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Rehab essentials

- Eccentric strengthening in elongated ROM
- Dynamic flexibility to open entire kinetic chain

Risk factors:

- Strength imbalances (Thorborg 2014, Arnason 2008, Yeung 2009)
 - Hamstring/quads
 - Add/abd
- ↓ Decreased ROM (Arnason 2004, Ibrahim 2007)

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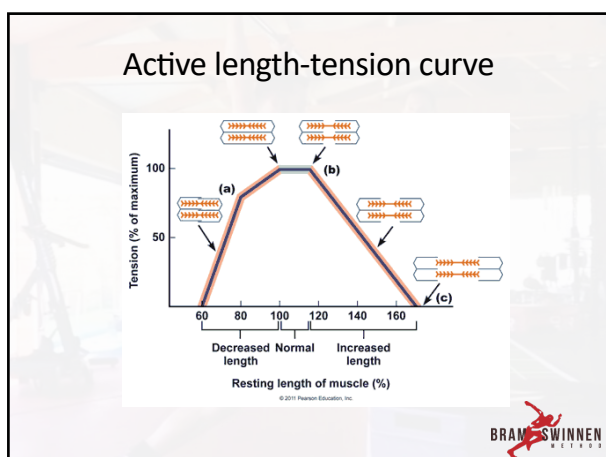
Altered muscle properties following hamstring injury:

(Brockett 2004, Brughelli 2009, Sanfilippo 2013)

- shifted length-tension curve towards shorter muscle lengths
 - ↓ end-range strength
 - Scar tissue
- ↓ activation of the biceps femoris towards full knee extension
 - Atrophy
 - Strength deficit → inhibition

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Strength & eccentrics

- Pre-season program to restore eccentric strength & hip adductor/abductor ratio → drastically ↓ risk to sustain or recur groin injury (Nunez 2020, Tyler 2002)
- Shift length-tension curve → prevent fibres from reaching a length where they are susceptible to tearing
- Static flexibility → unable to influence the length-tension relationship → ↓ stiffness

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Rehab essentials

- Energy absorption capacity
- Strength/strength endurance

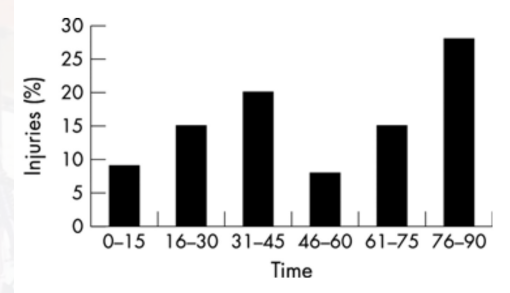
Risk factor:

- Fatigue → ↓ energy absorption capacity (Ekstrand 2011, Garrett 1990)



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Woods et al. 2004



Time	Injuries (%)
0-15	~9
16-30	~15
31-45	~20
46-60	~8
61-75	~15
76-90	~28

Time of hamstring strain sustained during a football match [2]

- Eccentric strengthening exercises at the end of sport-specific training




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Rehab essentials

- RFD
- Plyometrics → speed-end of F-V curve & stiffness

Risk factor:

- High-speed movement injuries




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Rehab essentials

- Intermuscular coordination – muscle slings
- Intersegmental neuromuscular control
- Horizontal force production/posterior pelvic tilt
- Proximal-to-distal sequencing of high speed movement

Risk factors:

- Previous groin/hamstring injury → 32-44% recurrence rate (Ibrahim 2007, Orchard 2002)
- Previous ankle, knee, thigh, shoulder injury → 5 x ↑ risk for groin injury (Langhout 2018, Verrall 2014)




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Rehab essentials

- Sport-specific & functional core stability – muscle slings

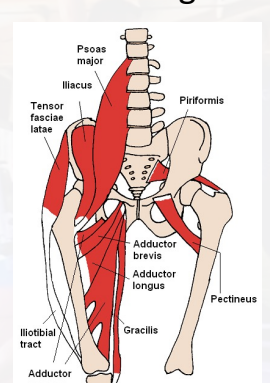

Risk factor:

- Core instability → anterior pelvic tilt ↓ hip internal rotation



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Adductor-related groin injury

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Intersegmental control, coordination & strength

- RESTORING PAIN-FREE FUNCTION → improves adductor function & strength (King 2018)
- ↓ glute & iliopsoas activation → ↑ ant. hip joint forces (Lewis 2007)
- Anterior pelvic tilt → ↑ femoroacetabular impingement & load across symphysis pubis (Delaney 2015, Spiteri 2013)




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Anterior oblique system





- hip adductors
- oblique abdominal muscles
- adductor-abdominal fascia
- M. Rectus abdominus



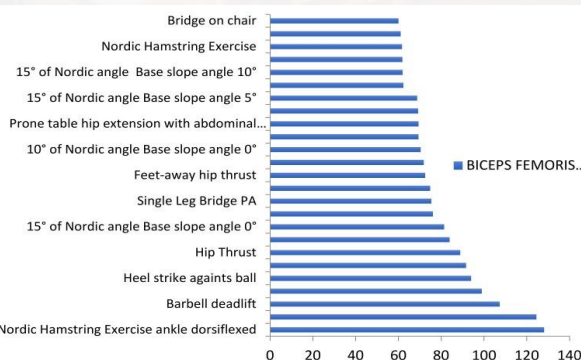
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The hamstrings

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Llurda-Almuzara et al. 2021




Exercise	Biceps Femoris Activity (approx. %MVC)
Bridge on chair	65
Nordic Hamstring Exercise	60
15° of Nordic angle Base slope angle 10°	60
15° of Nordic angle Base slope angle 5°	65
Prone table hip extension with abdominal...	70
10° of Nordic angle Base slope angle 0°	75
Feet-away hip thrust	80
Single Leg Bridge PA	85
15° of Nordic angle Base slope angle 0°	90
Hip Thrust	95
Heel strike againts ball	105
Barbell deadlift	115
Nordic Hamstring Exercise ankle dorsiflexed	125

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Hamstring muscle use assessed with functional MRI

- NHE → higher activation (Dooley 2020, Bourne 2017, Bourne 2016)
- NHE → chronic activation deficits compared with uninjured side (Bourne 2016)
- Leg extension exs. → more evenly distributed activity of all hamstring muscles (Messer 2018)
- BF/MH ratio (Bourne 2017, Dooley 2020, Messer 2018)
 - Lunge & back extension → Highest
 - NHE → Lowest



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Hegy et al. 2018

- NHE:
 - BH distal part
 - ST proximal & mid
- SDL:
 - less regional differences

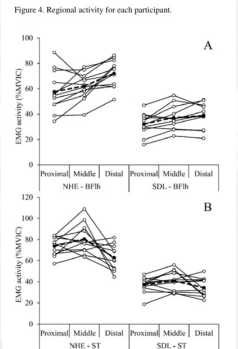
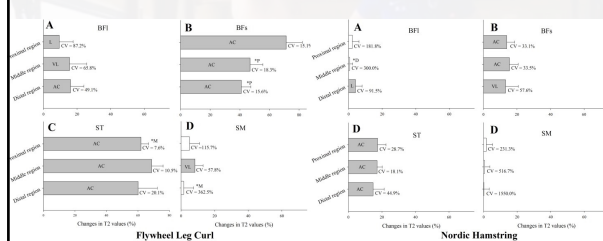


Figure 4. Regional activity for each participant.

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Site-specific hamstring muscles use with functional MRI in elite soccer players (Mendez-Villanueva et al. 2016)



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Architectural differences

- Architectural differences between the hamstring muscles → each muscle has its inherent function (Kellis 2012, Lieber 1993, 2000, Makihara 2006)
- Long head of the biceps femoris:
 - bulky muscle
 - shorter pennate fibres
 - Great amount of fast-twitch fibers (Evangelidis 2017, Afonso 2021)



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Re-activating long head of biceps femoris

- Anatomical characteristics → especially suited for high force contractions over a shorter ROM
- Stance phase of running
- Horizontal force production



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Horizontal force production

- Strongest predictor of Sprint acceleration (Rabita et al. 2015)
- ↑ Repeated sprint ability
- ↓ Hamstring injury recurrence (Mendiguchia 2016)
- RTP hamstring injury → ↓ HFP & sprinting speed (Roksund 2017, Mendiguchia 2014)



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Function of hamstring muscles during sprinting

- High speed sprinting → EMG activity higher than MVC (Kyrolainen 1999)
- Peak length 10% greater than the hamstring lengths during an upright stance (long head of biceps femoris) (Schache 2009)
- ↑ **running speed** from 80% to 100%: (Chumanov 2007)
 - 1.4-fold ↑ peak force - stance phase
 - 1.9-fold ↑ energy absorption - terminal swing



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Ballistics

- Stair bounds, hops, alternate leg bounds → ↑ hamstring stiffness → ↑ energy absorption capacity
- Maximal hip extension without maximal load in terminal swing phase



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Progressive sprint loading

- Uphill and resisted sprinting can help to make the transition from 80% to maximal speed.



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Role of integrated cognitive training in rehab

- Strength and corticospinal excitability were impaired at each time point compared with values in healthy control individuals, suggesting the need to address cortical function (Norte et al. 2018).



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Integrated brain training


- ↑ motor-cognitive dual task performance
- ↑ short-term benefits & long-term perseverance
- ↑ brain synchronization, activity & corticospinal excitability → counter reduced activation





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Thanks!

 **Bram-Swinnen-method**

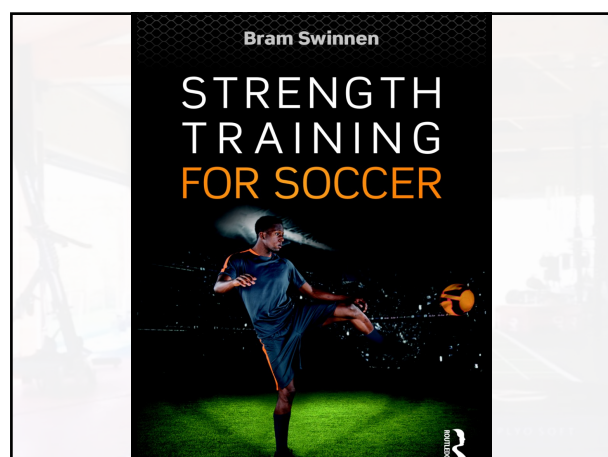
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