Hamstring Injury Research

Stephanie Lazarczuk

@StephLaz_

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Covered today…

- Re-cap epidemiology in European sports
- Injury classification
- RTP time
- Risk factors
- HSR
- Exercise Selection
- Rehab protocols

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Why Hamstrings?

- Cricket: leading cause of time-loss (Orchard et al., 2015; Ranson et al., 2013)
- Rugby Union = highest burden (England Rugby, 2018)
- European Football = ↑ 4% per season (Ekstrand et al., 2016)
- AFL (AFL, 2017)
  - Most frequent inj
  - Small ↓ in new HSI in 2017
  - Recurrence rates: 2008 = 27%, 2017 = 14%

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Injury Classification

- Munich Consensus statement (Mueller-Wohlfahrt et al., 2013)
- All muscle injuries

A. Indirect Muscle Disorder/ Injury	Functional Muscle Disorder	Type 1: Overexertion-related Muscle Disorder	Type 1A: Fatigue-induced Muscle Disorder
			Type 1B: DOMS
		Type 2: Neuromuscular Muscle Disorder	Type 2A: Spine-related Muscle Disorder
			Type 2B: Muscle-related Muscle Disorder
	Structural Muscle Injury	Type 3: Partial Muscle Tear	Type 3A: Minor Partial Muscle Tear
			Type 3B: Moderate Partial Muscle Tear
		Type 4: (Sub) Total Tear	Subtotal or Complete Muscle Tear Tendinous Avulsion
B. Direct Muscle Injury		Contusion	
		Laceration	

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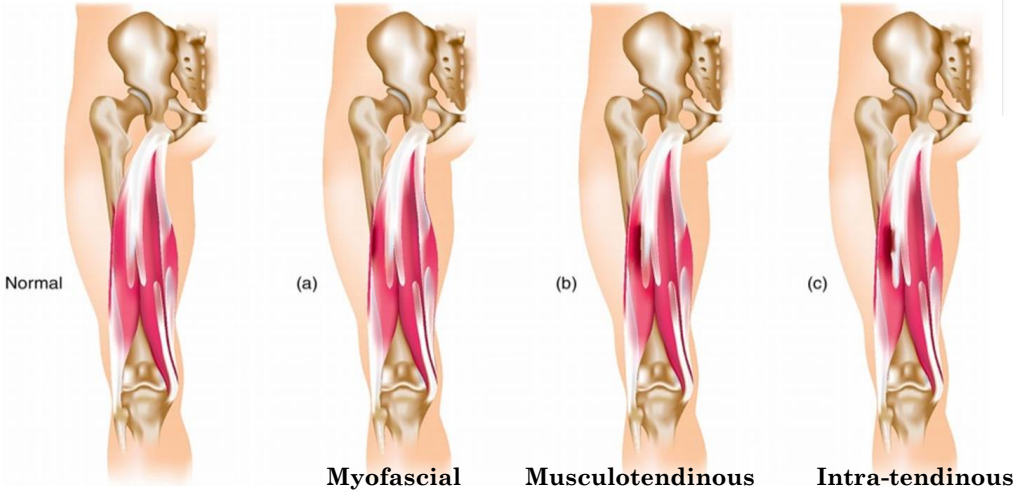
Injury Classification



Noel Pollock
@DrNoelPollock

Pollock et al., 2014

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RTP Times

- BA classification: 3c (Pollock et al., 2016)
- Mixed evidence for tendinous injury
  - Unless full thickness tear (van der Made et al., 2018)

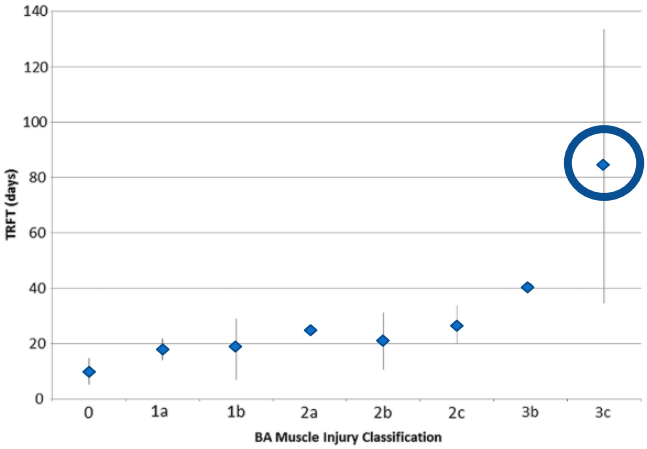

Figure 2 Mean±SD time (days) to return to full training (BA, British Athletics; TRFT, time to return to full training).

Noel Pollock
@DrNoelPollock

Anne van der Made
@AvanderMade

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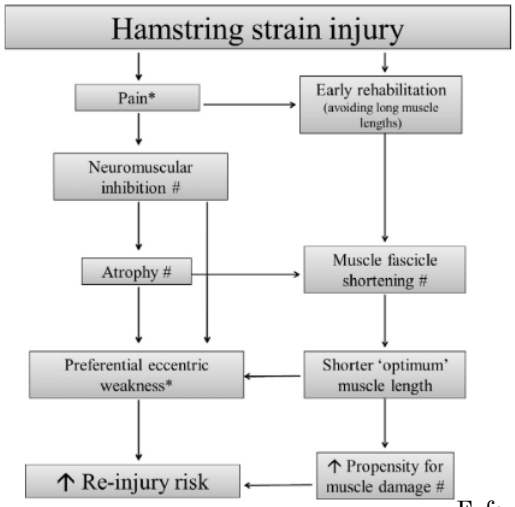
Why Hamstrings?

- Conceptual framework
- Premise for future work

- Pain at injury → deload = ↓ activity → ↓ FL + weakness



Jackson Fyfe
@jacksonfyfe

Fyfe et al., 2013

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Risk Factors

- Non-modifiable
  - PMH
  - Age

- Modifiable
  - Strength
  - Architecture
  - Prolonged neurological deficits
  - Exposure to HSR

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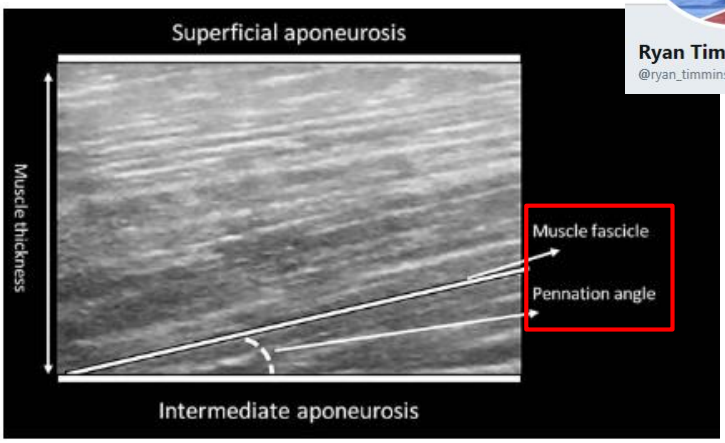
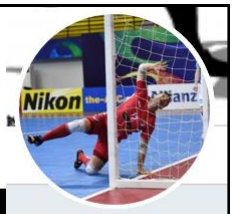
Architectural Ax

- 2D US imaging
- Mid-belly BFlh
- Estimation of FL from validated equation
- High intra-rater reliability from experienced assessor





Timmins et al., 2016a

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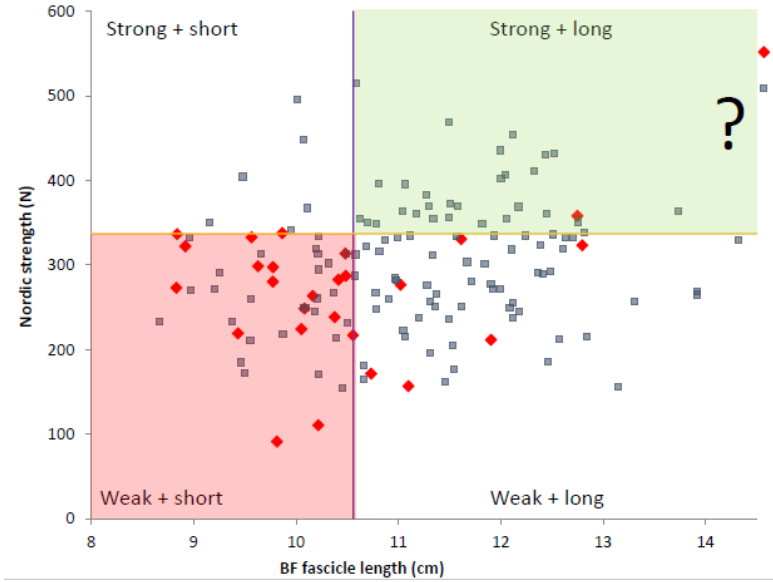
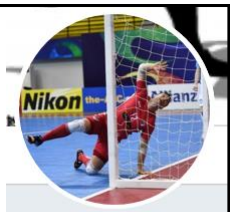
The hamstring quadrant of doom!!!





significantly increased the risk of a HSI. Multivariate logistic regression revealed significant effects when combinations of age, history of HSI, eccentric knee flexor strength and BFlh fascicle length were explored. From these analyses the likelihood of a future HSI in older athletes or those with a HSI history was reduced if high levels of eccentric knee flexor strength and longer BFlh fascicles were present.

Timmins et al., 2016b

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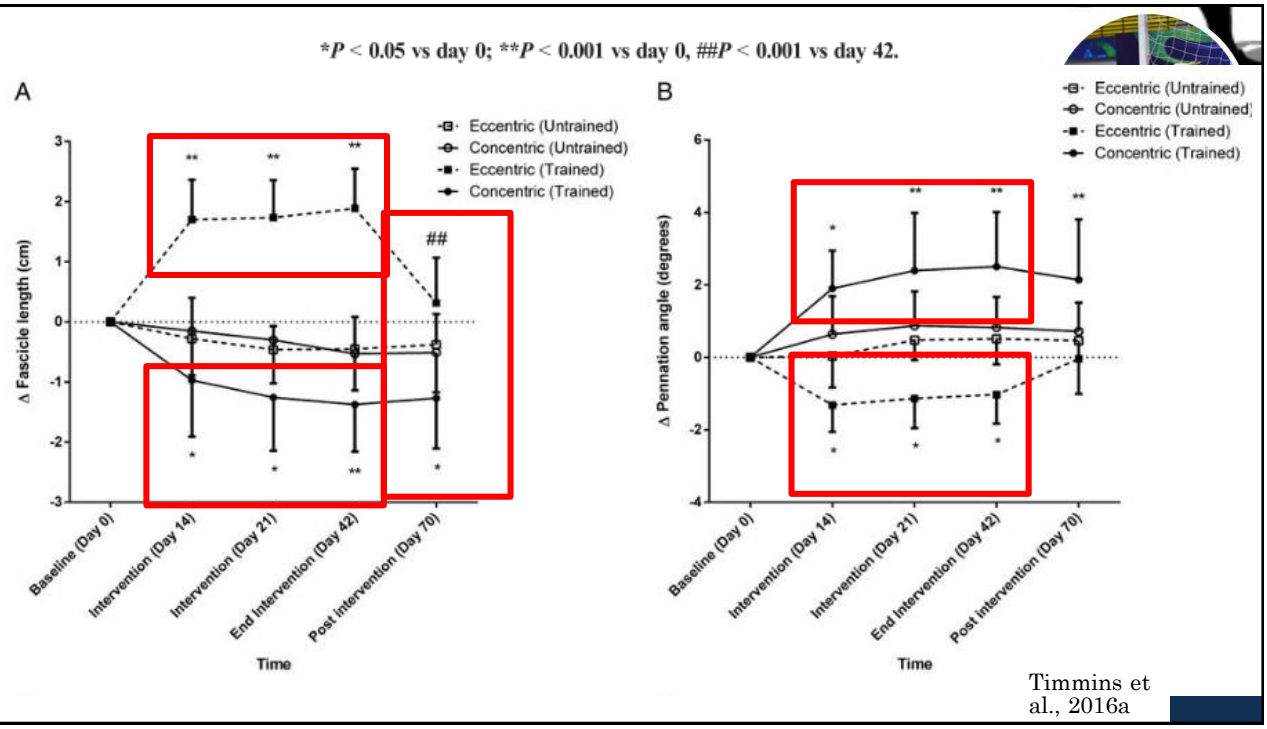

Timmins et al., 2016a

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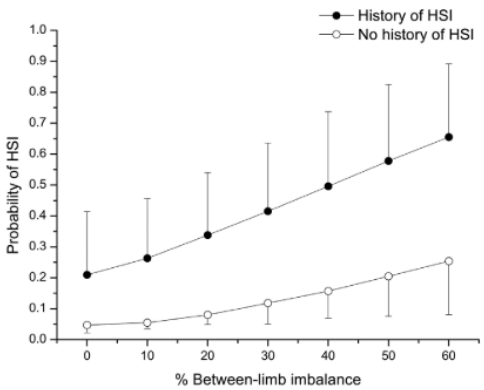
Risk Factors

Matt Bourne
@MBourne5

- Normative eccentric strength data = pop specific
- Rugby > AFL
- ↓ symmetry = ↑ risk
  - >15% = 2.4
  - >20% = 3.4
- If weak, get stronger
- If strong, get symmetrical?



Bourne et al., 2015

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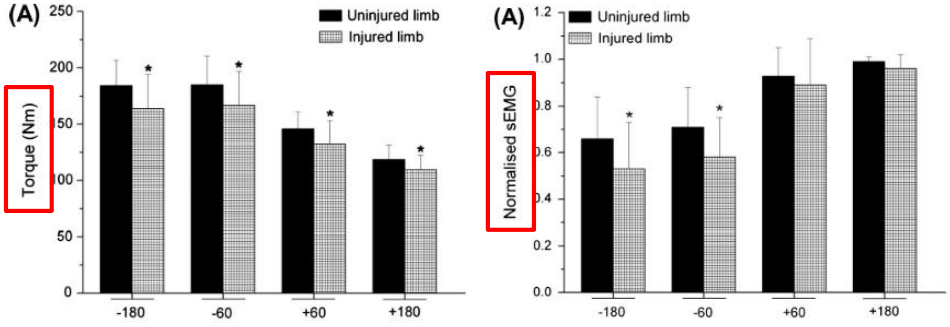
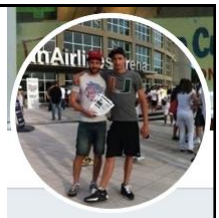
Risk Factors

- Prolonged deficits in torque and sEMG in previously injured individuals (inc at 18/12)



Dynamometer speeds. –ve = eccentric

Opar et al., 2013



David Opar
@davidopar

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Risk Factors
Prolonged deficits / PMH

- Likely centralised effects following peripheral injury (Buhmann & Shield, *under prep*)
  - Spinal level: reflex action
  - Brain level: motor cortex change

- In football codes (Messer & Shield, *under prep*):
  - ↑ risk of subsequent injury if prev sustained HSI, ACL inj or combination.
  - ST grafts → ↓ volume ST

Robert Buhmann
@BuhmannRobert

Daniel Messer
@messerd008

Tony Shield
@das_shield

QUT Queensland University of Technology

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HSI Prediction

- AFL (n = 262; Ruddy et al., 2018a)
  - Pre-season data collection: inc. injury Hx, personal data
  - Model unable to predict injury
- Pro Football, France (n = 194; Dauty et al., 2018)
  - No specific isokinetic cut off value
- Pro Football, Qatar (n = 614, van Dyk et al., 2018)
  - Isokinetic @ 60º/s & 300º/s, con/ecc
  - 2 variables with potential predictive effect
- SR & MA (Green et al., 2018)
  - Small, significant effect for 60°/s
  - Authors noted one study had large cohort – poss. change effect

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HSI Prediction

- Strength alone = poor predictor
- Multivariate analyses required
- Multiple sources of risk

<u>Note: doesn't mean strength is not important when combined with other factors</u>

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HSI & Running

- Spikes in workload:
  - In week prior to injury and/or ↑ vs. 2-yearly average (Duhig et al., 2016)
  - Large changes in running volume (Malone et al., 2016)
- Proportion of distance which is HSR (vs. moderate; Ruddy et al., 2018b; Colby et al., 2018):
  - High = ↑ risk
  - Low = ↑ risk ++

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Running Monitoring

- When GPS not possible…
- No. of sessions containing HSR/max efforts? (Colby et al., 2018)
- Session availability: 1/52 vs 12/52
- ↓ availability in prev 12/52 + 100% availability in week before injury (Ruddy et al., 2019)
- Perhaps: session availability + sessions of exposure = possible method?

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Section Take Homes

Target modifiable risk factors

Centralised effects of peripheral injury

Be aware of athletes PMH

Prediction not currently possible

Goldilocks approach to HSR

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Exercise Selection
Askling's L Protocol

- The Extender, Diver, Glider

Askling et al., 2013

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Exercise Selection
Askling's L Protocol

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

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

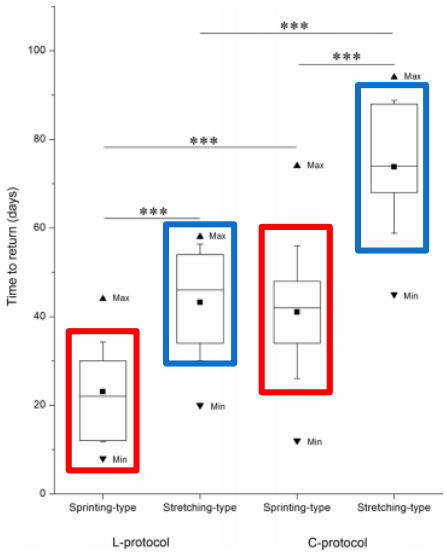

Figure 8 Time to return, in days, for players with either sprinting-type or stretching-type injuries in either the L-protocol (n=27 and 10, respectively) or C-protocol (n=27 and 11, respectively). The boxes represent IQRs; in the boxes the horizontal lines represent median values and black squares represent mean values; whiskers=mean±1 SD. *** Denotes significant difference (p<0.001, Mann-Whitney U test).

carl askling
@CAskling

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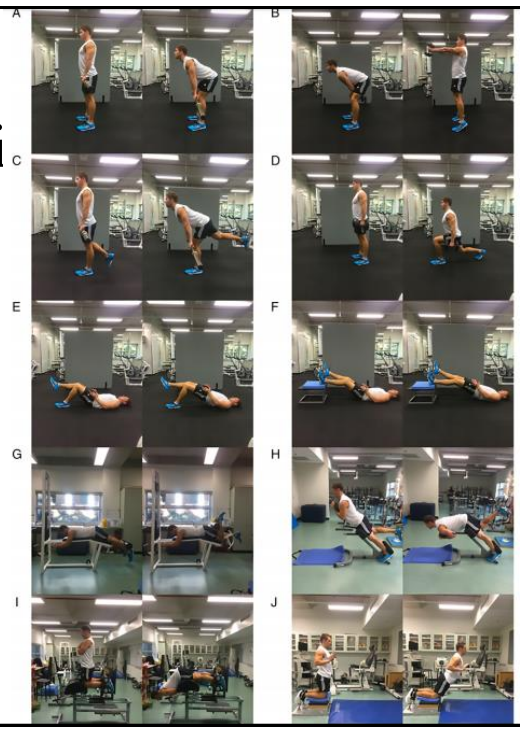
Exercise Selecti

- 10 exercises
- Hip vs. knee dominant
- Part One: sEMG
- Part Two: fMRI



Bourne et al., 2017

Matt Bourne
@MBourne5

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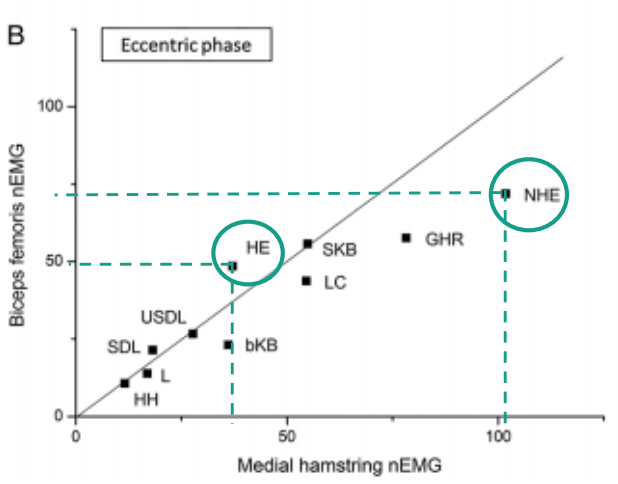
Exercise Selection



Matt Bourne
@MBourne5

Bourne et al., 2017

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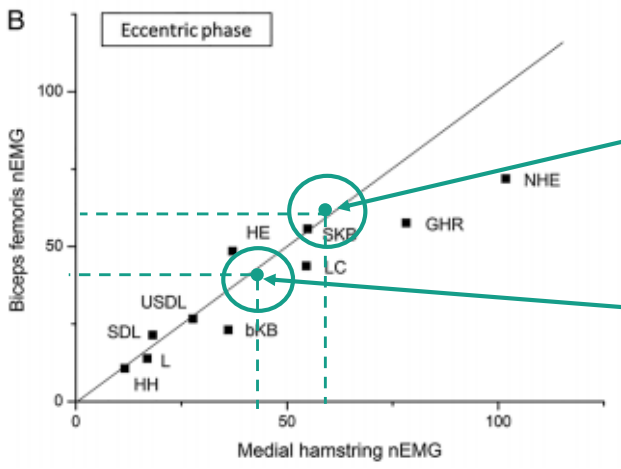
Exercise Selection



Glider
~60%

Diver
~40%

Matt Bourne
@MBourne5

Giacomo Severini
@Harsh_Science

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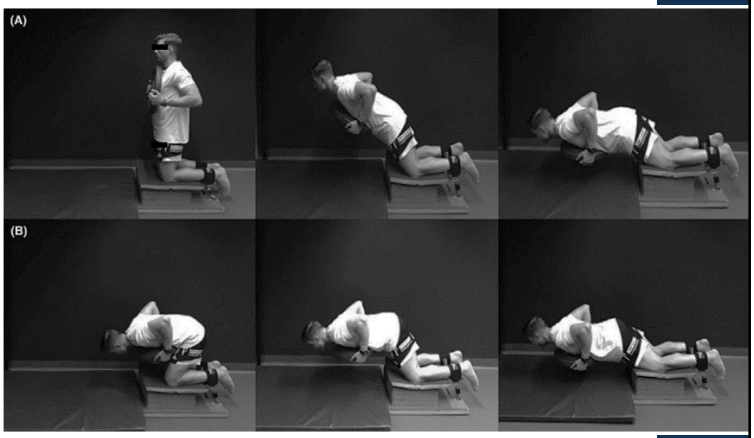
Exercise Selection
Razor Curls

Chris Pollard
@chriswpollard

- NHE (BW) vs. NHE (weighted) vs. razor curls
- FL + str: $NHE_{weighted}$ > NHE > Razor
- FL in razor group unchanged
- De-training effect greater in $NHE_{weighted}$ (1/52)



Pollard et al., 2019

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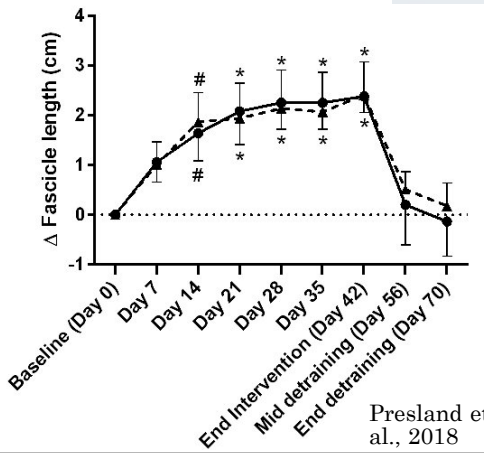
Exercise Volume

- High vol versus low vol group
- Completed NHE
- OM: BFlh architecture, strength
- No diff between high and low load groups

Week	High volume (reps)	Low volume (reps)
1	48	48
2	48	48
3	64	8
4	80	8
5	100	8
6	100	8

Joel Presland
@JoelPresland



Presland et al., 2018

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I'm not here to sell you Nordics but…

Sports Med (2017) 47:907–916
DOI 10.1007/s40279-016-0638-2

SYSTEMATIC REVIEW

Effect of Injury Prevention Programs that Include the Nordic Hamstring Exercise on Hamstring Injury Rates in Soccer Players: A Systematic Review and Meta-Analysis

Wesam Saleh A. Al Attar[1,2,3] · Najeebullah Soomro[1,4] · Peter J. Sinclair[1] · Evangelos Pappas[2] · Ross H. Sanders[1]

51% reduction in risk
RR = 0.49

Including the Nordic hamstring exercise in injury prevention programmes halves the rate of hamstring injuries: a systematic review and meta-analysis of 8459 athletes

Nicol van Dyk,[1] Fearghal P Behan,[2] Rod Whiteley[3]

Br J Sports Med 2019;**0**:1–10. doi:10.1136/bjsports-2018-100045

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Rationale for eccentric load

- Greater strength ↑
- ↑ Corticospinal excitability and motor cortex adaptations
- Cross-education between limbs (inherently CNS-based)

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Section Take Homes

Mechanical load is important

Can program low volumes with high stimulus exercise

Providing an eccentric stimulus may be beneficial for a number of reasons

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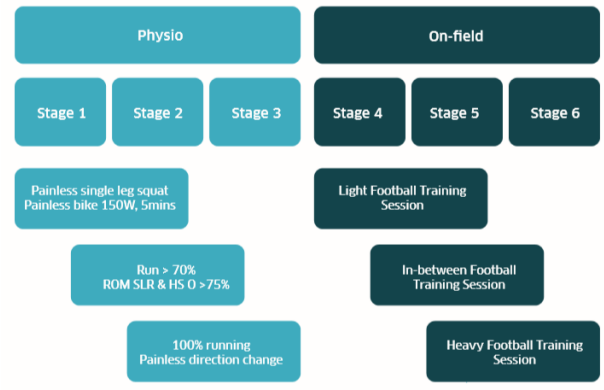
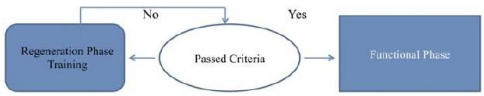
Rehab

- Criteria/time based vs symptom based
- Aspetar Protocol, Mendiguchia algorithm



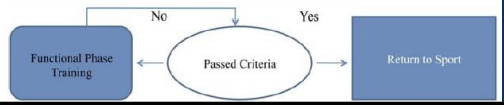
A Regeneration Phase

Variable	Test	Criteria for Progression
Pain after injury	Prone with knee flexed to 15° (10)	No pain
Isolated strength at long muscle lengths	Prone with knee flexed to 15° (21)	< 10% asymmetry
Neural deficiencies	Slump test (6)	No pain
Hamstring flexibility	Active knee extension (AKE) test (31)	< 10% asymmetry
Hip flexor flexibility	Modified Thomas test (MTT) (17)	+5 symmetry below horizontal



B Functional Phase

Variable	Test	Criteria for Progression
Pain	Palpation (10)	No pain
Peak torque (H/H) and conventional ratio (H/Q)	Isokinetic knee flexion/extension at 60°·s⁻¹ (8)	< 10% H/H and H/Q > 0.45 (Biodex) or > 0.47 (Cybex)
Hip extension strength	Prone hip extension (37)	< 10% asymmetry between legs
Distance	Triple hop test (16)	< 10% asymmetry between legs
Endurance (Repetition number)	Single leg bridge test (13)	> 25 and < 10% asymmetry between legs
Torsion capabilities	ASLR test (22)	No compensations
Insecurity and Pain	Askling H-test (2, 3)	No pain and insecurity



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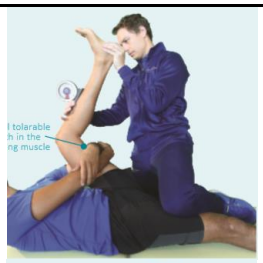
Rehab
Clinical Measures

- Aspetar Protocol (freely available)
- 15 daily clinical measures

- Tracking progress:
  - MHFAKE
  - Outer range strength – prog + perceived running speed
  - Length of pain



Rod Whiteley
@RodWhiteley

Whiteley et al., 2018

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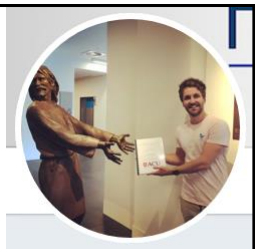
Rehab
Pain-free vs. Pain-threshold

- Median time to heavy eccentric load:
- Pain-free: 11 days
- Pain-threshold: 5 days

- No difference in adverse events at 6 month follow up

- Eccentric loading often better tolerated than isometric



Jack Hickey
@JackHickey89

Hickey et al., 2019

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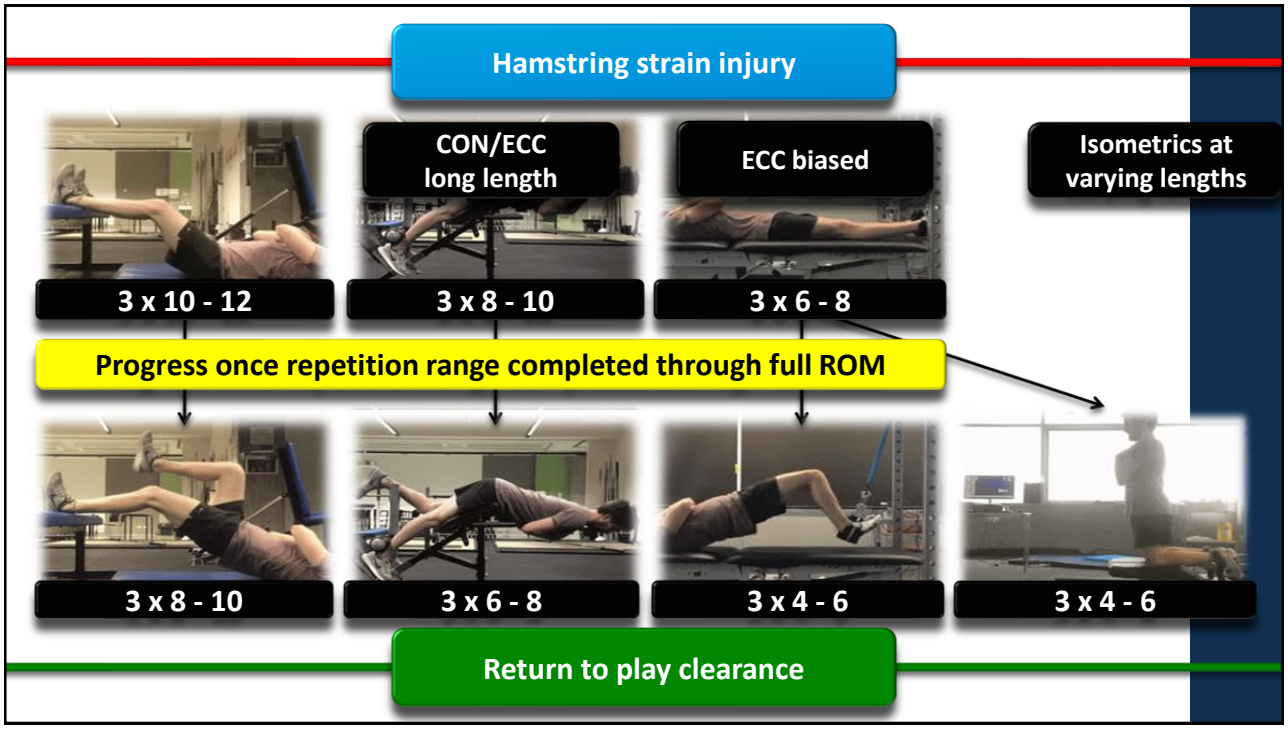

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Section Take Homes

Relatively few rehab protocols investigated

All include progressive overload

Exposure to exercise- and running-based sessions

Early loading possible

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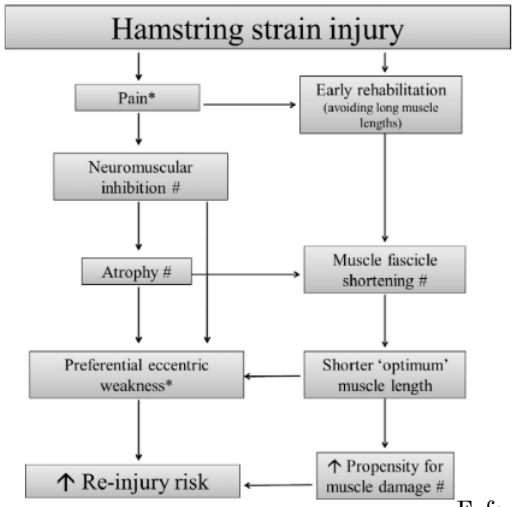
Why Hamstrings?

- Conceptual framework
- Premise for future work

- Pain at injury → deload = ↓ activity → ↓ FL + weakness



Fyfe et al., 2013

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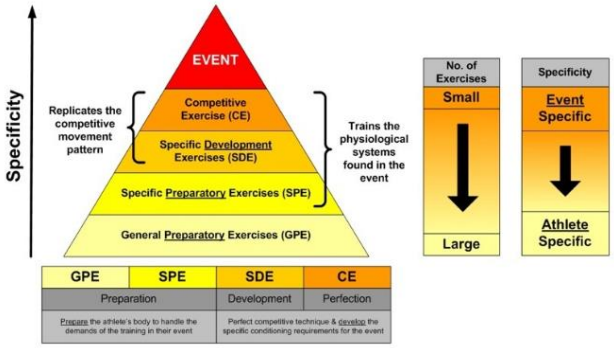
Programming



Bondarchuk, 2007

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Summary of Take Homes

HSI multi-factorial – consider modifiable risks

Ex selection based on adaptation

- Eccentric
- Volume

Rehab – gym, running, early?

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Final Thought…

Exposure is great…

…adherence is key

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