 도표의 설명(Caption)에 대한 **책임**은 저자에게 있음.

Consensus

● **Author**

저자권과 책임 (Authorship & Responsibility)

20. 저자는 LLM에 의해 생성된 모든 환자별 권고 사항이 정확한지 반드시 **확인**해야 함

27. 환자 **데이터를 분석**하기 위해 LLM을 사용하기 전, 저자는 환자의 개인정보 보호 및 관련 규정 준수를 보장하기 위해 반드시 **기관생명윤리위원회(IRB)의 승인**을 받아야 함.

Consensus

● **Author**

허용되는 활용 범위 (Appropriate Use)

6. **언어 교정**: 문법, 구문, 어조, 명확성 개선.
8. **형식** 및 구조: 참고문헌 스타일링, 학술지 구조 맞춤, 글자 수 제한 준수.
9. 초안 보조: 초록, 제목, 평이한 요약문작성을 도울 수 있으나 반드시 검증 필요.
10. **데이터 요약**: 요약본을 만들 수 있으나, 반드시 원본 소스와 대조하여 확인해야 함.
13. **검색** 전략: 검색어 제안이나 불리언(Boolean) 연산자 최적화 보조.

Consensus

● **Author**

허용되는 활용 범위 (Appropriate Use)

24. 브레인스토밍 과정의 일부로서 **개념도(conceptual mapping)** 작성을 지원하는 데 사용

25. **보고 표준(예: CONSORT, PRISMA, STROBE 등)의 준수 여부를 확인**하는 것은 LLM의 적절한 보조적 역할임. 단, 이러한 사용은 투명하게 공개되어야 하며 저자의 검토가 수반되어야 함.

26. 자동화 도구를 사용하여 **번역**된 원고는 최소 한 명 이상의 저자 또는 해당 언어에 능통한 전문 번역가에 의해 **정확성이 검토**되고 **확인**된 경우에만 수용 가능함

Consensus

● **Author**

절대 금지 및 제한 사항 (Strict Prohibitions)

14. **원천 데이터 생성**이나 **데이터셋 조작**에 LLM을 사용해서는 안됨.
15. **결과 해석, 결론 도출, 연구의 맥락 설정**은 오직 인간의 책임임.
16. **참고문헌 자동 생성** 금지: LLM이 스스로 인용문을 만들게 해서는 안 됨(환각 위험).
17. **개인정보 보호:** 환자 식별 정보나 기밀 데이터를 공개 LLM에 입력하는 것은 법적/윤리적으로 금지됨.
18. **통째로 쓰기** 금지: 원고 전체나 특정 섹션을 AI가 작성하게 하는 것 → 지적 저자권을 훼손하는 부적절한 행위

Consensus

● **Author**

절대 금지 및 제한 사항 (Strict Prohibitions)

19. **가설 설정**: 독창적인 연구 설계와 가설 생성은 연구자의 핵심적인 지적 책임임.
22. 저자는 저작권자의 명시적인 동의 없이 저작권이 있는 자료를 수정하거나 재구성(rephrase)하도록 LLM에 요청해서는 안 됨
23. 자료의 사용 또는 수정을 위한 허가를 받았더라도, 원본 출처는 항상 적절하게 인용되어야 함

Consensus

● **Author**

투명성(Transparency)

7. 투명한 공개: AI 생성 콘텐츠 포함 시 반드시 학술지 가이드라인에 따라 공개하여야 함
21. 저자는 원고 작성 과정에서 사용된 LLM의 모든 실질적인 사용 사례를 공개해야 하며, 도구가 어떻게, 어떤 목적으로 적용되었는지 구체적으로 명시해야 함

Consensus

● **AI Disclosure 예시**

"ChatGPT (GPT-4.1, accessed January 2026) was used for grammar editing. All outputs were verified by the authors."

Consensus

● **Editor, reviewer and publisher**

엄격한 처벌과 학술지의 책임 (Prohibitions & Responsibility)

1. LLM의 모든 **금지된 사용**은 심각한 위반(Breach) 으로 간주되어야 하며, 이는 **원고 거절** 또는 **철회(Retraction)**의 근거가 될 수 있음
2. 학술지는 전문적인 언어 교정이나 번역 서비스와 마찬가지로, LLM 사용을 공시하고 구체적인 기여 내용을 기술해야 함을 명확히 할 책임이 있음.
3. 학술지는 **LLM의 허용 가능한 사용 범위**와 공시 방법에 관한 명확한 지침을 수립할 책임이 있음

Consensus

● **Editor, reviewer and publisher**

엄격한 처벌과 학술지의 책임 (Prohibitions & Responsibility)

4. LLM이 생성한 콘텐츠에 기반하여 원고의 독창성, 영향력 또는 게재 승인 여부를 결정하는 편집상의 결정(Editorial decisions)은 허용되지 않음.
5. 출판사와 편집자는 투명한 정책을 시행할 책임을 공유한다

Consensus

● Editor, reviewer and publisher

편집 도구로서의 LLM 활용 (Editorial Support)

5. LLM은 편집자가 **표절, 중복 투고** 또는 AI 생성 콘텐츠의 잠재적 징후를 감지하는 데 도움을 줄 수 있음.

6. LLM은 **내부적 불일치**(예: 초록, 표, 본문 간의 불일치)를 찾아내는 데 도움을 줄 수 있으나, 저자와 편집자가 반드시 그 정확성을 확인해야 함

7. 필수 섹션, 단어 수, 형식 등 학술지 가이드라인 준수 여부를 확인하는 과정은 적절하게 자동화되거나 LLM의 지원을 받을 수 있음

Consensus

● Editor, reviewer and publisher

편집 도구로서의 LLM 활용 (Editorial Support)

12. LLM이 AI 생성 콘텐츠가 과도한 투고물을 식별하는 유일한 방법으로 사용되어서는 안 됨.

13. 편집 작업 흐름에는 언어 윤문이나 참고문헌 형식 교정을 위한 LLM 기반 도구가 포함될 수 있음. 단, 그 사용은 **투명하게 공개**되어야 함.

14. LLM은 전문 지식과 이해 상충 여부를 데이터베이스에서 검색하여 심사위원 후보를 찾는 데 도움을 줄 수 있음. 그러나 심사위원 배정의 최종 책임은 편집자에게 있음.

Consensus

● Editor, reviewer and publisher

심사 과정에서의 기밀 유지와 책임 (Reviewing & Confidentiality)

9. LLM으로 생성된 심사평(Peer review reports)은 **허용되지 않음**. 이는 **기밀 유지 의무를 위반**하는 행위이기 때문임.

10. 기밀이 유지되어야 하는 원고는 학술지가 승인한 보안 AI 시스템으로만 처리해야 하며, 공개 도구(Public tools)에 업로드하는 것은 기밀 유지 의무 위반임.

11. 편집자와 심사위원은 평가 과정에서 LLM을 사용한 경우, 어떤 LLM을 사용했고 어떤 업무를 지원받았는지 명시하여 이를 공개해야 함.

Consensus

● Editor, reviewer and publisher

심사 과정에서의 기밀 유지와 책임 (Reviewing & Confidentiality)

15. LLM이 생성한 요약본은 학술지가 해당 업무에 대해 승인한 경우에 한해 심사위원이 원고를 분류(Triaging)하는 데 도움을 줄 수 있음. 그러나 최종 평가는 전적으로 인간의 검토에 달려 있음.

16. 심사위원은 피드백의 명확성이나 언어 표현을 개선하기 위해 LLM을 사용할 수 있음. 그러나 심사평의 내용과 진실성에 대한 모든 책임은 심사위원 본인에게 있음.

Consensus

● Editor, reviewer and publisher

LLM 공시 (LLM Disclosure)

1. 원고 작성 과정에서 LLM 사용을 투명하게 공개하지 않는 것은 신뢰를 저해하며, 이러한 사용에 관한 의도적인 기만은 학술적 부정행위에 해당함.

2. 보고의 일관성을 위해, 이해상충(Conflict-of-interest) 선언과 유사한 형태의 표준화된 **'AI 공시 문구(AI Disclosure Statement)'** 섹션을 원고에 추가해야 함.

3. 연구 방법론과 관련된 모든 LLM 사용은 방법(Methods) 섹션에 투명하게 보고되어야 한다.

Consensus

● Editor, reviewer and publisher

LLM 공시 (LLM Disclosure)

4. 공시 문구에는 도구 명칭, 버전, 접속 날짜 및 사용 범위를 명시해야 함.

5. 학술지는 투고물 간의 통일성을 보장하기 위해 저자에게 표준화된 공시 템플릿을 제공해야 함.

6. 출판사와 학술지는 공시의 목적이 처벌이 아니라 투명성, 신뢰 및 책임 있는 사용을 증진하기 위함임을 강조해야 함.

Consensus

● **Editor, reviewer and publisher**

LLM 공시 (LLM Disclosure)

7. 저자는 커버 레터(Cover letter)에서 LLM 사용의 성격, 범위 및 목적을 명시하여 공개할 것이 권장됨.
8. 기존의 문법 교정 소프트웨어와 마찬가지로, 단일 단어나 짧은 문장의 철자 또는 구두점 점검은 공시를 요구하지 않음.
9. 저자는 투명성과 책임성을 위해 LLM에 사용된 프롬프트, 파라미터(매개변수) 및 작업 흐름을 기록해 둘 것이 권장됨.

Consensus

● **Editor, reviewer and publisher**

인식된 위험 (Perceived risks)

1. LLM은 조작된 데이터, 참고문헌 또는 그럴듯하지만 틀린 진술과 같은 '환각(Hallucinations)'을 생성하기 쉬우며, 이는 독자를 오도할 수 있다.
2. 적절한 훈련 없는 LLM에 대한 과도한 의존은 비판적 사고, 독창성, 과학적 글쓰기 능력을 포함한 필수적인 학문적 역량을 약화시킬 수 있다.
3. LLM 사용은 의도치 않게 기밀 사항이나 미발표 자료를 노출시켜 지식재산권 침해의 위험을 초래할 수 있다.

Consensus

● **Editor, reviewer and publisher**

인식된 위험 (Perceived risks)

4. 저품질 AI 생성 원고의 확산은 심사 시스템을 마비시키고 출판 표준을 하락시킬 위험이 있다.
5. LLM 사용에 대한 교육은 책임 있는 학술 활동의 일부로 간주되어야 한다.
6. LLM의 출력값은 예측 가능하지 않다. 동일한 프롬프트라도 모델 버전이나 맥락에 따라 다른 응답을 내놓을 수 있으며, 이는 재현성(Reproducibility)을 복잡하게 만든다.

Consensus

● **Editor, reviewer and publisher**

인식된 위험 (Perceived risks)

7. AI 생성 원고의 통제되지 않은 증가는 미래의 AI 도구가 자신이 만든 인공적인 콘텐츠를 다시 학습하게 만들 수 있으며, 이는 '모델 붕괴(Model collapse)'를 일으켜 과학적 결과물의 질을 떨어뜨릴 수 있다.

Key Messages

● **핵심메세지**

- 대규모 언어 모델(LLM)은 **과학적 글쓰기**와 편집 워크플로우에서 특정 측면을 **지원**하는 데 활용될 수 있다.
- LLM의 사용이 투명하게 **공개**되고, 인간에 의해 신중하게 **검증**되며, 최종적인 **책임**이 전적으로 인간에게 있는 경우라면, 이러한 허용된 사용은 원고의 질을 저하시키지 않는다.
- LLM 기술은 급격히 발전하고 있기 때문에, 본 권고사항은 정기적인 업데이트가 필요한 '살아있는 프레임워크(living framework)'로 간주되어야 한다.

Conclusion

- AI 시대에 살아남는 연구자는 가장 빠른 사람이 아니다.
- 가장 정직한 사람이다.
- AI가 연구자를 대체하지는 않는다.
- 그러나 AI를 무비판적으로 사용하는 연구자는 도태될 것이다.


Q
& A


Q
& A
Hank you

김지형

학력

서울대학교 의학과 학사
서울대학교병원 인턴
삼성서울병원 정형외과 레지던트

주요 경력

statistical editor, in Clinics in Orthopedic Surgery
statistical editor, in Hip and Pelvis
statistical editor, in Korean Journal of Sports Medicine
statistical editor, in Knee Surgery & Related Research
Graphics Editor, in Journal of Korean Medical Science (JKMS)

현재 소속 및 직위

서울성심병원 정형외과 과장

대표논문

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3. Muñoz Laguna, Javier, Hyangsook Lee, Eduard Poltavskiy, Jeehyoung Kim, and Heejung Bang.“Participant’s Treatment Guesses and Adverse Events in Back Pain Trials: Nocebo in Action?” Clinical Trials, September 13, 2024, 17407745241276124. https://doi.org/10.1177/17407745241276124.

대표저서

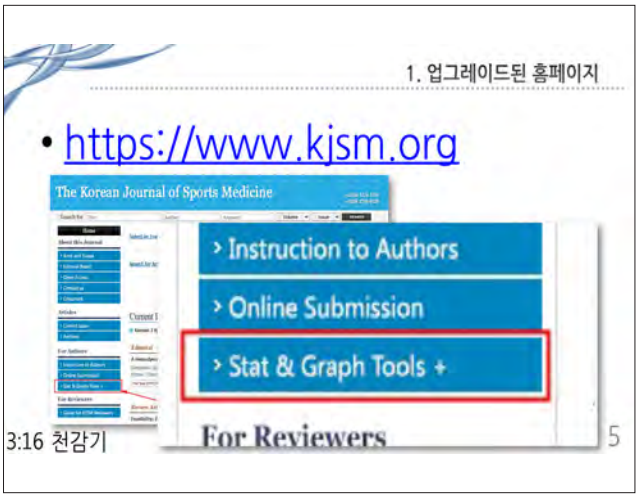
『일차진료의를 위한 정형외과』 1판, 2판, 3판
『논문 쉽고 편하게 쓰자』 1판, 2판, 3판
『한눈에 쏙쏙 의학 통계 배우기』 (문화체육관광부 우수학술도서상) 1판, 2판, 3판
『쉽고 편하게, 메타분석』 (문화체육관광부 우수학술도서상)

의학논문 작성 시 쉽게 활용하는 통계 꿀팁
Statistical Tips for Easily Writing Medical Papers

서울성심병원
김지형

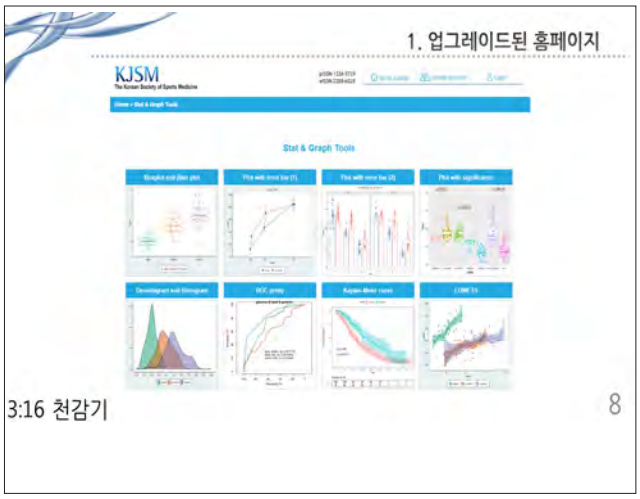


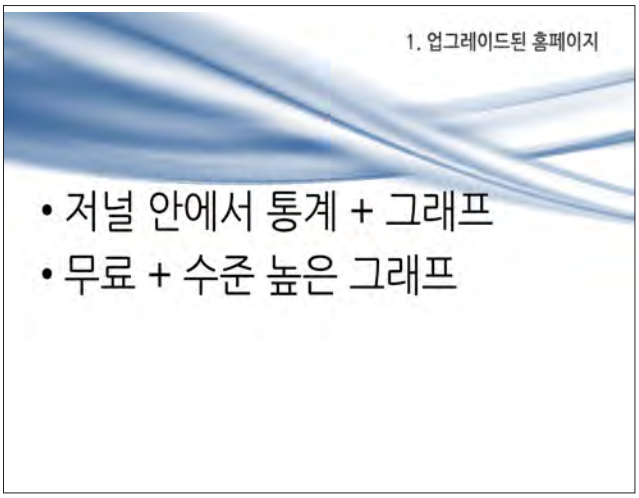




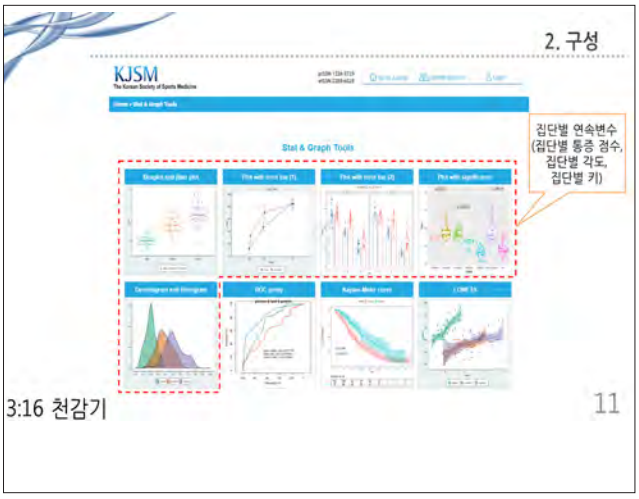


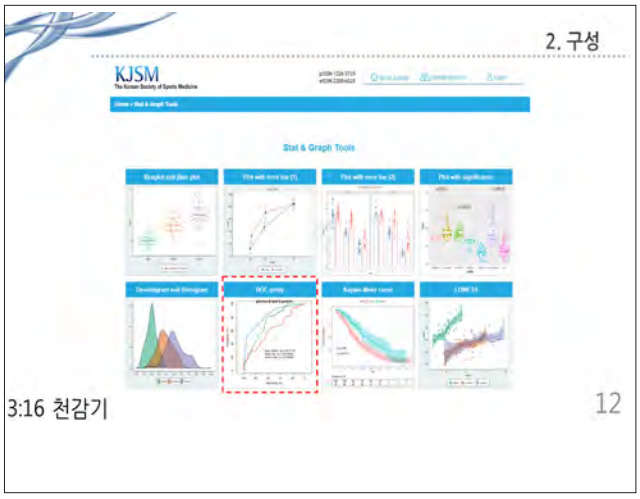

1. 업그레이드된 홈페이지
survival analysis
3:16 천감기
7

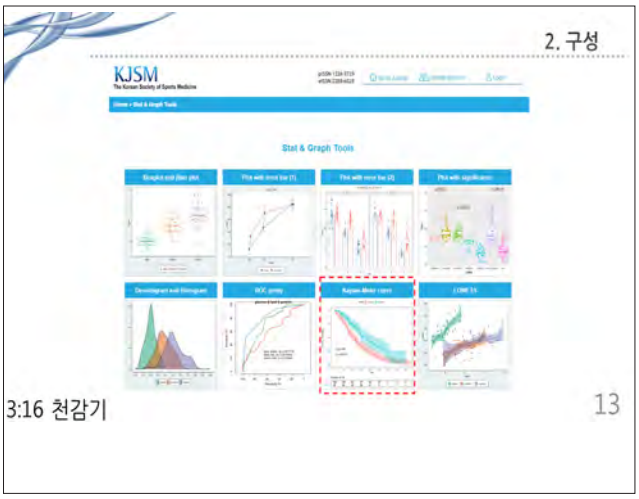

1. 업그레이드된 홈페이지
KJSM
Stat & Graph Tools
3:16 천감기
8

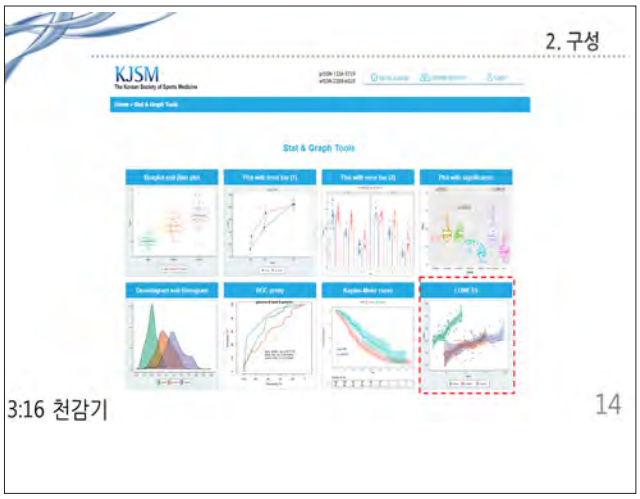

1. 업그레이드된 홈페이지
• 저널 안에서 통계 + 그래프
• 무료 + 수준 높은 그래프

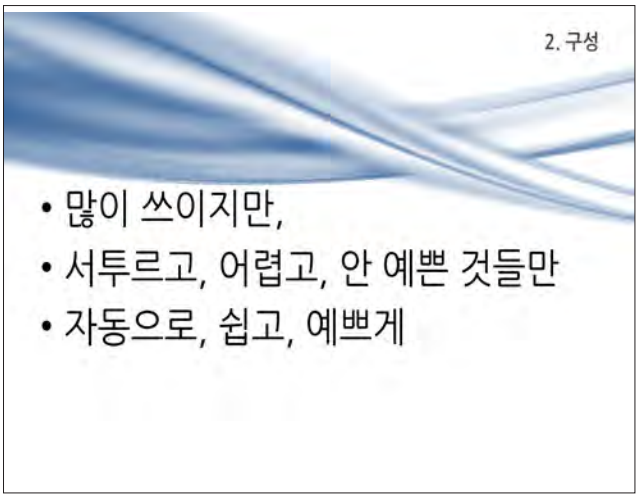

2. 구성
In God we trust; all others must bring data (protocol and SAS output). --- W. Deming

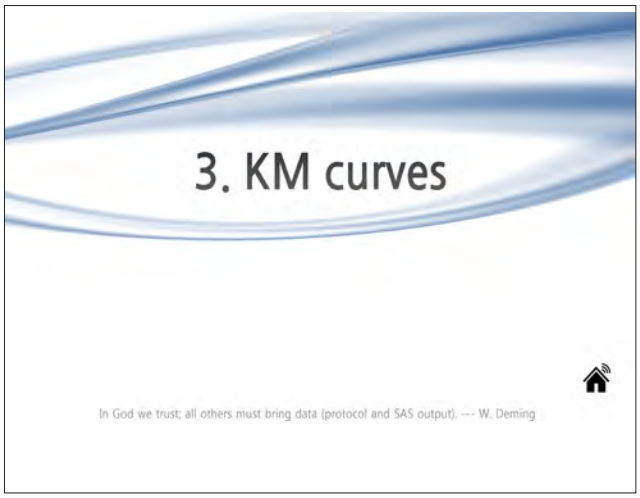

2. 구성
KJSM
Stat & Graph Tools
집단별 연속변수
(집단별 통증 점수,
집단별 각도,
집단별 키)
3:16 천감기
11


2. 구성
KJSM
Stat & Graph Tools
3:16 천감기
12

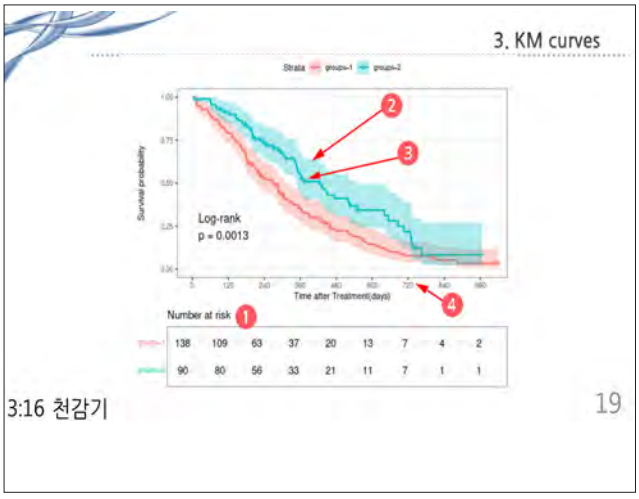

2. 구성
KJSM
Stat & Graph Tools
3:16 천감기
13


2. 구성
KJSM
Stat & Graph Tools
3:16 천감기
14


2. 구성
• 많이 쓰이지만,
• 서투르고, 어렵고, 안 예쁜 것들만
• 자동으로, 쉽고, 예쁘게


3. KM curves
In God we trust; all others must bring data (protocol and SAS output). --- W. Deming


3. KM curves
Show List of Stat & Graph Tools
survival analysis
3:16 천감기
18

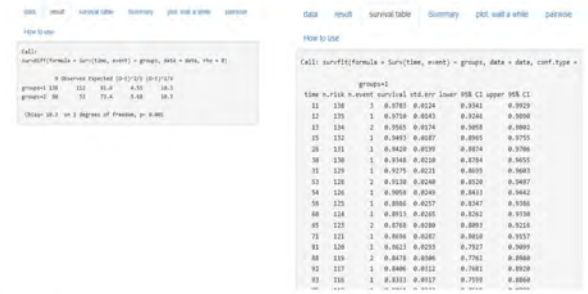

3. KM curves
Log-rank
p = 0.0013
Time after Treatment(days)
Number at risk
3:16 천감기
19

3. KM curves

- SPSS → No at risk table 불가능
- R, python, Stata, SAS 편집하면
- X축 편집, 까다로움

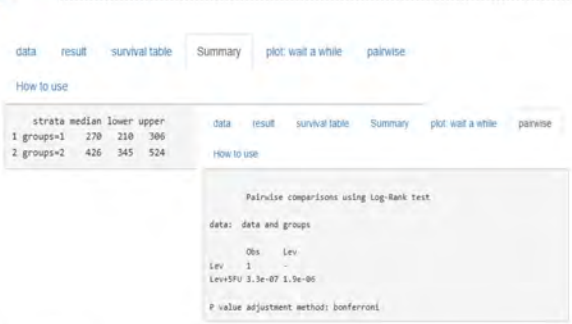
3:16 천감기 20

3. KM curves



3:16 천감기 21

3. KM curves



3:16 천감기 22

3. KM curves

- 최소한의 편집으로
- 국제적인 권장사항에 맞는
- 자유로운 편집 가능

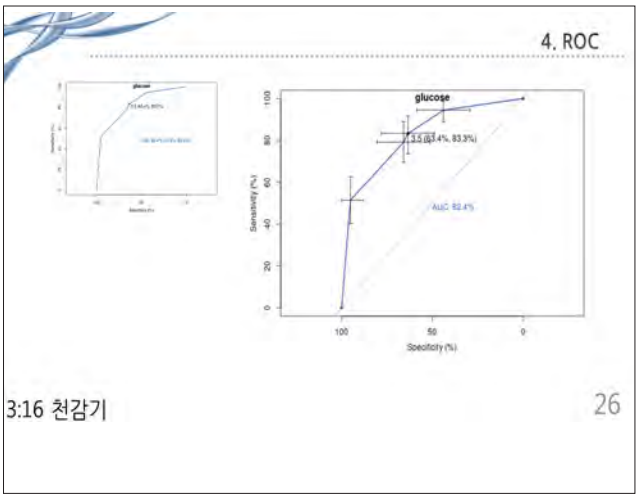
4. ROC

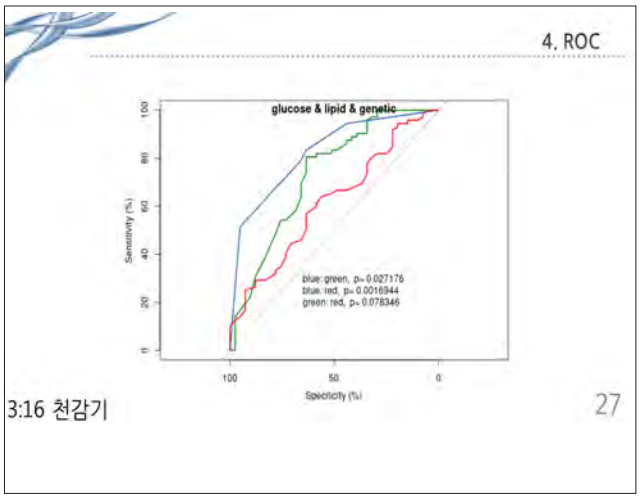
In God we trust; all others must bring data (protocol and SAS output). --- W. Deming

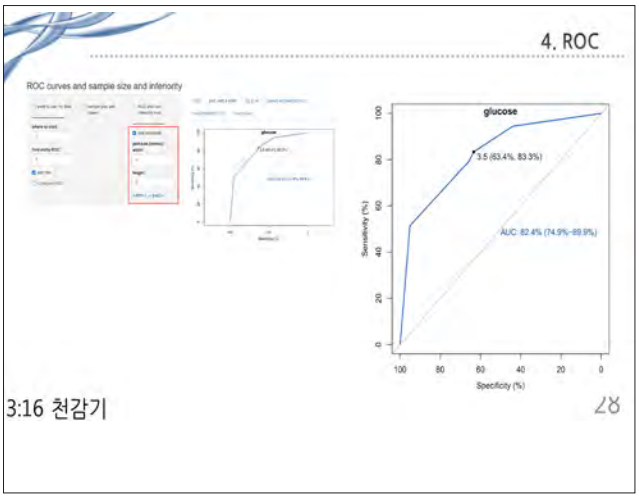
4. ROC

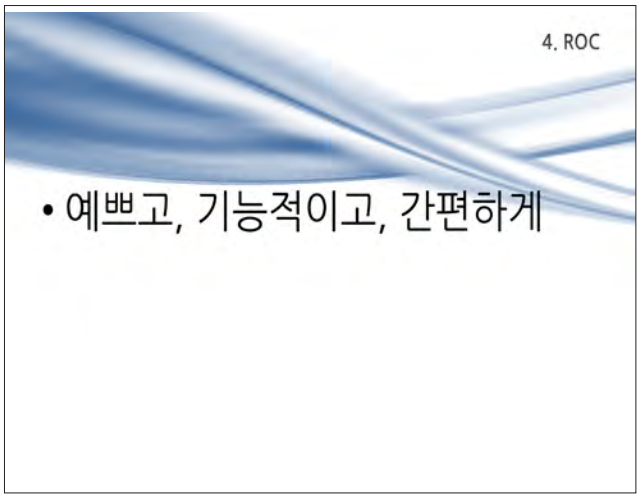
- SPSS → 그래프 안 예쁘다.
  –두 곡선을 비교해 주지 않는다.

3:16 천감기 25

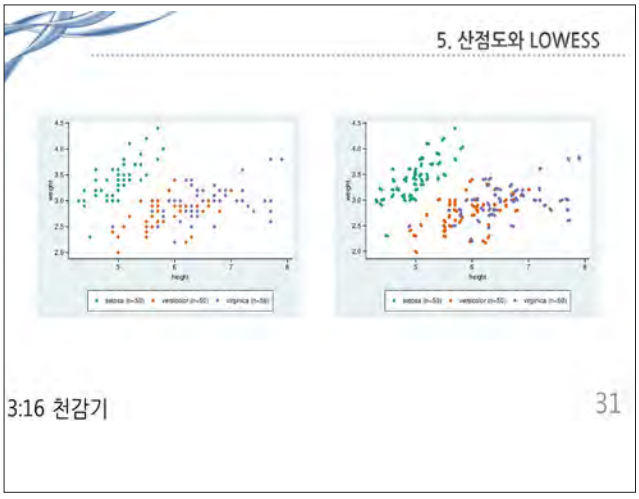

4. ROC
glucose
3.5 (83.4%, 83.3%)
AUC: 82.4%
Sensitivity (%)
Specificity (%)
3:16 천감기
26

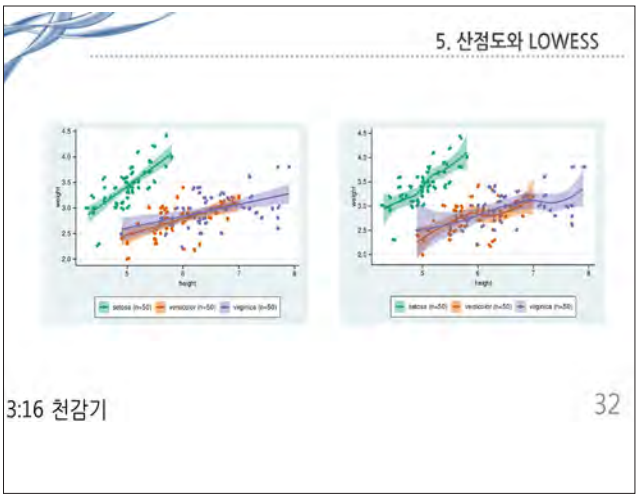

4. ROC
glucose & lipid & genetic
blue: green, p= 0.027176
blue: red, p= 0.0016944
green: red, p= 0.078346
Sensitivity (%)
Specificity (%)
3:16 천감기
27

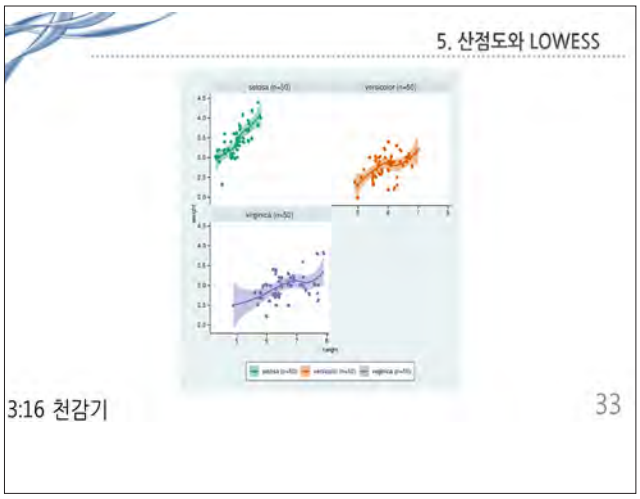

4. ROC
ROC curves and sample size and inferiority
glucose
3.5 (83.4%, 83.3%)
AUC: 82.4% (74.9%-89.9%)
Sensitivity (%)
Specificity (%)
3:16 천감기
28


4. ROC
• 예쁘고, 기능적이고, 간편하게


5. 산점도와 LOWESS
In God we trust; all others must bring data (protocol and SAS output). -- W. Deming

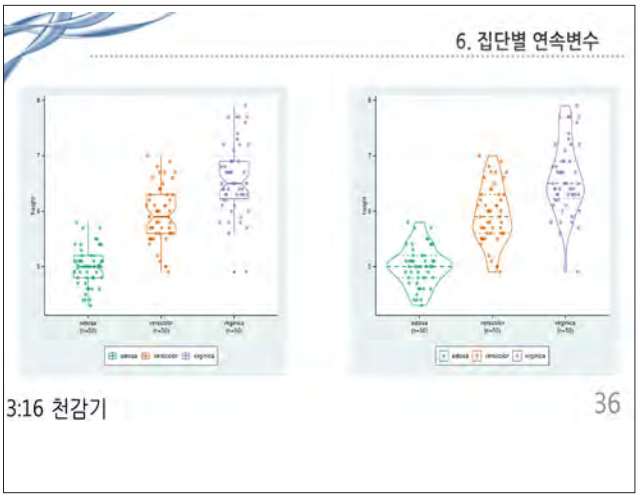

5. 산점도와 LOWESS
height
3:16 천감기
31

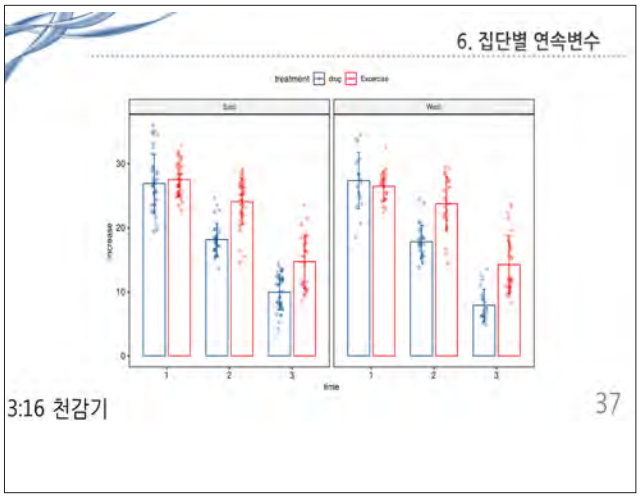

5. 산점도와 LOWESS
3:16 천감기
32

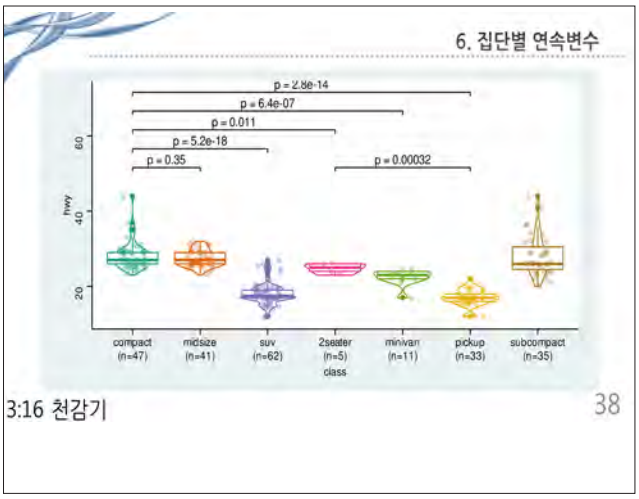

5. 산점도와 LOWESS
3:16 천감기
33

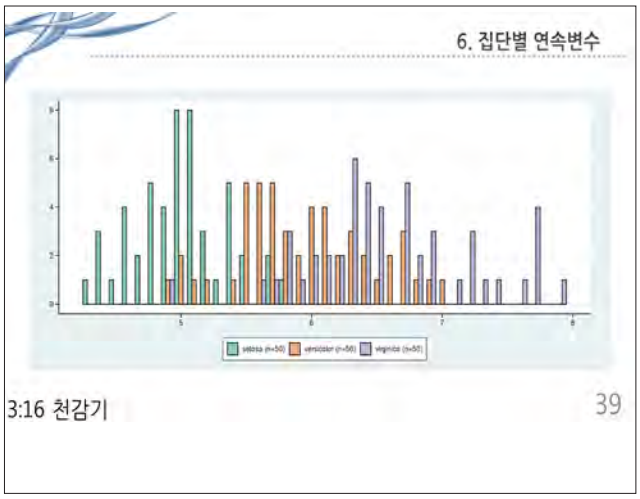

5. 산점도와 LOWESS
• 산점도의 다양한 활용
• 엑셀 어려운 jitter, LOWESS

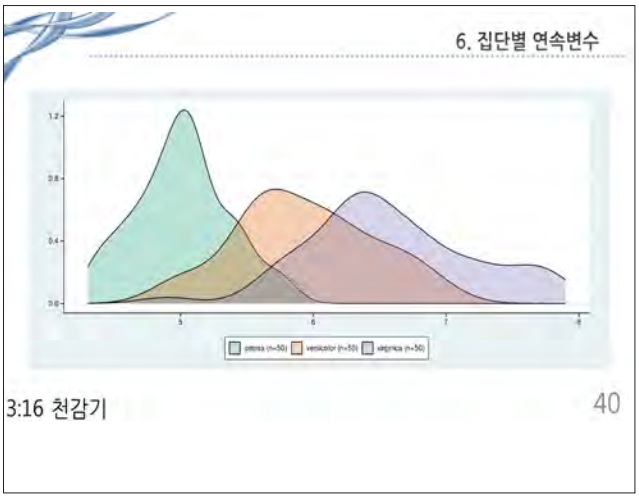

6. 집단별 연속변수
In God we trust; all others must bring data (protocol and SAS output). -- W. Deming

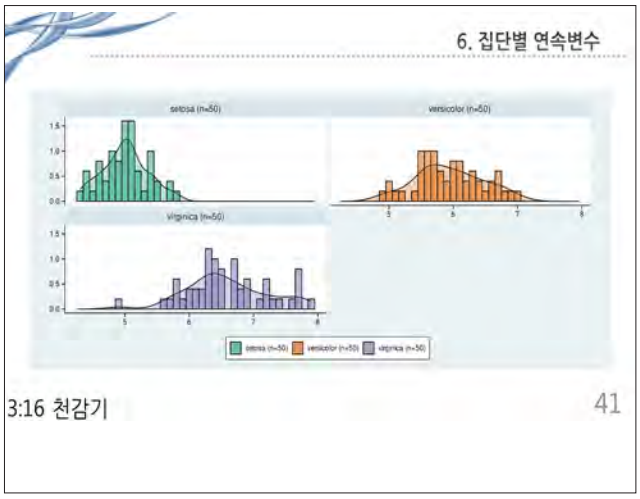

6. 집단별 연속변수
3:16 천감기
36

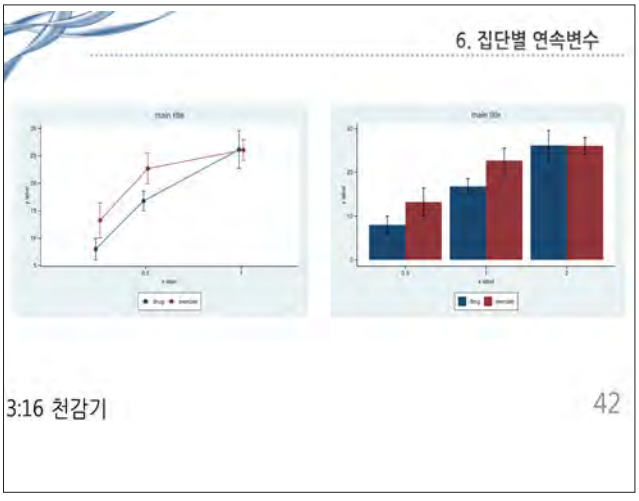

6. 집단별 연속변수
3:16 천감기
37

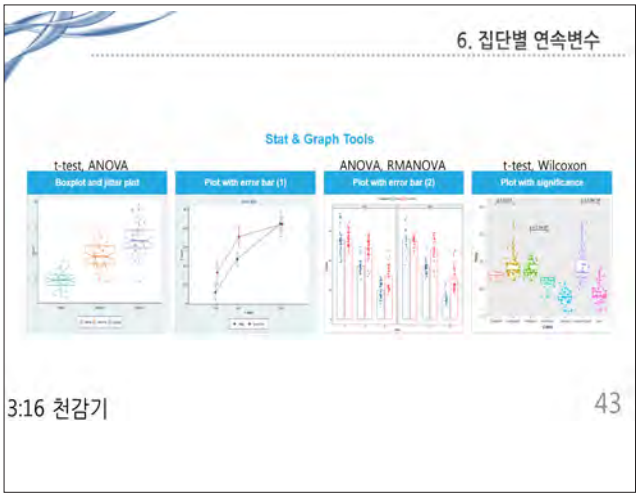

6. 집단별 연속변수
p = 2.8e-14
p = 6.4e-07
p = 0.011
p = 5.2e-18
p = 0.35
p = 0.00032
hwy
60
40
20
compact (n=47)
midsize (n=41)
suv (n=62)
2seater (n=5)
minivan (n=11)
pickup (n=33)
subcompact (n=35)
class
3:16 천감기
38


6. 집단별 연속변수
3:16 천감기
39


6. 집단별 연속변수
3:16 천감기
40


6. 집단별 연속변수
setosa (n=50)
versicolor (n=50)
virginica (n=50)
3:16 천감기
41


6. 집단별 연속변수
3:16 천감기
42


6. 집단별 연속변수
Stat & Graph Tools
t-test, ANOVA
ANOVA, RMANOVA
t-test, Wilcoxon
Boxplot and jitter plot
Plot with error bar (1)
Plot with error bar (2)
Plot with significance
3:16 천감기
43

6. 집단별 연속변수

- 데이터가 투명하게 보이는
- 통계량(평균, 중앙값, 표준편차…)이 충분히 표현되는
- Jitter plot + box plot + violin plot
- N 수는 꼭 표시(by CONSORT 2025)

7. 마무리

In God we trust; all others must bring data (protocol and SAS output). --- W. Deming

7. 마무리

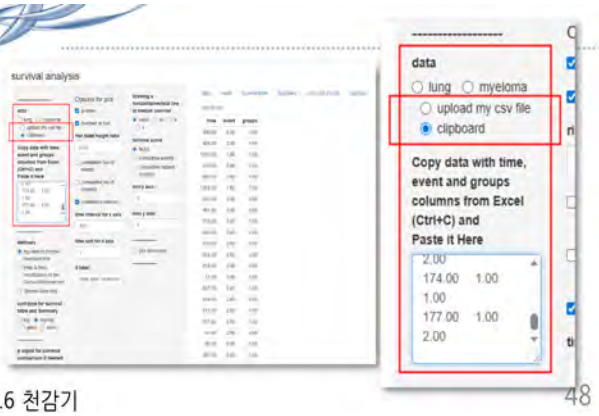
- 많이 사용되는 그래프를
- 원칙에 맞게, 쉽게
- 상당 수 통계도 쉽게
- 더 많은 통계와 그래프는

3:16 천감기 46

7. 마무리

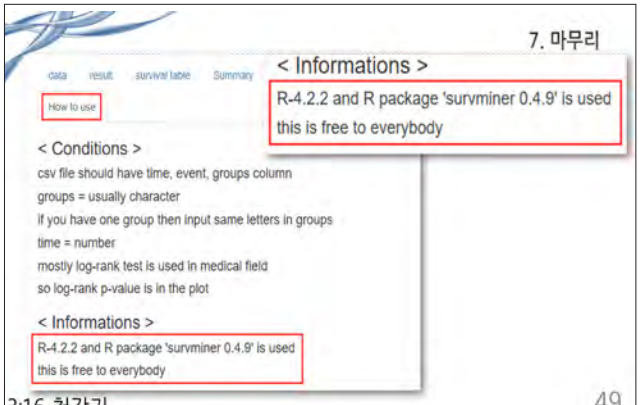


3:16 천감기 47



3:16 천감기 48

7. 마무리



3:16 천감기 49

정규성

학력

한양대학교 의학과 학사

한양대학교 일반대학원 의학과 석사

한양대학교 일반대학원 의학과 박사

주요 경력

대한스포츠의학회 분과 전문의, 편집위원회 간사

K 리그 프로축구연맹 의무위원 (슬관절)

한국전력 빅스톰 프로배구단 팀닥터

대한핸드볼협회 의무위원회 필드닥터

평창동계올림픽 바이애슬론 의무지원

현재 소속 및 직위

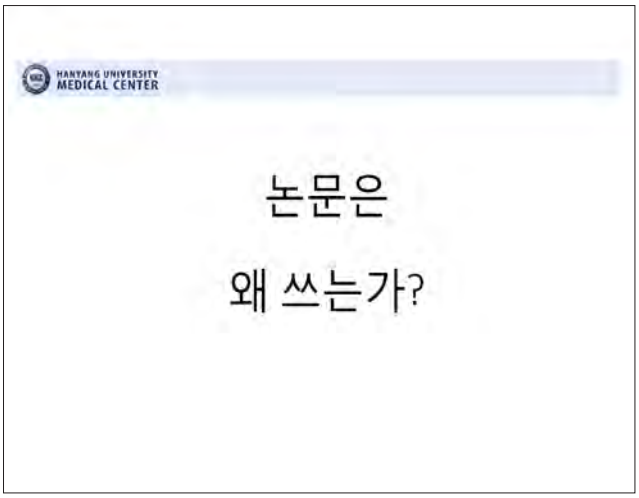
한양대학교 구리병원 정형외과 부교수

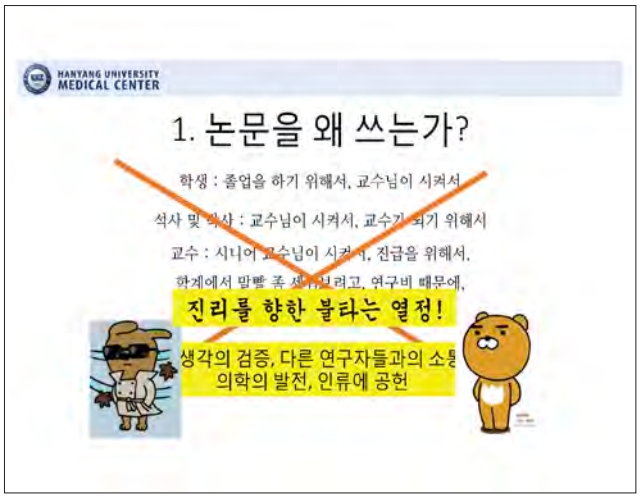
대표논문

1. Comparison of Clinical and Radiologic Results Between Partial Meniscectomy and Refixation of Medial Meniscus Posterior Root Tears: A Minimum 5-Year Follow-up
   ; Chung KS, Ha JK, Yeom CH, Ra HJ, Jang HS, Choi SH, Kim JG
   ; Arthoscopy. 2015 Oct;31(10):1941-50
2. Are Muscle Strength and Function of the Uninjured Lower Limb Weakened After Anterior Cruciate Ligament Injury? Two-Year Follow-up After Reconstruction.
   ; Chung KS, Ha JK, Yeom CH, Ra HJ, Lim JW, Kwon MS, Kim JG
   ; Am J Sports Med. 2015 Dec;43(12):3013-21
3. Root Repair Versus Partial Meniscectomy for Medial Meniscus Posterior Root Tears: Comparison of Long-term Survivorship and Clinical Outcomes at Minimum 10-Year Follow-up.
   ; Chung KS, Ha JK, Ra HJ, Yu WJ, Kim JG
   ; Am J Sports Med. 2020 Jul;48(8):1937-1944

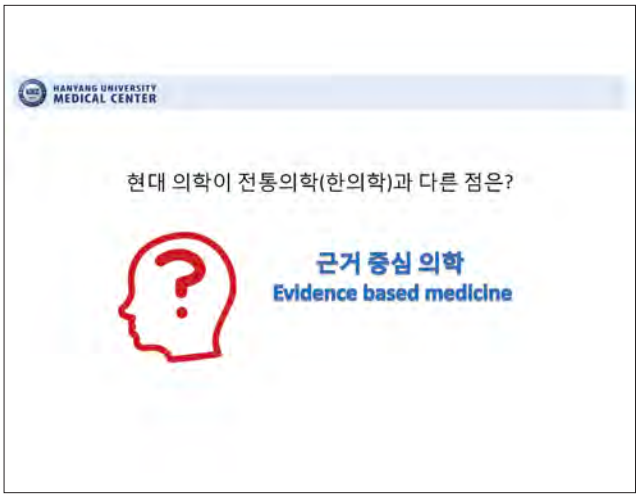
의학 논문 쉽게 쓰기; 스텝 바이 스텝
Writing Medical Papers Made Easy; Step by Step

한양의대
정규성









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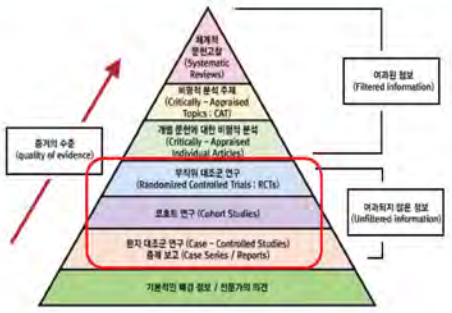
논문을 쓰기 위해서는?

주제 선정 → 데이터 모으기 → 통계처리 및 데이터 분석 → 논문 작성 → 영문교정 → 저널 업로드 → 권고사항 교정 → 최종 출판

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저널에 출판하기 위한 전략

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어떤 주제를 쓸 것인가?

내가 논문에서 말하고자 하는 것이 무엇인가?

새로운 수술방법, 치료방법, 진단방법의 효과

- 기존의 치료방법에 대한 효과를 검증

이전에 발표된 적이 없거나 드물어야 하며,

의학발전이나 환자 진료에 도움이나 변화가 있어야 함

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논문작성의 실제

어떤 주제를 쓸 것인가?

독창성 (Originality)

과학적 의의 (Significance)

원저성 (first disclosure)

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Google 학술 검색

거인의 어깨에 올라서서 더 넓은 세상을 바라보라 - 아이작 뉴턴

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연구 시작하기!

적절한 논문 아이템 선정

Item을 선정하고 관련된 최근 논문을 최소한 10여편 숙독

최근의 경향 파악

Key 논문의 설정

What has been will be again,

what has been done will be done again;

there is nothing new under the sun

(해아래 새것이 없나니. 전도서 1:9)

우리가 생각하는 논문은 세상의 누군가가 반드시 썼다!!

니가 생각하는 것을 설마 너만 생각했겠냐.

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Data 모으기

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평균, 표준편차, 범위 등등 결과 얻기

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의학통계의 기본

통계 – 우리가 얻은 값이 진리인지 아닌지를 알고자 하는 것

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의학통계의 기본

통계 – 우리가 얻은 값이 진리인지 아닌지를 알고자 하는 것

P-value : 얻어진 값이 우연일 확률

P<0.05 : 얻어진 값이 '우연히' 나올 확률은 0.05 미만이다.

즉, 우연히 나왔을 가능성은 매우 낮으므로 '진실'일 가능성이 높다.

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변수의 종류



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무엇을 검정(test)할 것인가?

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무엇을 검정(test)할 것인가?

1) 차이가 있는지 없는지 ?

양 군간의 비교

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무엇을 검정(test)할 것인가?

1) 차이가 있는지 없는지 ?

양 군간의 비교

2) 관계가 있는지 없는지?

상관관계

두 변수 간의 관계 correlation

결과변수에 영향을 미치는 원인 변수의 분석 causal relation ship

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비교 comparison

		연속변수		이산 변수	
비교 대상		모수적 검정	비모수적 검정	순위변수	명목변수
2군	독립된 자료	Student t test	Mann-Whiteny test		Chi square test
	짝지워진 자료	Paired t test	Wilcoxn signed Rank test		McNemar test
3군	독립된 자료	ANOVA	Kruskal Wallis test		Chi Square test
	짝지워진 자료	Repeated measures ANOVA	Friedman test		Cochrane Q test

Comparison of Clinical and Radiologic Results Between Partial Meniscectomy and Refixation of Medial Meniscus Posterior Root Tears: A Minimum 5-Year Follow-up

2 군을 비교함

Table 3. Comparison of Postoperative Clinical and Radiologic Outcomes Between Groups (n = 57)

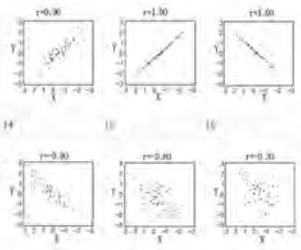
	Meniscectomy Group (n = 20)	Repair Groups (n = 37)	P Value
Clinical outcomes			
Lysholm score	62.8 ± 24.9	84.1 ± 12.1	.002
IKDC Subjective Knee Form score	49.3 ± 23.5	73.7 ± 11.1	< .001
Tegner activity score	2.4 ± 1.9	3.6 ± 1.1	< .001
Conversion to total knee arthroplasty, n (%)	7 (35)	0 (0)	< .001
Radiologic outcomes			
Width of medial joint space, mm	2.2 ± 1.1	4.1 ± 1.1	< .001
Joint space narrowing, mm	2.3 ± 1.4	0.8 ± 0.7	< .001
Joint space narrowing ≥2 mm, n (%)	9 (45)	2 (5)	.001
Kellgren-Lawrence grade 0/1/2/3/4, n	0/1/4/6/9	0/11/20/6/0	< .001
Kellgren-Lawrence progression, n (%)	20 (100)	25 (68)	.005
Kellgren-Lawrence progression ≥2 grades, n (%)	16 (80)	5 (14)	< .001

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상관관계

상관관계 Correlation analysis

원인에 대한 분석 Causal relation ship



Prognostic Factors in the Midterm Results of Pullout Fixation for Posterior Root Tears of the Medial Meniscus

상관관계

Table 2. Results of Correlation of Clinical Factors by Pearson Correlation Analysis

Continuous Variables	Coefficient	P Value	Coefficient	P Value
Preoperative factors				
Age, yr	−0.358	.023	0.444	.004
Body mass index	0.015	.927	−0.058	.722
Mechanical varus alignment, °	−0.394	.012	−0.385	.014
Joint space, mm	0.288	.072	0.308	.053
Meniscus extrusion, mm	0.058	.724	0.001	.999
Postoperative factors				
Joint space, mm	0.526	.001	0.536	.001
Meniscus extrusion, mm	−0.356	.024	−0.400	.010
Difference (pre − post) factors				
Joint space, mm	−0.416	0.008	−0.401	.010
Meniscus extrusion, mm	0.449	0.008	0.443	.004

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Statistical analysis

Sample size

- 도대체 몇명을 대상으로 할 것인가!
- 너무 많아도, 너무 적어도 문제
- 원하는 결과를 얻기 위해 필요한 최소인원을 계산하는 통계적 방법 (G power 등등)

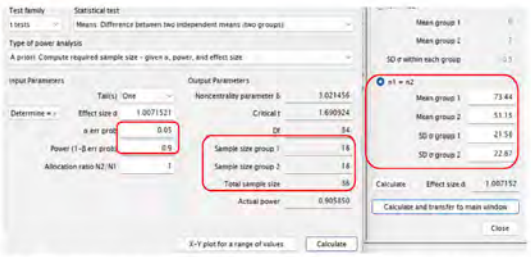
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" G power "

Power 90% : 각 18명

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Results

질문에 대한 해답을 제공

방법에서 제시했던 모든 내용들은 결과에 다 언급되어야 한다.

표를 보지 않아도 주요 결과는 본문만으로 다 알 수 있어야 한다.

: 표, 사진, 그림

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Results

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표의 구성

Table 1 – demographic data (인구학적 특징)

Table 2, 3 – 주요 결과 비교

Table 4 – 세부 그룹 비교, 꼭 보여주고 싶은 특이한 결과

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Comparison of Clinical and Radiologic Results Between Partial Meniscectomy and Refixation of Medial Meniscus Posterior Root Tears: A Minimum 5-Year Follow-up

Kyu Sung Chung, M.D., Jeong Ku Ha, M.D., Cheol Hyun Yeom, M.D., Ho Jong Ra, M.D., Ho Su Jang, M.D., Seung Hyuk Choi, M.D., and Jin Goo Kim, M.D., Ph.D.

Purpose: To compare the clinical and radiologic results of partial meniscectomy with those of refixation in patients with medial meniscus posterior root tears (MMPRTs) at a minimum 5-year follow-up. **Methods:** Between 2005 and 2009, patients with MMPRTs who had been followed up for at least 5 years after a partial meniscectomy (group M, n = 20) or pullout repair (group R, n = 37) were screened. The mean follow-up duration was 67.3 months in group M and 72.0 months in group R. Clinical assessments, including the Lysholm score and International Knee Documentation Committee (IKDC) subjective knee form score, and radiographic assessments, including the Kellgren-Lawrence (K-L) grade and medial joint space width, were evaluated preoperatively and at final follow-up. We compared the preoperative results, both the final results in each group, and we compared the final results of groups M and R. Two-year survival rates were also evaluated. **Results:** The mean Lysholm score ($P = .039$) and IKDC score ($P = .047$) improved significantly; however, the width of the medial joint space ($P < .001$) and K-L grade ($P = .001$) worsened significantly in both groups. When we compared the final results, group R had significantly better Lysholm scores ($P = .002$) and IKDC scores ($P < .001$) than group M. Group R showed less K-L grade progression ($P = .007$) and less medial joint space narrowing ($P < .001$) than group M. The rate of conversion to total knee arthroplasty was 15% in group M, whereas there was no conversion to total knee arthroplasty in group R. The 5-year survival rates in groups M and R were 75% and 100%, respectively ($P < .001$). **Conclusions:** For MMPRTs, refixation was more effective than partial meniscectomy in terms of the clinical and radiologic outcomes and survival for at least 5 years' follow-up. Refixation showed the progression of arthritic changes compared with partial meniscectomy, although it did not prevent the progression of arthritis completely. **Level of Evidence:** Level III, retrospective comparative study.

초록은

이야기하고 싶은

핵심적인 것!!!

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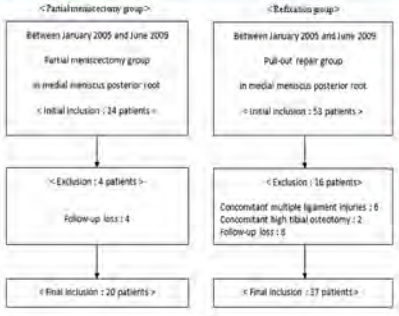


Figure 1 –

어떤 환자를

포함시키고

제외하였는지 !!!

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Table 1

demographic data

(인구학적 특징)

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Table 2, 3 –

주요 결과 비교

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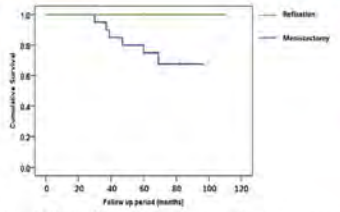


Fig. 5. Kaplan-Meier survival curve showing patients free from conversion to total knee arthroplasty through minimum 5-year follow-up. The 5-year survival rate of the refixation group (100%) was significantly better than that of the partial meniscectomy group (75%) by log-rank test ($P < .001$).

Fig 2, 3 –

보여주고 싶은

중요한

그림들

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Discussion

~~주제와 관련한 전반적인 배경에 대해 개괄적으로 설명하고,~~

~~관련 문헌들에 대해 포괄적으로 리뷰를 한다.~~

- 본 논문의 **주요 결과**에 대해 **요약**하고, **가설을 검정**한다! - **두괄식으로 전개**

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Discussion – 단락의 구성

- 문단 1 – 주요 결과 정리 및 가설 검증
- 문단 2, 3, … – 가설 1, 2, …에 대한 정리. 문헌 리뷰. 우리 결과와 비교
- 추가 문단 – 가설과는 관계없지만, 방법적인 측면에서의 검토
  - 우리 방법의 독창성을 자랑. 다른 방법들과의 비교
- Limitation 문단
- 결론 문단

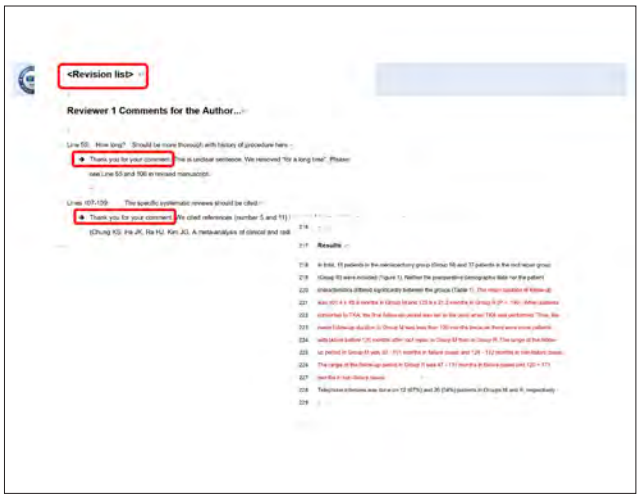
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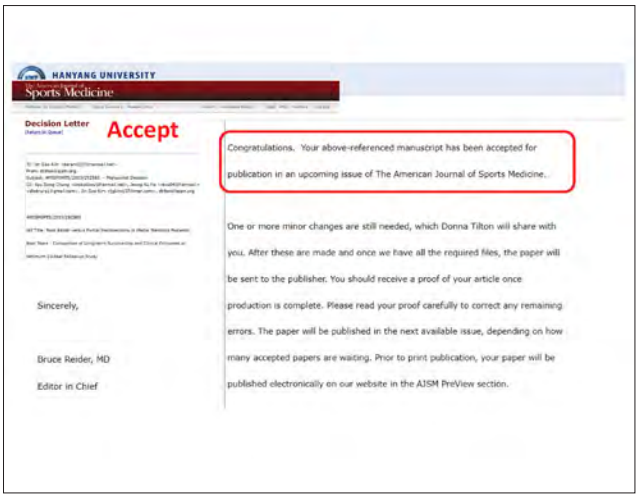
Discussion

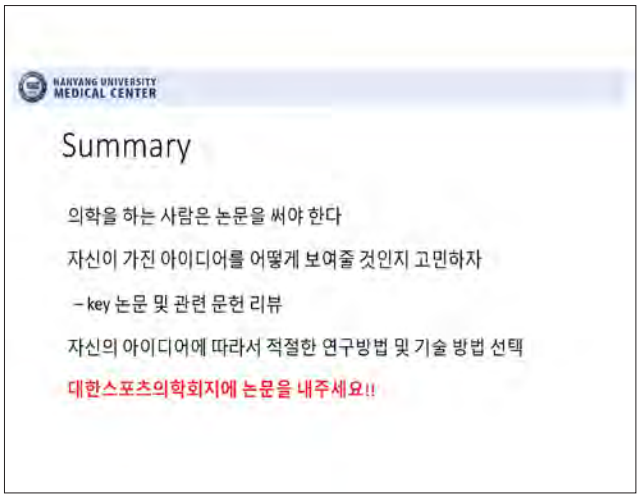
DISCUSSION

The most important finding of this study was that compared with increased meniscus extrusion, decreased meniscus extrusion correlated with more favorable clinical and radiological midterm outcomes after pullout fixation for MMPRTs. Pullout fixation showed significantly improved clinical scores


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Discussion
Limitations
This study had several limitations. First, as a nonrandomized retrospective study without a pre-established protocol, there is no standardization of variables, which makes comparisons less reliable. Second, the sample size was relatively small; however, statistical power was sufficient to evaluate the difference between the 2 groups. Third, the actual restoration of hoop tension and the healing status of the fixed root were not assessed because second-look arthroscopic surgery was not performed. Fourth, MRI was not performed immediately after repair. Therefore, the status of meniscus extrusion could not be evaluated as to whether the meniscus was completely reduced. Fifth, MRI was not performed at 5-year follow-up because of economic considerations, so this analysis was based on the 1-year MRI findings, and the actual status of meniscus extrusion was unknown at final follow-up. Yet, given that the meniscus status postoperatively is generally assessed during the early postoperative period within 1 or 2 years, these findings are considered valuable.
CONCLUSION
For MMPRTs, gallant fixation can lead to favorable outcomes, regardless of the residual meniscus extrusion associated with the repair. However, when meniscus extrusion is shown to be reduced after repair, more favorable clinical outcomes and diagnostic study results can be seen when compared with cases in which extrusion has not been corrected or worsened. This study indicates that efforts to reduce meniscus extrusion at the time of MMPRT fixation can be rewarded with improved results.


<Revision list>
Reviewer 1 Comments for the Author...
Thank you for your comment.
Thank you for your comment.
Results


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Sports Medicine
Decision Letter
Accept
Congratulations. Your above-referenced manuscript has been accepted for publication in an upcoming issue of The American Journal of Sports Medicine.
One or more minor changes are still needed, which Donna Tilton will share with you. After these are made and once we have all the required files, the paper will be sent to the publisher. You should receive a proof of your article once production is complete. Please read your proof carefully to correct any remaining errors. The paper will be published in the next available issue, depending on how many accepted papers are waiting. Prior to print publication, your paper will be published electronically on our website in the AJSM PreView section.
Sincerely,
Bruce Reider, MD
Editor in Chief


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Summary
의학을 하는 사람은 논문을 써야 한다
자신이 가진 아이디어를 어떻게 보여줄 것인지 고민하자
– key 논문 및 관련 문헌 리뷰
자신의 아이디어에 따라서 적절한 연구방법 및 기술 방법 선택
대한스포츠의학회지에 논문을 내주세요!!


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2026
대한스포츠의학회
제68차 추계학술대회
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The 68th Spring Conference of Korean Society of Sports Medicine

사단법인 대한스포츠의학회
제68차 춘계학술대회

Poster



주간의 플라이오메트릭 훈련이 아마추어 축구선수의 직선 및 곡선 스프린트 성능과 기술 체력에 미치는 영향

The Effects of a 6-Week Plyometric Training Program on Linear and Curve Sprint Performance and Skill-Related Fitness in Amateur Soccer Players

국립부경대학교

김규성

ICT 스마트 센서(장력센서)를 활용한 어깨 가쪽돌림 운동의 근육 활성화 정량적 검증: 예비 연구

Quantitative Verification of Muscle Activation during Shoulder External Rotation Exercises Using ICT-Based Smart Sensors(Tension Sensor): A Pilot Study

국립부경대학교 스포츠과학 연구소, 국립부경대학교 체육학과 대학원, 양산부상대학교병원 물리치료실,
국립부경대학교 스마트헬스케어학부 해양스포츠전공

유일영, 정경열, 임나단, 김수용, 김태규*

목적

This pilot study study aimed to examine muscle activation patterns during shoulder external rotation exercises using ICT-based smart sensors, with implications for future clinical applications and large-scale trials in populations with sarcopenia.

대상 및 방법

Eighteen adults performed four external rotation exercises: prone external rotation (PER), side-lying wiper (SWE), sitting external rotation (SITER), and standing external rotation (STER). Exercises were conducted under low- and medium-intensity resistance using a smart tension sensor. Surface electromyography recorded activation of the infraspinatus and posterior deltoid muscles. Muscle activation was compared across exercise conditions.

결과

Infraspinatus activation was highest during SITER, significantly higher than the other three exercises (p<.05). Posterior deltoid activation was highest during SWE, significantly greater than SITER, STER, and PER (p<.05).

결론

SITER most effectively activated the infraspinatus, while SWE elicited the greatest posterior deltoid involvement. The use of smart tension sensors enabled objective quantification of resistance intensity,

demonstrating feasibility for systematic exercise prescription beyond simple muscle activity analysis. These findings suggest potential integration with elastic bands to provide seniors with structured training intensities. As a pilot study, stepwise validation is required, supporting expansion into subsequent research and clinical applications.

6주간의 슬라이드 레그 훈련과 노르딕 햄스트링 훈련이 하지 근기능 및 스프린트 수행 특성에 미치는 영향

Effects of 6-Week Slide Leg Exercise and Nordic Hamstring Exercise on Lower Limb Muscle Function and Sprint Performance Characteristics

국립부경대학교 체육학과 대학원, 한국체육대학교, 국립부경대학교 체육진흥원,
국립부경대학교 스마트헬스케어학부 해양스포츠전공

이지원, 신리나, 장동니, 류무리, 차정훈, 최호경, 김태규*

목적

본 연구의 목적은 6주간의 슬라이드 레그 훈련과 노르딕 햄스트링 훈련이 하지 근기능 및 스프린트 수행 특성에 미치는 영향을 비교·분석하는 데 있다. 특히, 스프린트 동작 중 발생하는 뒤넙다리근 부상 위험을 감소시키고 기능적 수행을 향상시킬 수 있는 효과적인 편심성 훈련 전략에 대한 기초자료를 제공하고자 하였다.

대상 및 방법

연구 대상자는 남성 축구 동호인 30명으로 구성되었으며, 무작위 배정을 통해 슬라이드 레그 훈련군(SLG, n=10), 노르딕 햄스트링 훈련군(NHG, n=10), 대조군(CG, n=10)의 세 집단으로 구분하였다. 각 훈련 프로그램은 총 6주간 적용되었으며, 중재 전·후 측정을 통해 무릎관절 굽힘근 편심성 근력, 기능적 H:Q 비율, 엉덩관절 폄 편심성 근력, 유연성, 스프린트 시간 및 스프린트 동안의 운동학적 변인(몸통 각도, 엉덩관절 각도, 무릎관절 각도, 보폭)을 평가하였다.

결과

6주간의 훈련 프로그램 적용 결과, 60°/s 및 180°/s에서 측정된 무릎관절 굽힘근의 편심성 근력은 SLG와 NHG에서 유의한 향상을 보였으며, 무릎 굽힘 20도에서는 SLG에서만 유의한 향상이 나타났다. 기능적 H:Q 비율에서는 SLG, NHG에서 유의한 향상을 보였으며, 엉덩관절 폄근의 편심성 근력은 120°/s에서 SLG에서만 유의한 향상이 나타났다. 유연성은 SLG와 NHG 모두에서 훈련 후 유의하게 향상되었고, 스프린트 동안의 무릎관절 각도는 SLG와 NHG에서 향상되었다. 반면, 몸통각도, 엉덩관절각도, 보폭 및 시간은 유의한 차이가 나타나지 않았다.

결론

슬라이드 레그 훈련은 뒤넙다리근 손상이 발생하기 쉬운 관절 가동 범위 내에서도 근력 향상이 나타난다는 점에서, 기존 NHE의 한계를 보완할 수 있는 효과적인 대안적 편심성 훈련 전략으로 고려될 수 있을 것으로 판단된다.

사단법인 대한스포츠의학회

제68차 춘계학술대회

발행일. 2026년 3월 21일

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