Developing a Return to Sport Algorithm

Mark Karam PT, DPT, SCS, CSCS

Evidence In Motion

Game Plan

- Return to Sport (RTS) Testing:
  - Are we doing a good job?
  - Why is it important?
- How do we define Success for our athletes
- Understanding the athlete
  - StARRT Framework
- Developing Algorithms
  - ACL Reconstruction
  - Hamstring Strain
  - Lateral Ankle Sprain

Are Athletes Passing Return To Sport Criteria?

In ACL population of 115 youth athletes, how many people do you think?

- Passed all hop testing : 53%
- Passed quad and hamstring strength testing: 28%
- Passed both strength and hop testing : 14%

Toole, Allison R., et al. “Young Athletes after Anterior Cruciate Ligament Reconstruction Cleared for Sports Participation: How Many Actually Meet Recommended Return-to-Sport Criteria Cutoffs?” Journal of Orthopaedic & Sports Physical Therapy, 2017, pp. 1–27., https://doi.org/10.2519/jospt.2017.7227.

Why is Testing Important?

- Participates who FAILED RTS criteria: **38.2%** reinjury rate
- Participates who PASSED RTS criteria: **5.6%** reinjury rate
  - Passing criteria defined as >90% KOS ADL, Global rating scale of function, isokinetic quad testing, hop testing (single hop, triple cross over, triple hop, 6m timed hop)
- The quad strength component of the RTS battery was a significant predictor of a knee re-injury

Test, Don't Guess

Grindem, Hege, et al. "Simple Decision Rules Can Reduce Reinjury Risk by 84% after ACL Reconstruction: The Delaware-Oslo ACL Cohort Study." British Journal of Sports Medicine, vol. 50, no. 13, 2016, pp. 804–808, https://doi.org/10.1136/bjsports-2016-096031.

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SUCCESS

What is success for your patient?

- Return to Participation:
  - Return to training or participation in sport at a lower level, but not yet ready to return to full sporting activity at the previous level
- Return to Sport:
  - Return to the defined sport, but desired performance level is not yet reached
- Return to Performance:
  - Return to performance at the pre-injury level of sport

Ardern, Clare L, et al. “2016 Consensus Statement on Return to Sport from the First World Congress in Sports Physical Therapy, Bern.” British Journal of Sports Medicine, vol. 50, no. 14, 2016, pp. 853–864., https://doi.org/10.1136/bjsports-2016-096278.

Game Plan

- Return to Sport (RTS):
  - Why is it important?
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- Algorithms
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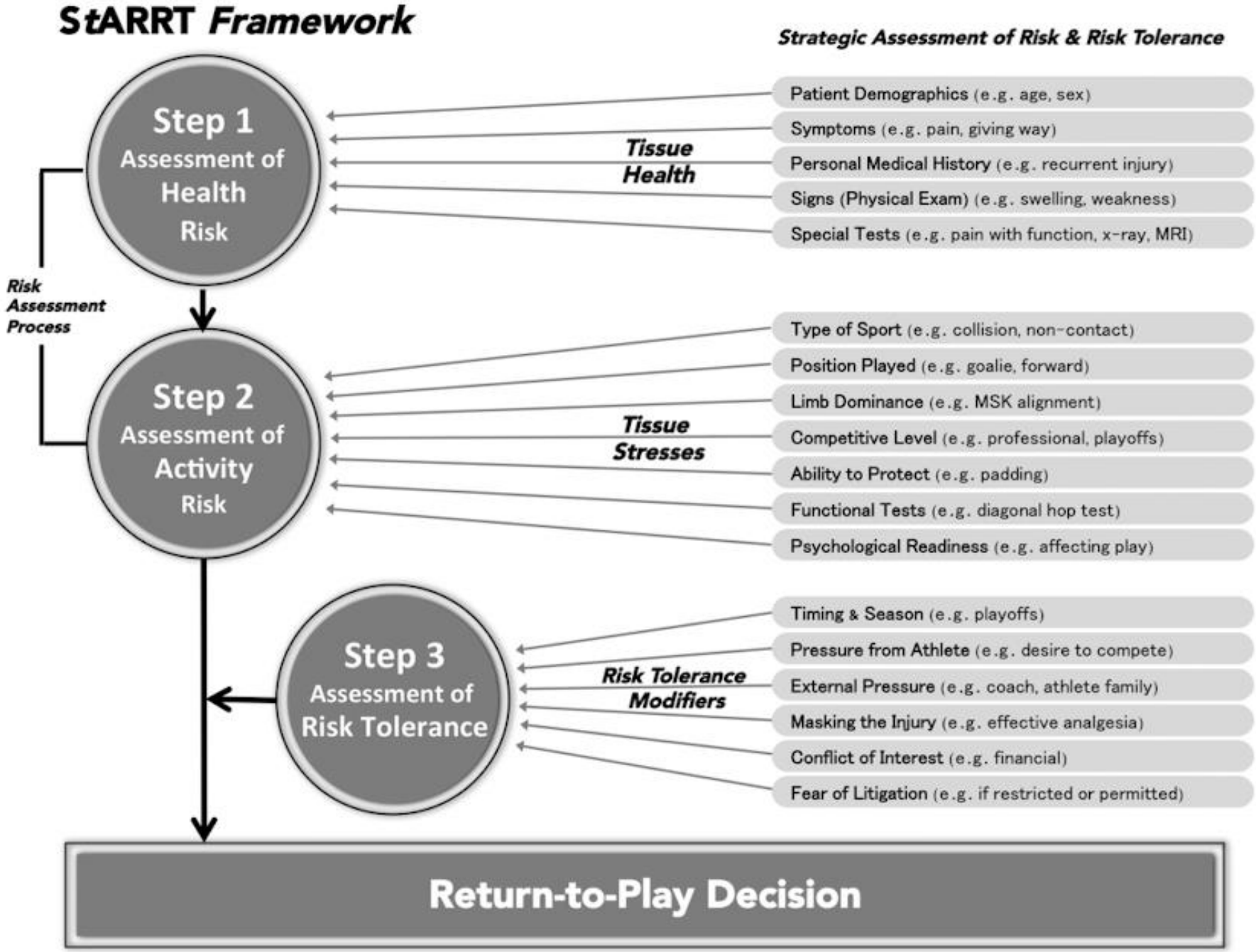
Where Do We StARRT?



It’s a Team Decision

Meredith, Sean J., et al. “Return to Sport after Anterior Cruciate Ligament Injury: Panther Symposium ACL Injury Return to Sport Consensus Group.” Knee Surgery, Sports Traumatology, Arthroscopy, vol. 28, no. 8, 2020, pp. 2403–2414., https://doi.org/10.1007/s00167-020-06009-1.

Game Plan

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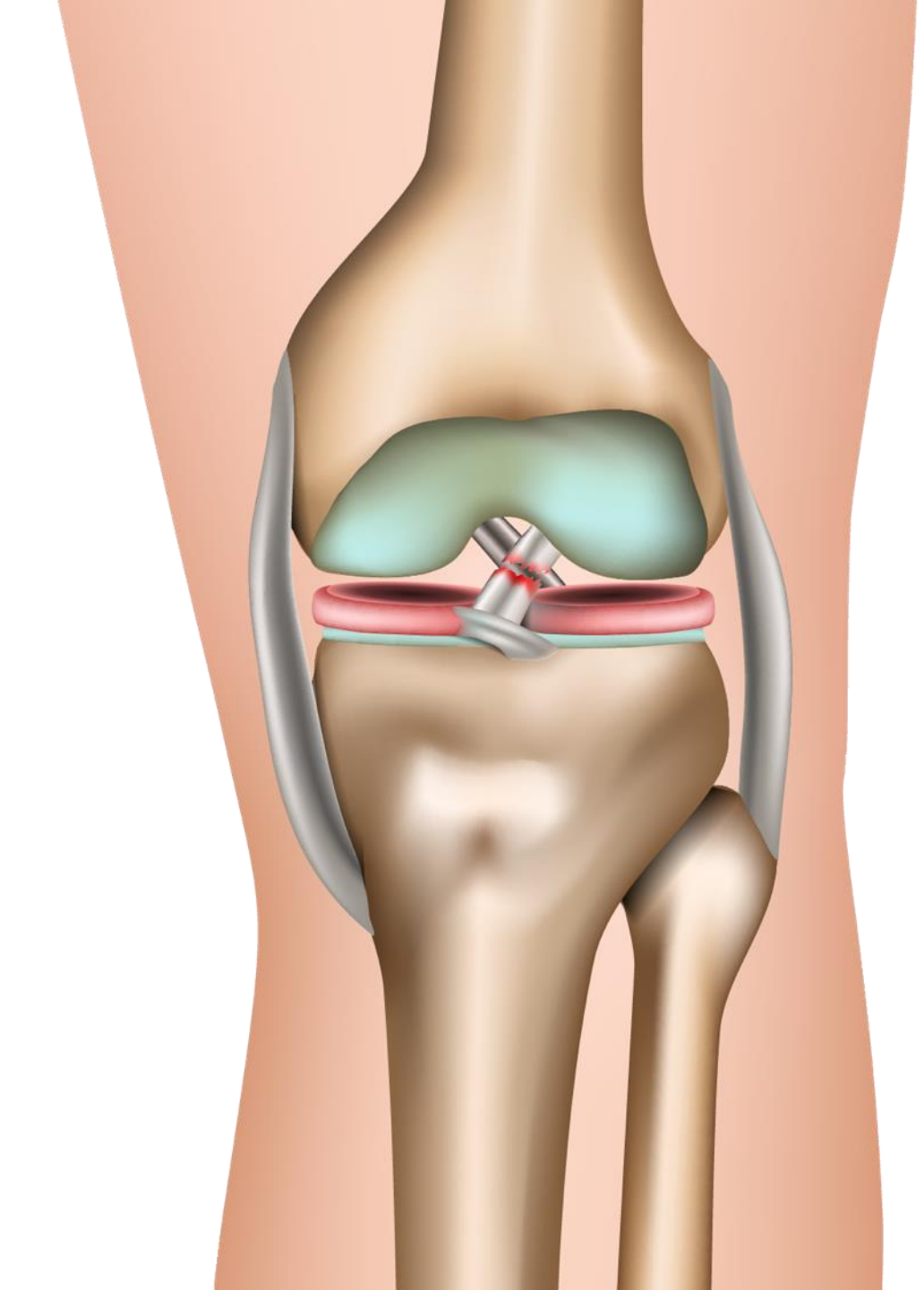


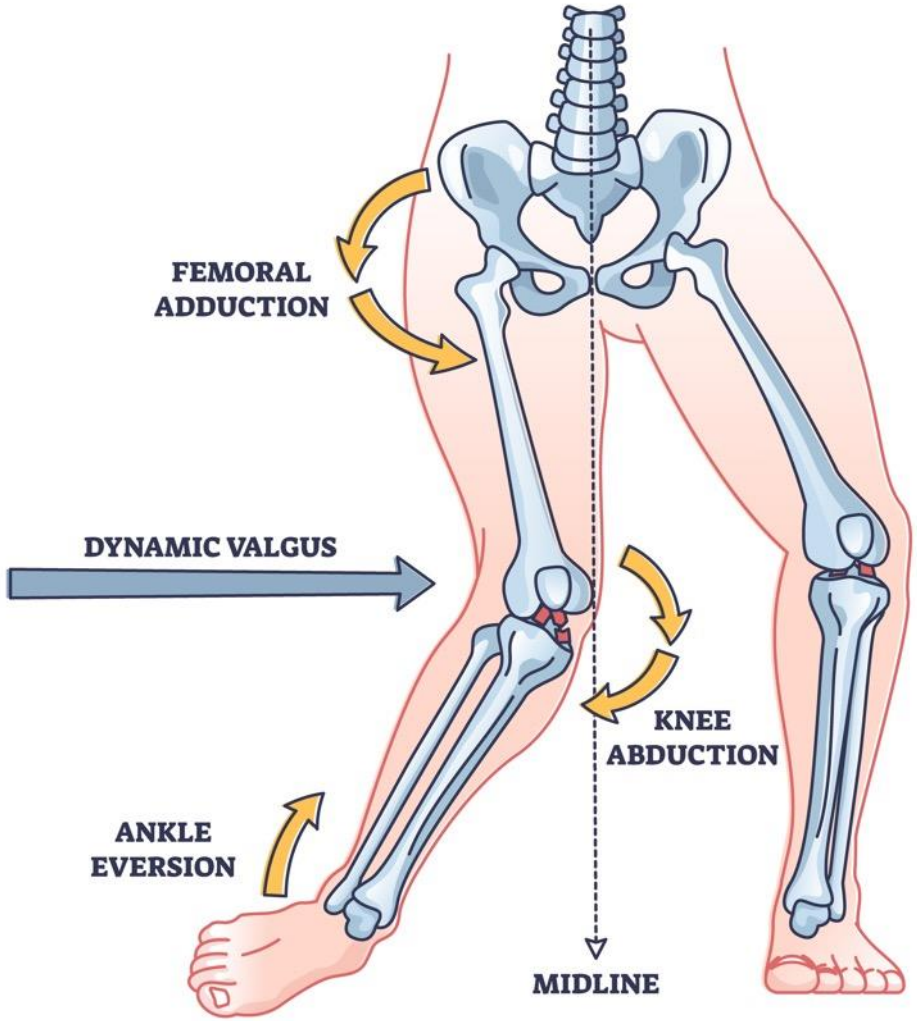
ACL Reconstruction

Evidence In Motion

ACL: Background

Mechanism of Injury:

- Anatomical consideration: Femoral adduction, knee abduction, tibial internal rotation, ankle eversion
- Low knee flexion angle ~20-30*
- 3-4x body mass
- Rapid valgus/internal rotation development (40 milliseconds)
- During change of direction, landing, deceleration, defending



Koga, Hideyuki, et al. "Mechanisms for Noncontact Anterior Cruciate Ligament Injuries." The American Journal of Sports Medicine, vol. 38, no. 11, 2010, pp. 2218–2225, https://doi.org/10.1177/0363546510373570.

Della Villa, Francesco, et al. "Systematic Video Analysis of ACL Injuries in Professional Male Football (Soccer): Injury Mechanisms, Situational Patterns and Biomechanics Study on 134 Consecutive Cases." British Journal of Sports Medicine, vol. 54, no. 23, 2020, pp. 1423–1432, https://doi.org/10.1136/bjsports-2019-101247.

Risk Factors

Intrinsic

- Female
- Intercondylar femoral notch width
- Anterior knee laxity
- Tibial plateau slope
- Previous ACL injury
- Family history of ACL injury
- Sport participation
- Increased BMI
- Athletes younger than 25

Extrinsic

- Dry weather
- Artificial Turf
- Combined loading pattern
- Trunk displacement deficits
- Lower Extremity Asymmetries
- Neuromuscular control (Dominance Patterns)

Hewett, Timothy E., et al. “Mechanisms, Prediction, and Prevention of ACL Injuries: Cut Risk with Three Sharpened and Validated Tools.” Journal of Orthopaedic Research, vol. 34, no. 11, 2016, pp. 1843–1855, https://doi.org/10.1002/jor.23414.

Logerstedt, David S., et al. “Knee Stability and Movement Coordination Impairments: Knee Ligament Sprain.” Journal of Orthopaedic & Sports Physical Therapy, vol. 40, no. 4, 2010, https://doi.org/10.2519/jospt.2010.0303.

Myer, Gregory D, et al. “Real-Time Assessment and Neuromuscular Training Feedback Techniques to Prevent Anterior Cruciate Ligament Injury in Female Athletes.” Strength & Conditioning Journal, vol. 33, no. 3, 2011, pp. 21–35, https://doi.org/10.1519/ssc.0b013e318213afa8.

ACL Injury and RTS Statistics

- Prevalence: 200,000-250,000
  - Increasing each year (specifically high school)
- Reinjury rate: 30-39%
- Cost: $20,000-$50,000
  - Financial burden on families

Ardern, Clare L, et al. “2016 Consensus Statement on Return to Sport from the First World Congress in Sports Physical Therapy, Bern.” British Journal of Sports Medicine, vol. 50, no. 14, 2016, pp. 853–864., https://doi.org/10.1136/bjsports-2016-096278.

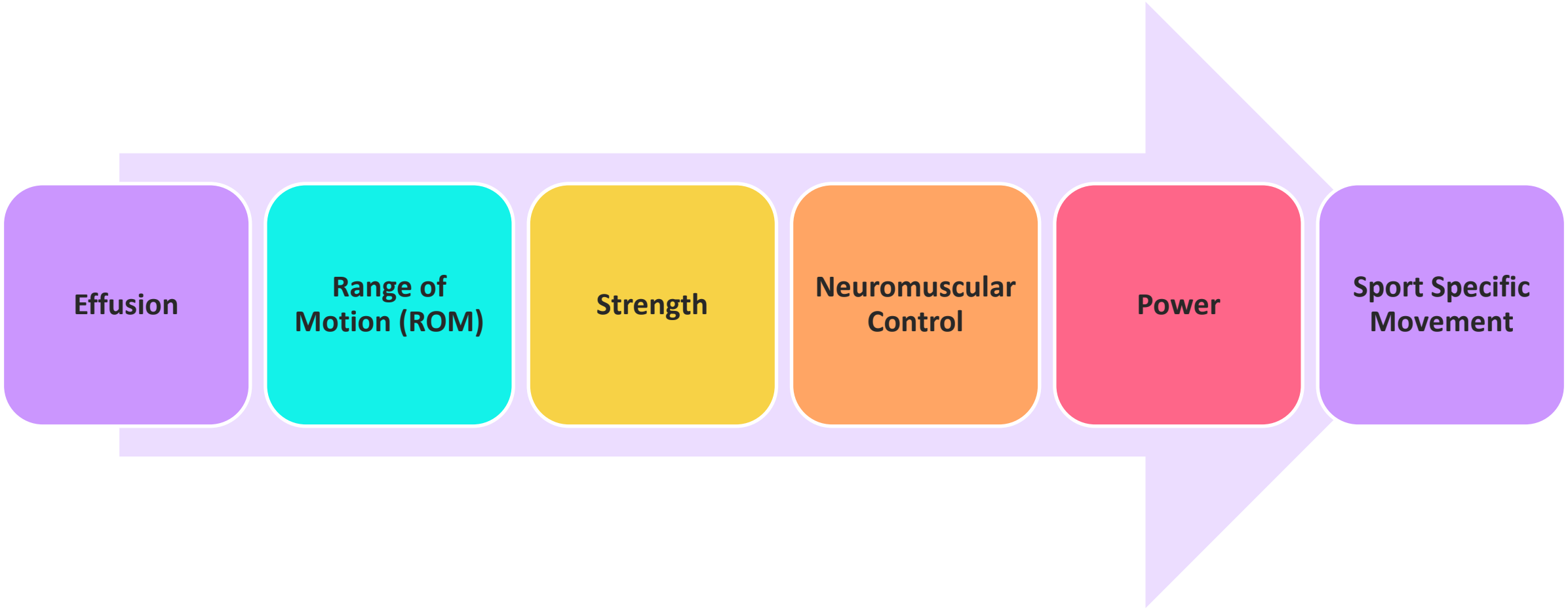
Wilk, Kevin, et al. “The Need to Change Return to Play Testing in Athletes Following ACL Injury: A Theoretical Model.” International Journal of Sports Physical Therapy, vol. 18, no. 1, 2023, https://doi.org/10.26603/001c.67988.

ACL Injury and RTS Statistics

- Returning to some sporting activity: 81%
- Returning to pre-injury sport: 65%
- Returning to competitive level: 55%

Toole, Allison R., et al. “Young Athletes after Anterior Cruciate Ligament Reconstruction Cleared for Sports Participation: How Many Actually Meet Recommended Return-to-Sport Criteria Cutoffs?” Journal of Orthopaedic & Sports Physical Therapy, 2017, pp. 1–27., https://doi.org/10.2519/jospt.2017.7227.

ACL Algorithm



Effusion Assessment: Sweep Test

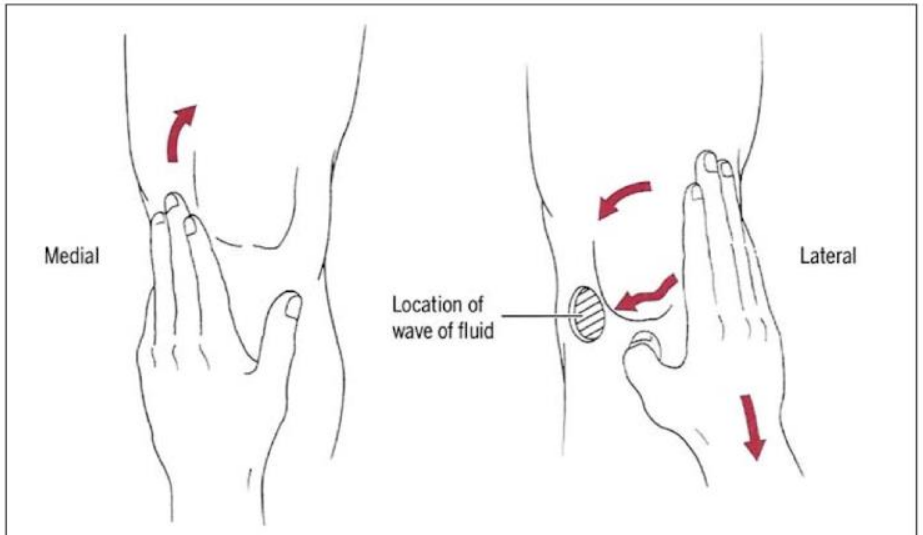


FIGURE. Diagram depicting the stroke test.[12] (A) Examiner strokes upwards from the medial joint line towards the suprapatellar pouch. (B) A downward stroke on the distal lateral thigh from the suprapatellar pouch towards the lateral joint line is performed; a wave of fluid is observed at the medial knee. Figure published with permission from *Orthopedic Physical Assessment*, 4th edition, David J. Magee, Knee chapter, page 726, Copyright Elsevier, 2002.

TABLE 1 EFFUSION GRADING SCALE OF THE KNEE JOINT BASED ON THE STROKE TEST

Grade	Test Result
Zero	No wave produced on downstroke
Trace	Small wave on medial side with downstroke
1+	Larger bulge on medial side with dowstroke
2+	Effusion spontaneously returns to medial side after upstroke (no downstroke necessary)
3+	So much fluid that it is not possible to move the effusion out of the medial aspect of the knee

- Sweep Test
  - Assessment of joint fluid
- Role in decision making:
  - Causes arthrogenic muscle inhibition (AMI)
  - Impacts full ROM
  - Provides information on how the injured tissue is tolerating activity
- Recommendation:
  - trace or less

Sturgill, Lynne Patterson, et al. "Interrater Reliability of a Clinical Scale to Assess Knee Joint Effusion." *Journal of Orthopaedic & Sports Physical Therapy*, vol. 39, no. 12, 2009, pp. 845–849, https://doi.org/10.2519/jospt.2009.3143.

Range of Motion

Knee Extension/Flexion

- Role in decision making:
  - Provides information on stiffness of the joint which can lead to asymmetries during sport specific movement
- Recommendation:
  - Full, pain free, non-resistive range of motion compared to contralateral side

Strength Testing

Types:

- Isokinetic Dynamometer (Gold Standard)
- Handheld Dynamometry (HHD)
- Tindeq
- Estimation of 1 rep max
- Manual Muscle Testing

Strength Testing

- Role in decision making:
  - Patient quadriceps LSI < 90% significantly increases risk of knee re-injury
  - For every 1% increase in strength symmetry, there is a 3% reduction in rate for re-injury
  - LSI < 90%: 33% suffered re-injury
  - LSI > 90%: 12.5% suffered re-injury
  - Quadriceps strength is required for deceleration tasks such as landing and change of direction
- Recommendation:
  - LSI >102% with HHD testing
  - Torque: RTS: 3.0 Nm/kg*BW

Grindem, Hege, et al. “Simple Decision Rules Can Reduce Reinjury Risk by 84% after ACL Reconstruction: The Delaware-Oslo ACL Cohort Study.” British Journal of Sports Medicine, vol. 50, no. 13, 2016, pp. 804–808, https://doi.org/10.1136/bjsports-2016-096031.

Kuenze, Christopher, et al. “Clinical thresholds for quadriceps assessment after Anterior Cruciate Ligament Reconstruction.” Journal of Sport Rehabilitation, vol. 24, no. 1, Feb. 2015, pp. 36–46, https://doi.org/10.1123/jsr.2013-0110.

Strength Testing

- Comparison of strength testing to gold standard (isokinetic dynamometer)
  - ONLY HHD met inter-class correlation (ICC) of cut off score 0.7
  - KX 45* and KX 90* where next best tests
- HHD
  - Slightly over-estimates true limb symmetry index (LSI)

Sinacore, J. A., Evans, A. M., Lynch, B. N., Joreitz, R. E., Irrgang, J. J., & Lynch, A. D. (2017). Diagnostic accuracy of handheld dynamometry and 1-repetition-maximum tests for identifying meaningful quadriceps strength asymmetries. *Journal of Orthopaedic & Sports Physical Therapy*, *47*(2), 97–107. https://doi.org/10.2519/jospt.2017.6651

Strength Testing: HHD

TABLE 5 CUT POINTS FOR HHD ALTERNATIVE MEASURE TO IDENTIFY CLINICAL THRESHOLD QI SYMMETRY*

	Clearance for Return to Running (80% QI)			Clearance for Return to Play (90% QI)		
	Cut Point	Observed Specificity	Observed Sensitivity	Cut Point	Observed Specificity	Observed Sensitivity
Minimum specificity						
80%	85.9	83.3	72.2	99.1	80.0	41.7
85%	86.5	88.9	72.2	102.8	86.7	33.3
90%	100.7	94.4	36.1	103.7	90.0	33.3
Area under the curve†		87.2 (76.6, 97.8)			73.3 (60.2, 86.5)	

Abbreviations: HHD, handheld dynamometry; QI, quadriceps index.
**Values are percent.*
†*Values in parentheses are 95% confidence interval.*

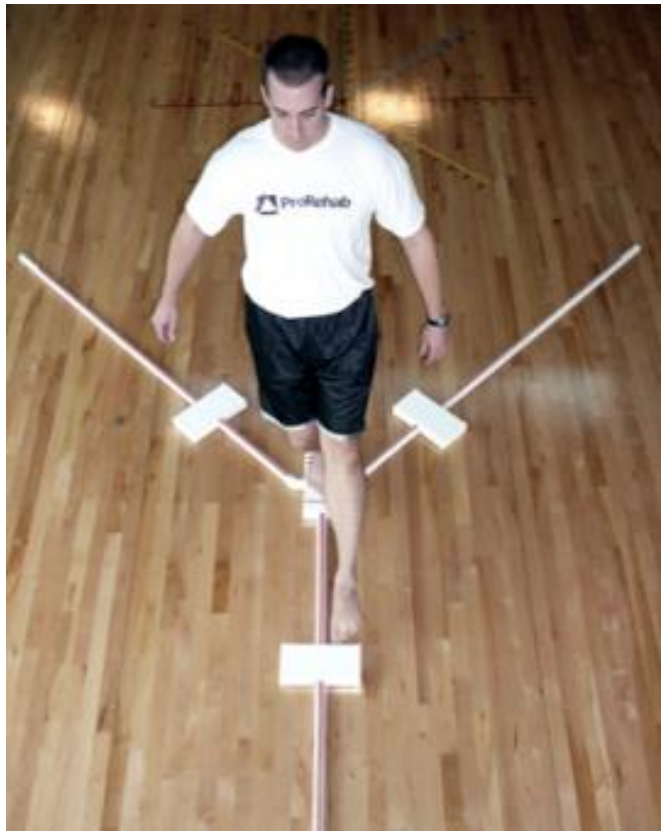
Sinacore, J. A., Evans, A. M., Lynch, B. N., Joreitz, R. E., Irrgang, J. J., & Lynch, A. D. (2017). Diagnostic accuracy of handheld dynamometry and 1-repetition-maximum tests for identifying meaningful quadriceps strength asymmetries. *Journal of Orthopaedic & Sports Physical Therapy*, *47*(2), 97–107. https://doi.org/10.2519/jospt.2017.6651

Strength Testing: MMT

An athlete who weighs 165 pounds can generate 145 pounds of force during knee extension testing

Evidence In Motion

Neuromuscular Control Testing



- Anterior reach portion of Y balance
  - Assessment of single leg stability requiring ankle dorsiflexion, balance, controlled knee flexion, and quadriceps strength
- Role in decision making:
  - Neuromuscular control deficits are a risk factor for ACL injuries
  - > 4cm difference between limbs is associated with 2.5 x more likely to suffer lower extremity injury
- Recommendation:
  - < 4cm

Plisky PJ, Gorman PP, Butler RJ, Kiesel KB, Underwood FB, Elkins B. The reliability of an instrumented device for measuring components of the star excursion balance test. N Am J Sports Phys Ther. 2009 May;4(2):92-9. PMID: 21509114; PMCID: PMC2953327.

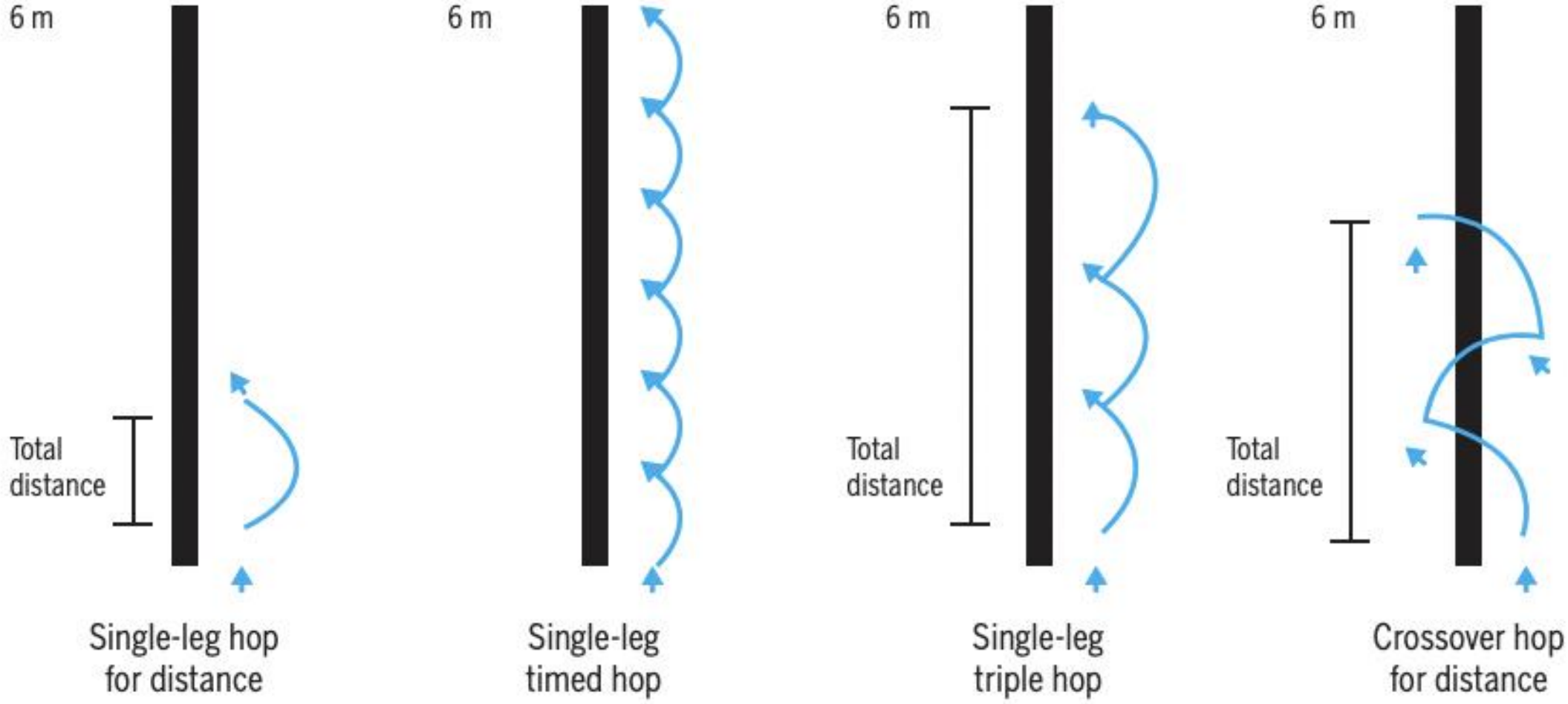
Myer, Gregory D, et al. “Real-Time Assessment and Neuromuscular Training Feedback Techniques to Prevent Anterior Cruciate Ligament Injury in Female Athletes.” Strength & Conditioning Journal, vol. 33, no. 3, 2011, pp. 21–35, https://doi.org/10.1519/ssc.0b013e318213afa8.

Gribble PA, Hertel J, Plisky P. Using the star excursion balance test to assess dynamic postural control deficits and outcomes in lower extremity injury: a literature and systematic review. Journal of Athletic Training. 2012; 47(3): 339-357

Power Testing

- Hop Testing
  - Horizontal
  - Vertical
- Change of direction
  - Proactive
  - Reactive

Horizontal Hop Testing

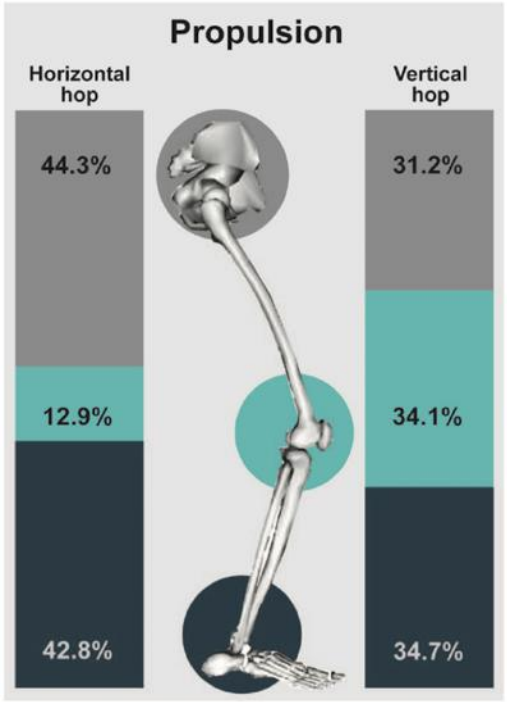


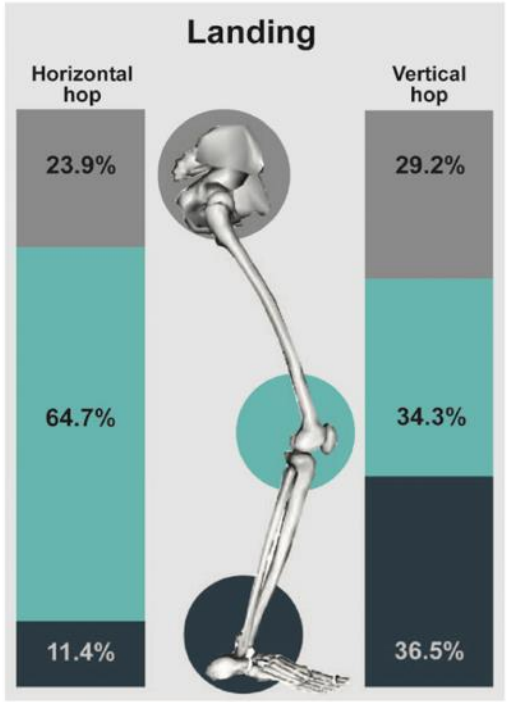
Haitz K, Shultz R, Hodgins M, Matheson GO. Test-retest and interrater reliability of the functional lower extremity evaluation. J Orthop Sports Phys Ther. 2014 Dec;44(12):947-54. doi: 10.2519/jospt.2014.4809. Epub 2014 Nov 13. PMID: 25394690.

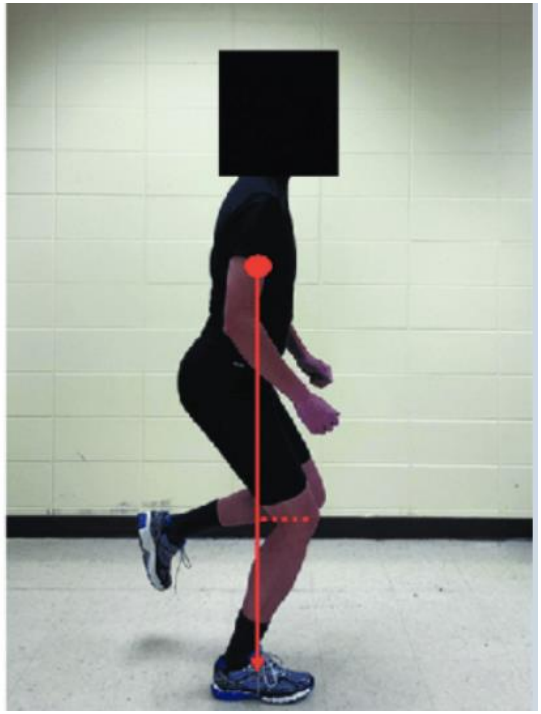
Question

What does hop testing tell you about the function of the knee following ACL reconstruction?

What is Horizontal Hop Testing Assessing?







Yu Song, Ling Li, Gerwyn Hughes & Boyi Dai (2021): Trunk motion andanterior cruciate ligament injuries: a narrative review of injury videos and controlled jump-landingand cutting tasks, Sports Biomechanics

Kotsifaki, Argyro, et al. “Vertical and Horizontal Hop Performance: Contributions of the Hip, Knee, and Ankle.” *Sports Health: A Multidisciplinary Approach*, vol. 13, no. 2, 2021, pp. 128–135, https://doi.org/10.1177/1941738120976363.

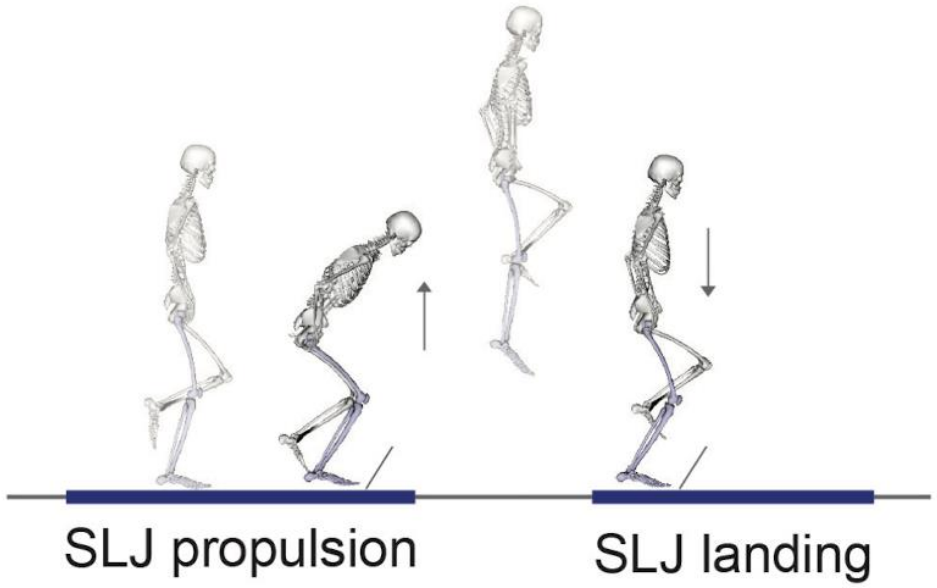
Power Testing

- Horizontal Hop Testing Battery:
  - Assessment of lower extremity power to propel and decelerate during jumping and landing
- Role in decision making:
  - Altered landing mechanics with hop testing is a predictor of second ACL injury
- Recommendation:
  - > 95% LSI with hop testing
  - Qualitative analysis of proper landing mechanics allowing knee to flex

Kotsifaki, Argyro, et al. “Vertical and Horizontal Hop Performance: Contributions of the Hip, Knee, and Ankle.” *Sports Health: A Multidisciplinary Approach*, vol. 13, no. 2, 2021, pp. 128–135, https://doi.org/10.1177/1941738120976363.

Vertical Hop Testing

- Single Leg Jump
  - Assessment of power with propulsion and deceleration in vertical plane
- Role in Decision Making
  - Requires even amount of knee function during jumping and landing
  - Simulates required movement pattern of many sports such as basketball and volleyball
  - Despite achieving symmetry (~97%) with horizontal hop testing, ACLR patients continue to demonstrate vertical jump deficits between limbs
- Recommendation
  - >95% LSI with jump height / time off the ground



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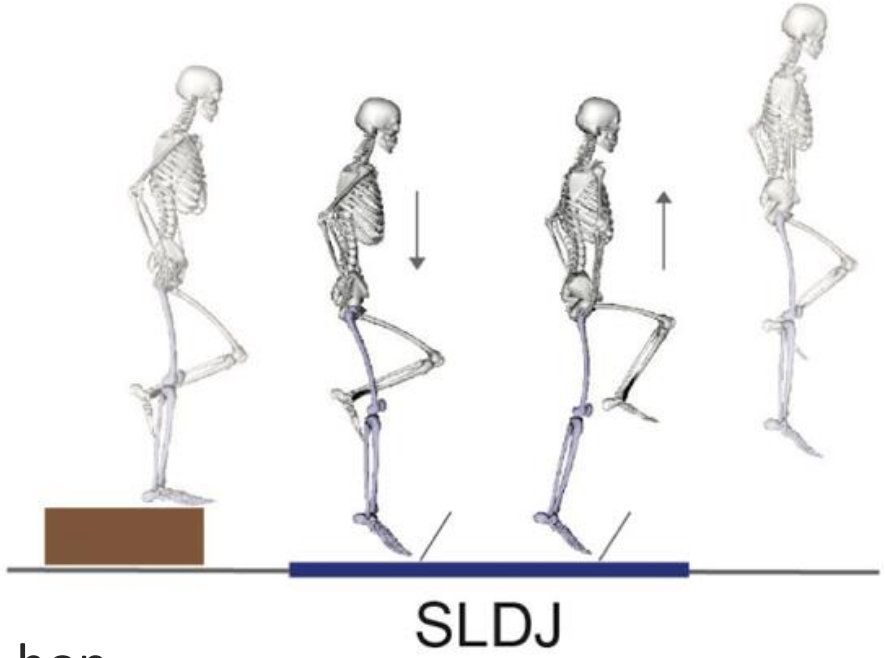
Kotsifaki, Argyro, et al. "Vertical and Horizontal Hop Performance: Contributions of the Hip, Knee, and Ankle." *Sports Health: A Multidisciplinary Approach*, vol. 13, no. 2, 2021, pp. 128–135, https://doi.org/10.1177/1941738120976363.

Vertical Hop Testing

- Single Leg Drop Jump
  - Assessment of power with propulsion and deceleration in vertical plane
- Role in Decision Making
  - Requires even amount of knee function during jumping and landing
  - Simulates required movement pattern of many sports such as basketball and volleyball
  - Despite achieving symmetry (~97%) with horizontal hop testing, ACLR patients continue to demonstrate vertical jump deficits between limbs
- Recommendation
  - >95% LSI with contact time/flight time (lower scores = better)



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Vertical Jump Testing

My Jump App

- Records video in slow motion and provides contact time and time off the ground comparing between limbs

Evidence In Motion

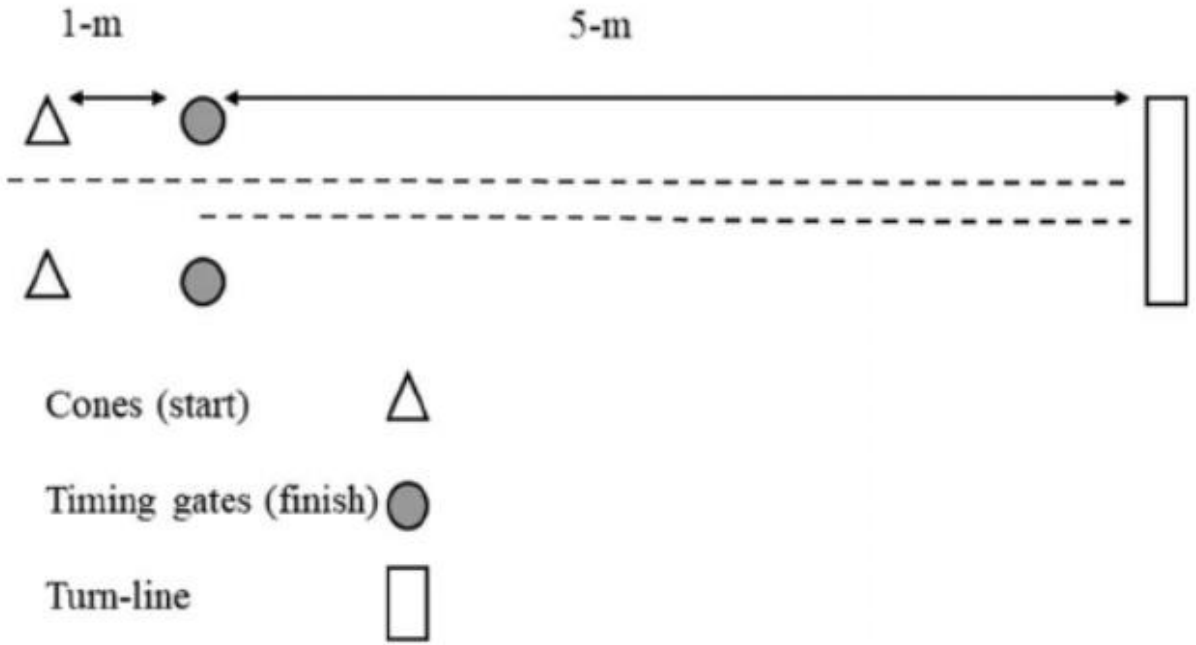
Change of Direction

- Change of direction occurs frequently during sport
  - ~100 turns during soccer match
- Change of direction is a key mechanism of non-contact ACL injury
- Eccentric quadriceps strength is required for efficient change of direction

Della Villa F, Buckthorpe M, Grassi A, Nabiuzzi A, Tosarelli F, Zaffagnini S, Della Villa S. Systematic video analysis of ACL injuries in professional male football (soccer): injury mechanisms, situational patterns and biomechanics study on 134 consecutive cases. Br J Sports Med. 2020 Dec;54(23):1423-1432. doi: 10.1136/bjsports-2019-101247. Epub 2020 Jun 19. PMID: 32561515.

Change of Direction

- Modified 5-0-5 test:
  - Assessment of change of direction/deceleration
- Role in decision making:
  - Lower knee flexion angles with change of direction are thought to place higher stress on ACL
- Recommendation:
  - Utilize as qualitative assessment to look at knee flexion angle and apprehension



Taylor, Jonathan & Cunningham, Louis & Hood, Peter & Thorne, Ben & Irvin, Greg & Weston, Matthew. (2018). The reliability of a modified 505 test and change-of-direction deficit time in elite youth football players. Science and Medicine in Football. 3. 1-6. 10.1080/24733938.2018.1526402.

Reactive Testing

- Reactive Testing
  - Della Villa et al. noted 2/3 of ACL injuries during a soccer match occurred during defending
  - Sport task requires numerous unpredictable movements with change of direction
  - More injuries tend to happen during competition versus practice (unknown versus known)
- Technology being used
  - Blazepods
  - Trazer

Unverzagt, Casey, et al. “ACL Return to Sport Testing: It’s Time to Step up Our Game.” *International Journal of Sports Physical Therapy*, vol. 16, no. 4, 2021, https://doi.org/10.26603/001c.25463.

Wilk, Kevin, et al. “The Need to Change Return to Play Testing in Athletes Following ACL Injury: A Theoretical Model.” International Journal of Sports Physical Therapy, vol. 18, no. 1, 2023, https://doi.org/10.26603/001c.67988.

Psychological Readiness

- Psychological Outcome Measure
  - Self reported, subjective measurement of fear of movement
- Role in Decision Making
  - Fear of reinjury is a psychological response to injury leading to reduced sports participations, delayed return to sport, and reduce self reported function
  - In one meta-analysis, fear of reinjury is the most frequently cited reason for reduction in sports participation
  - Significantly associated with second ACL injury (3-6x higher) in athletes
  - + Effect on psychological readiness at 12 months: male sex, younger age, higher frequency of sports participation

Ardern, Clare L, et al. “2016 Consensus Statement on Return to Sport from the First World Congress in Sports Physical Therapy, Bern.” British Journal of Sports Medicine, vol. 50, no. 14, 2016, pp. 853–864., https://doi.org/10.1136/bjsports-2016-096278.

McPherson, April L., et al. “Psychological Readiness to Return to Sport Is Associated with Second Anterior Cruciate Ligament Injuries.” *The American Journal of Sports Medicine*, vol. 47, no. 4, 2019, pp. 857–862., https://doi.org/10.1177/0363546518825258.

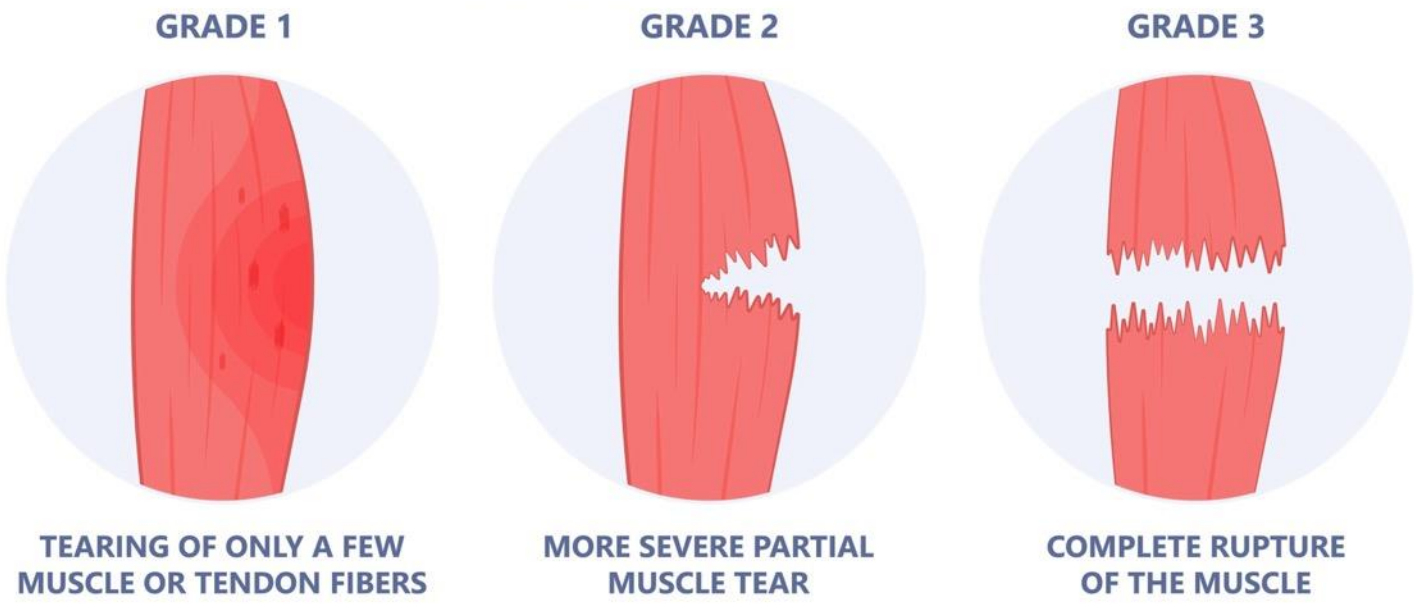
Psychological Readiness: Outcome Measures

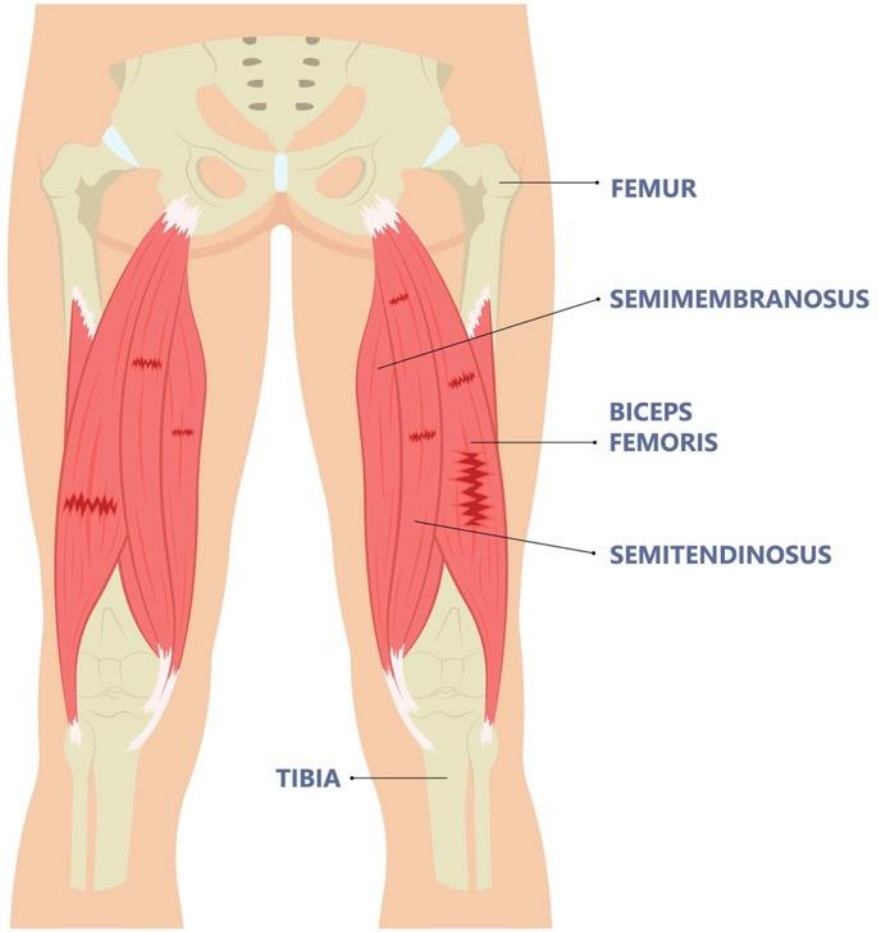
Recommendation

- ACL-RSI: >76

McPherson, April L., et al. “Psychological Readiness to Return to Sport Is Associated with Second Anterior Cruciate Ligament Injuries.” *The American Journal of Sports Medicine*, vol. 47, no. 4, 2019, pp. 857–862., https://doi.org/10.1177/0363546518825258.

Hamstring Strain





Hamstring Strain: Background

- Statistics for injury in sports
  - Increased risk in sports that involve sprinting, kicking (field sports > court sports), and extensive muscle lengthening-type maneuvers (dancing)
  - Competition > Practice
  - Preseason > regular season and postseason
  - ⅓ recur (Higher risk is within first 2 weeks of RTS)
- Mechanism of injury
  - Extensive muscle lengthening or rapid eccentric contraction during terminal swing
  - Sprinting: Biceps femoris > intramuscular tendon
  - Stretching (gymnastics): Semimembranosus > Proximal free tendon

Erickson, Lauren N., and Marc A. Sherry. "Rehabilitation and Return to Sport after Hamstring Strain Injury." *Journal of Sport and Health Science*, vol. 6, no. 3, 2017, pp. 262–270., https://doi.org/10.1016/j.jshs.2017.04.001.

Risk Factors

Intrinsic

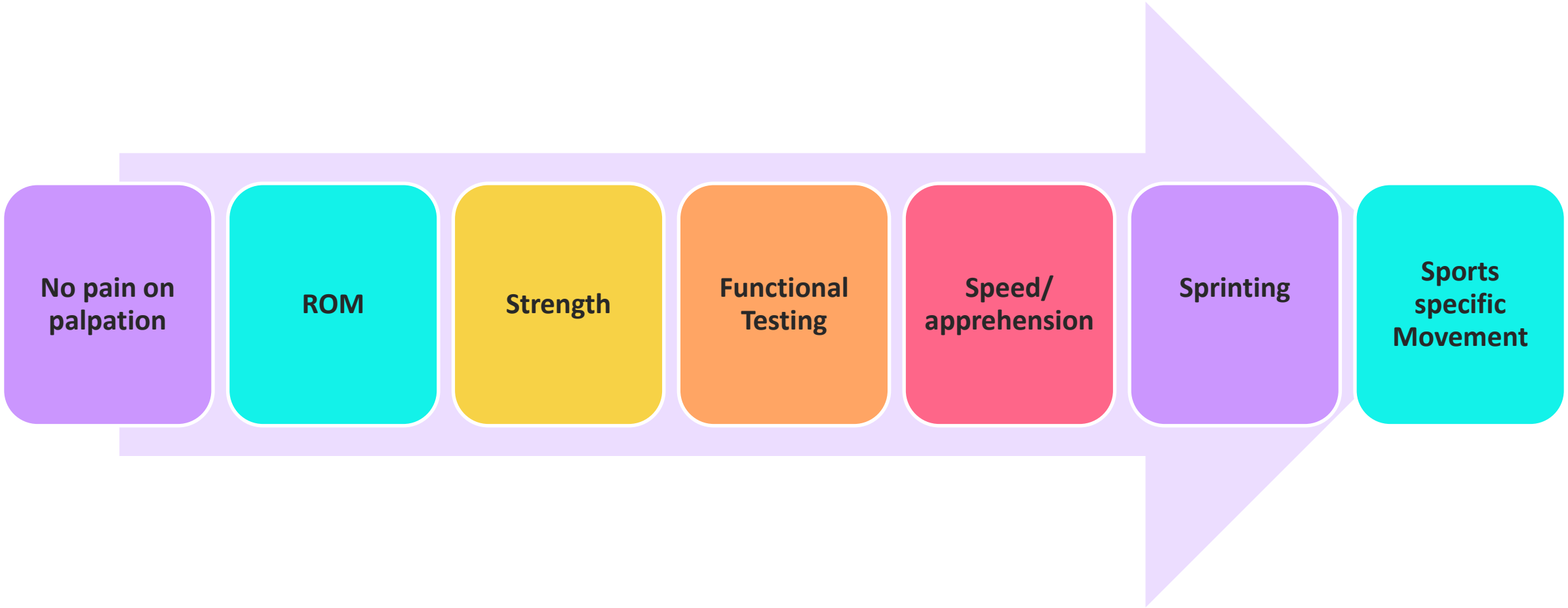
- Previous Hamstring Strain (smaller increases in eccentric hamstring strength compared to non-jured)
- Older age
- Previous knee injury

Extrinsic

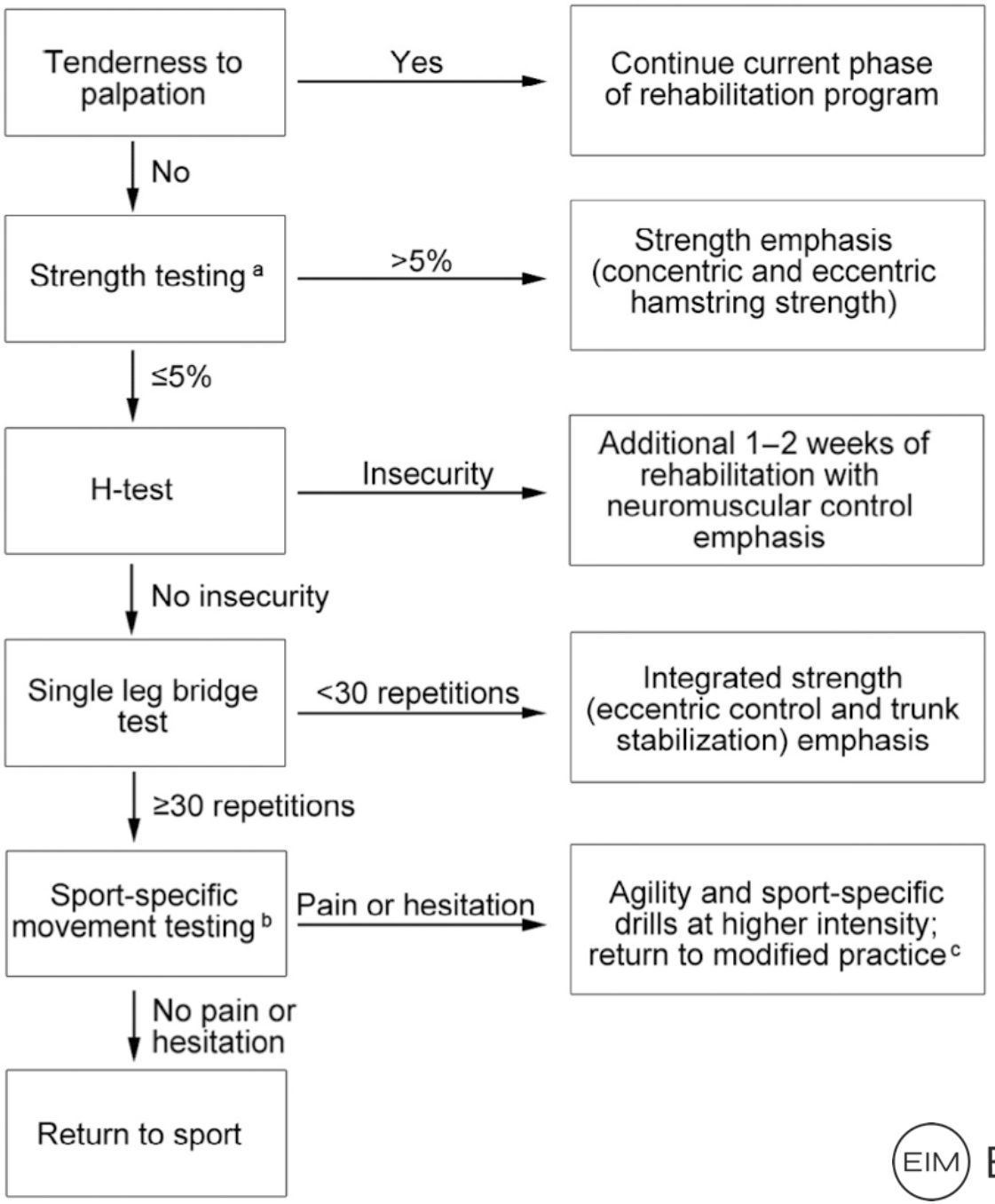
- Hamstring weakness and fatigue
- Imbalances in hamstring eccentric and quadriceps concentric strength
- Contralateral quadriceps/hip flexor mobility deficits
- Strength and coordination deficits of the pelvis and trunk

Erickson, Lauren N., and Marc A. Sherry. “Rehabilitation and Return to Sport after Hamstring Strain Injury.” *Journal of Sport and Health Science*, vol. 6, no. 3, 2017, pp. 262–270., https://doi.org/10.1016/j.jshs.2017.04.001.

Return to Sport Algorithm



Hamstring Algorithm



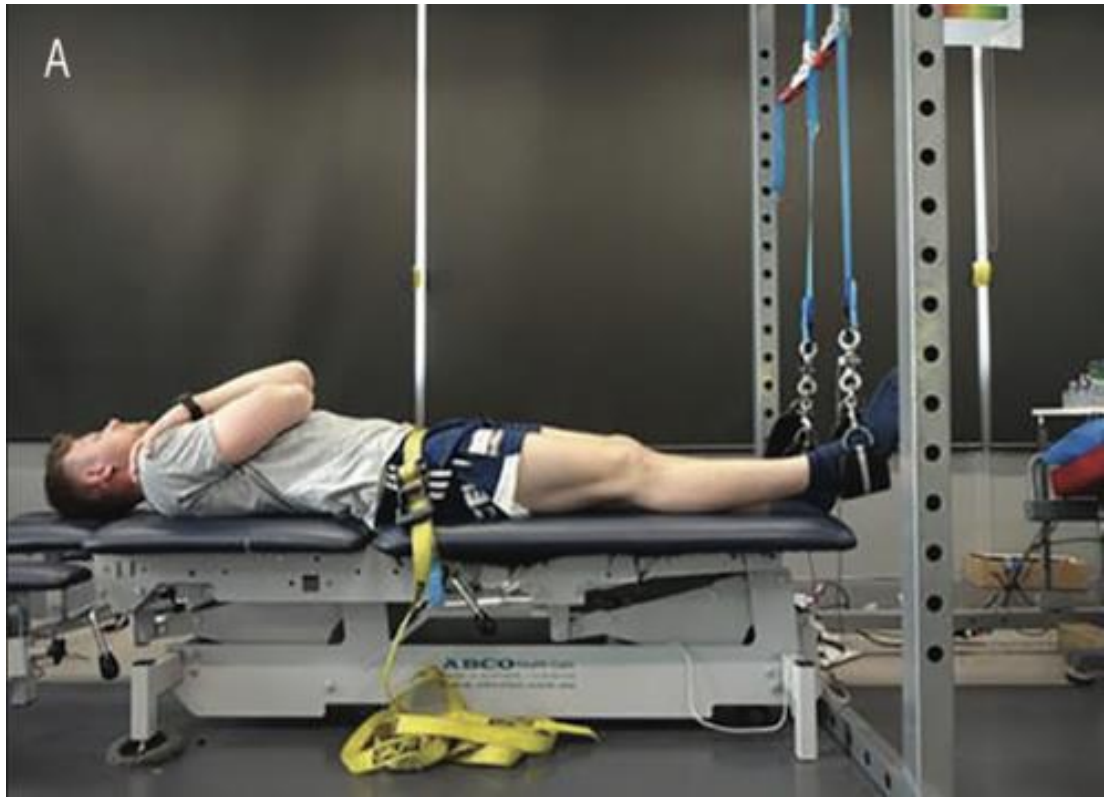
Erickson, Lauren N., and Marc A. Sherry. "Rehabilitation and Return to Sport after Hamstring Strain Injury." *Journal of Sport and Health Science*, vol. 6, no. 3, 2017, pp. 262–270., https://doi.org/10.1016/j.jshs.2017.04.001.

Range of Motion Testing: Active Straight Leg Raise

- Assessment of active hamstring length
- Role in decision Making:
  - Deficits with active straight leg raise are significantly correlated to days missed due to injury
  - Full ROM is required for terminal swing during sprinting when large forces are placed on the hamstring
- Cut off score:
  - Pain free symmetrical range of motion

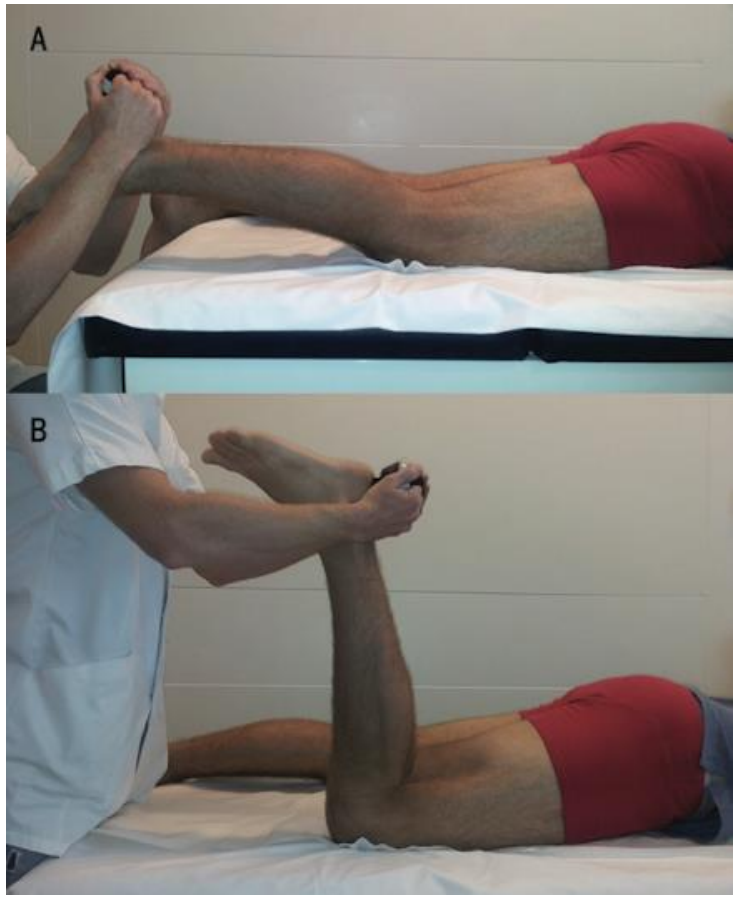
Reurink, Gustaaf, et al. “Reliability of the Active and Passive Knee Extension Test in Acute Hamstring Injuries.” *The American Journal of Sports Medicine*, vol. 41, no. 8, 2013, pp. 1757–1761, https://doi.org/10.1177/0363546513490650.

Strength Testing: HHD



Hickey, Jack T., Peter F. Hickey, et al. “A Novel Apparatus to Measure Knee Flexor Strength during Various Hamstring Exercises: A Reliability and Retrospective Injury Study.” *Journal of Orthopaedic & Sports Physical Therapy*, vol. 48, no. 2, 2018, pp. 72–80, https://doi.org/10.2519/jospt.2018.7634.

Strength Testing: HHD



- Hamstring Strength HHD
  - Assessment of isolated muscle strength
- Role in clinical decision making:
  - Athletes with recent hamstring injury demonstrate significantly decreased knee flexion torque in the lengthened range of contraction
  - Deficits in knee flexion strength between limbs may increase risk of re-injury
  - Eccentric strength is required for terminal swing during sprinting
- Recommendation:
  - >95% LSI with HHD testing, pain free

Erickson, Lauren N., and Marc A. Sherry. "Rehabilitation and Return to Sport after Hamstring Strain Injury." *Journal of Sport and Health Science*, vol. 6, no. 3, 2017, pp. 262–270., https://doi.org/10.1016/j.jshs.2017.04.001.

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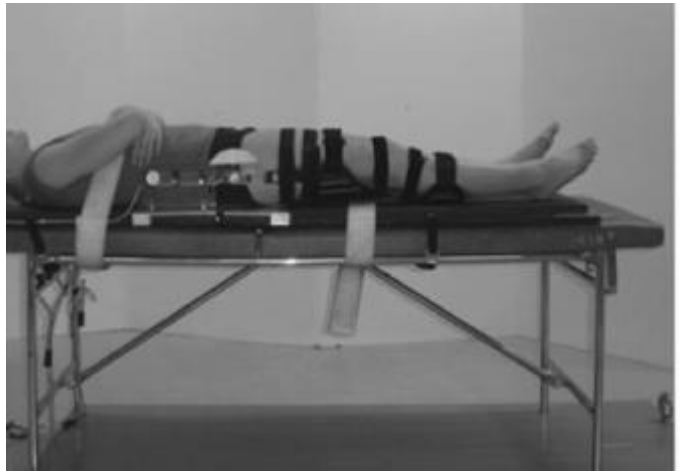
Functional Strength Testing

- Single Leg Bridge
  - Assessment of functional strength and endurance in position similar to terminal swing where hamstring injuries happen
- Role in decision making:
  - Lower SLBT are correlated with risk of hamstring injury
  - Decreased hamstring endurance is modifiable risk factor for hamstring injury
- Recommendation: >30 reps
  - Poor: < 20
  - Average: 25
  - Good: > 30

Freckleton, Grant, et al. "The Predictive Validity of a Single Leg Bridge Test for Hamstring Injuries in Australian Rules Football Players." *British Journal of Sports Medicine*, vol. 48, no. 8, 2013, pp. 713–717, https://doi.org/10.1136/bjsports-2013-092356.

H-Test

- H-Test
  - Assessment of ability to move muscle through range of motion quickly, includes subjective score about apprehension and pain
- Role in decision making
  - Completing tasks with fast movement and assesses for apprehension
  - Significantly slower hip velocity and higher self reports of insecurity are seen in the injured leg
- Cut off score:
  - Completing through full ROM without apprehension



Askling, C. M., et al. "A New Hamstring Test to Complement the Common Clinical Examination before Return to Sport after Injury." *Knee Surgery, Sports Traumatology, Arthroscopy*, vol. 18, no. 12, 2010, pp. 1798–1803, https://doi.org/10.1007/s00167-010-1265-3.

Return to Sport Progression

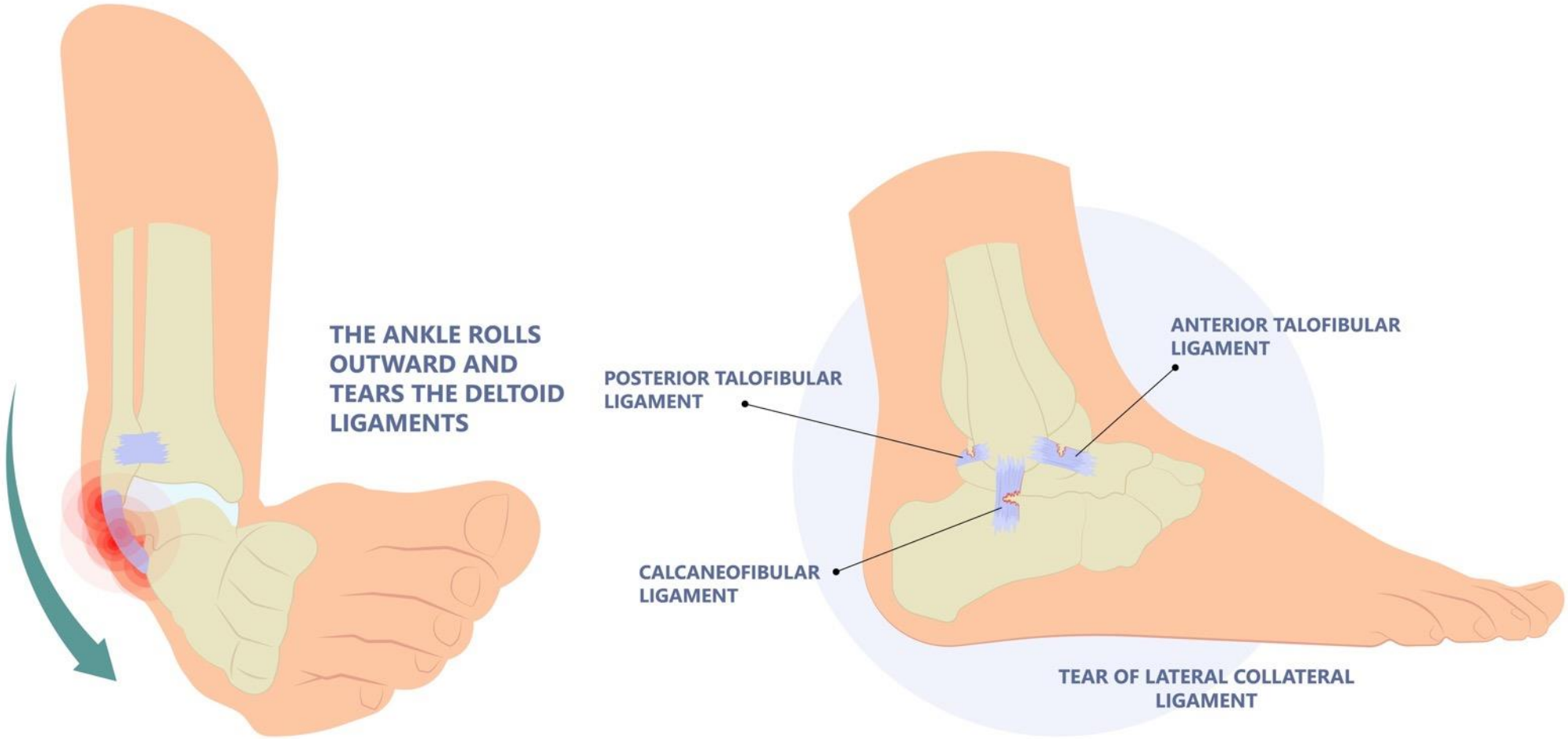
TABLE 2 Intensity and Distance of the 9-Stage Progressive Running Protocol[a]

Stage	Acceleration Phase	Hold Phase	Deceleration Phase
1	Walk 20 m	Jog 10 m	Walk 20 m
2	Walk 15 m	Jog 20 m	Walk 15 m
3	Walk 10 m	Jog 30 m	Walk 10 m
4	Jog 20 m	Run 10 m	Jog 20 m
5	Jog 15 m	Run 20 m	Jog 15 m
6	Jog 10 m	Run 30 m	Jog 10 m
7	Run 20 m	Sprint 10 m	Run 20 m
8	Run 15 m	Sprint 20 m	Run 15 m
9	Run 10 m	Sprint 30 m	Run 10 m

[a]*Walk is defined as regular gait, jog as less than 50% of perceived maximal running speed, run as less than 70% of perceived maximal running speed, and sprint as greater than 90% of perceived maximal running speed.*

Hickey JT, Timmins RG, Maniar N, Rio E, Hickey PF, Pitcher CA, Williams MD, Opar DA. Pain-Free Versus Pain-Threshold Rehabilitation Following Acute Hamstring Strain Injury: A Randomized Controlled Trial. J Orthop Sports Phys Ther. 2020 Feb;50(2):91-103. doi: 10.2519/jospt.2020.8895. PMID: 32005093.

Lateral Ankle Sprain



Lateral Ankle Sprain

- Statistics
  - Most common lower limb musculoskeletal injury incurred by individuals who participate in sports and recreational physical activity
  - In high school sports, lateral ankle sprains occur at a rate of 3.13 per 10,000 exposures
  - 12.8% of general population experience a lateral ankle sprain
- Recurrent injury
  - Rate in high school athletes: 29%
  - Twofold increased risk of reinjury in the year following initial injury

Delahunt, Eamonn, et al. "Clinical Assessment of Acute Lateral Ankle Sprain Injuries (Roast): 2019 Consensus Statement and Recommendations of the International Ankle Consortium." *British Journal of Sports Medicine*, vol. 52, no. 20, 2018, pp. 1304–1310, https://doi.org/10.1136/bjsports-2017-098885.

Martin, Robroy L., et al. "Ankle Stability and Movement Coordination Impairments: Lateral Ankle Ligament Sprains Revision 2021." *Journal of Orthopaedic & Sports Physical Therapy*, vol. 51, no. 4, 2021, https://doi.org/10.2519/jospt.2021.0302.

Risk Factors

- Previous injury
- Female
- Decreased ankle ROM
- Decreased hip abductor strength (<33% of mass in resistance increases risk)
- Participating in court sports
- Not using prophylactic bracing
- Not participating in an exercise balance program (first time versus subsequent injury)
- Higher BMI

Delahunt, Eamonn, et al. “Clinical Assessment of Acute Lateral Ankle Sprain Injuries (Roast): 2019 Consensus Statement and Recommendations of the International Ankle Consortium.” *British Journal of Sports Medicine*, vol. 52, no. 20, 2018, pp. 1304–1310, https://doi.org/10.1136/bjsports-2017-098885.

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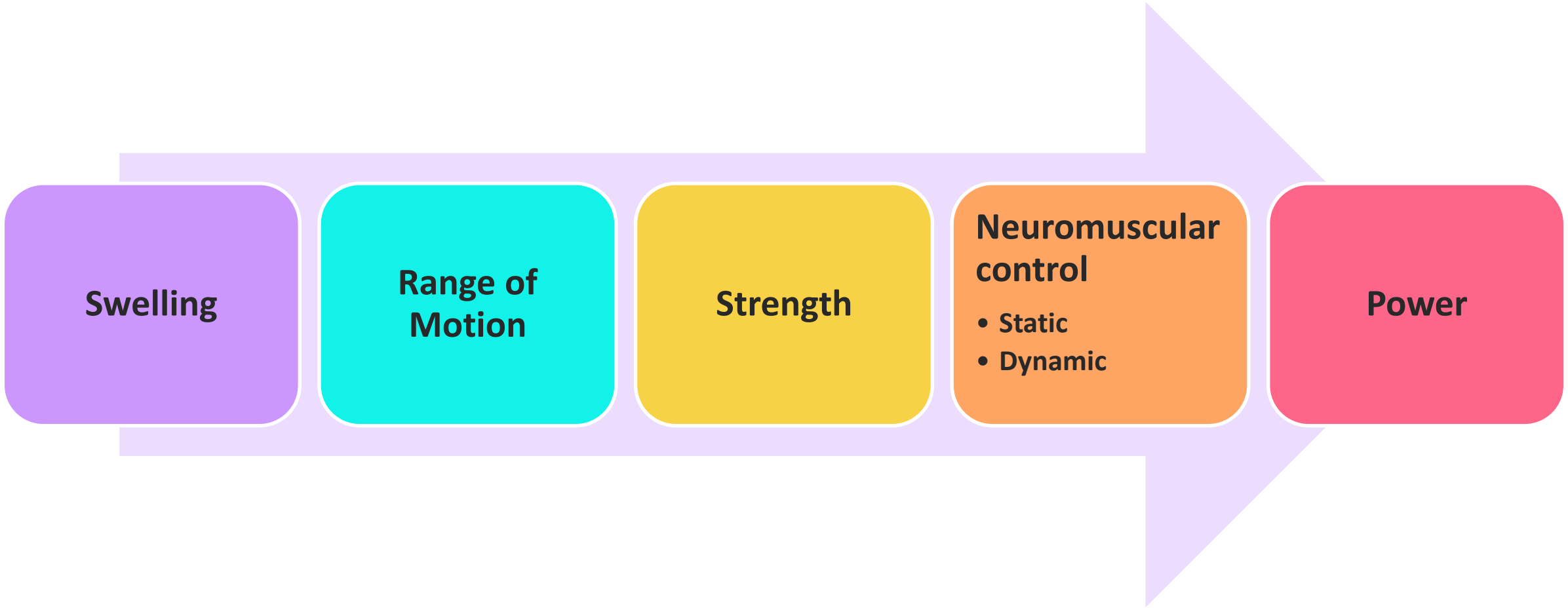
Algorithm



Swelling

- Figure 8
  - Assessment for ankle swelling
- Role in decision making
  - Causes arthrogenic muscle inhibition (AMI)
  - Guide tolerance of exercise-based rehabilitation
  - Evaluate efficacy of treatments implemented
- Recommendation:
  - No cut off score
  - Utilize to monitor effect of activity

Watson, Cameron & Boland, Robert & Refshauge, Kathryn. (2008). Measurement Reliability of Swelling in the Acute Ankle Sprain. The Foot & Ankle Journal. 1. 10.3827/faoj.2008.0112.0004.

Mawdsley, Roberta H., et al. "Criterion-Related Validity of the Figure-of-Eight Method of Measuring Ankle Edema." *Journal of Orthopaedic & Sports Physical Therapy*, vol. 30, no. 3, 2000, pp. 149–153, https://doi.org/10.2519/jospt.2000.30.3.149.

Range of Motion

- Dorsiflexion Lunge Test
  - Weight bearing assessment of dorsiflexion range of motion test
- Role in decision making:
  - Predictive of future injury
  - Weight bearing measures are more likely than non weight bearing measures to detect treatment effects
  - Ankle injuries have a high propensity for the development of a dorsiflexion deficit
  - Sufficient DF is important in dynamic postural balance performance,
- Recommendation:
  - 9-10 cm (likely greater in performance athletes: dance, gymnastics)

Clanton, Thomas O., et al. “Return to Play in Athletes Following Ankle Injuries.” *Sports Health: A Multidisciplinary Approach*, vol. 4, no. 6, 2012, pp. 471–474, https://doi.org/10.1177/1941738112463347.

Strength Testing

- Ankle Eversion, Inversion
- Hip Extension, Abduction

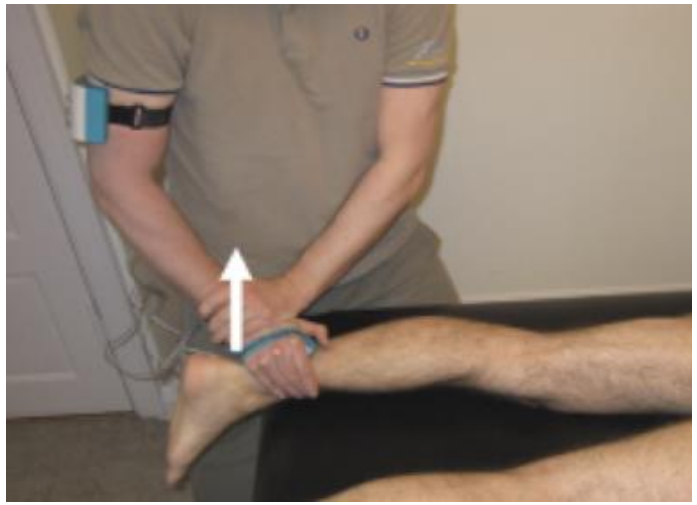
Strength:

- Eversion HHD testing
  - Assessment of isolated muscle strength
- Role in decision making:
  - Patient with recent lateral ankle sprain demonstrate ankle strength deficits
- Recommendation:
  - Eversion: Inversion ratio <1.0

Spink, Martin J., et al. “Foot and Ankle Strength Assessment Using Hand-Held Dynamometry: Reliability and Age-Related Differences.” *Gerontology*, vol. 56, no. 6, 2009, pp. 525–532, https://doi.org/10.1159/000264655.

Wilkerson, Gary B., et al. “Invertor vs. Evertor Peak Torque and Power Deficiencies Associated with Lateral Ankle Ligament Injury.” *Journal of Orthopaedic & Sports Physical Therapy*, vol. 26, no. 2, 1997, pp. 78–86, https://doi.org/10.2519/jospt.1997.26.2.78.

Strength:



- Hip Extension / Abduction HHD
  - Assessment of isolated muscle strength
- Role in decision making:
  - Decreased hip abduction was found to increase risk of lateral ankle sprain (CPG)
- Recommendation:
  - >95% LSI

Thorborg, K., et al. "Clinical Assessment of Hip Strength Using a Hand-Held Dynamometer Is Reliable." *Scandinavian Journal of Medicine & Science in Sports*, vol. 20, no. 3, 2009, pp. 493–501, https://doi.org/10.1111/j.1600-0838.2009.00958.x.

Neuromuscular Control (Static)

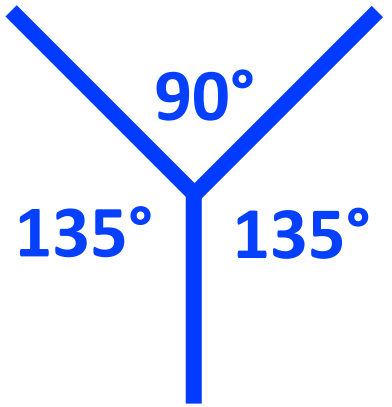
- Foot Lift Off Test
  - Assessment for proprioception as patient balances on 1 limb with eyes closed and hands on hips for 30s
- Role in decision making
  - Grade A recommendation to assess single leg balance with eyes closed on a firm surface (CPG)
  - Impairment of static postural balance is consistently identified in patient's with chronic ankle instability
  - Loss of proprioception is a risk factor for re-injury
- Recommendation: < 5 faults

Linens, Shelley W., et al. "Postural-Stability Tests That Identify Individuals with Chronic Ankle Instability." *Journal of Athletic Training*, vol. 49, no. 1, 2014, pp. 15–23, https://doi.org/10.4085/1062-6050-48.6.09.

Martin, Robroy L., et al. "Ankle Stability and Movement Coordination Impairments: Lateral Ankle Ligament Sprains Revision 2021." *Journal of Orthopaedic & Sports Physical Therapy*, vol. 51, no. 4, 2021, https://doi.org/10.2519/jospt.2021.0302.

Neuromuscular Control (Dynamic)

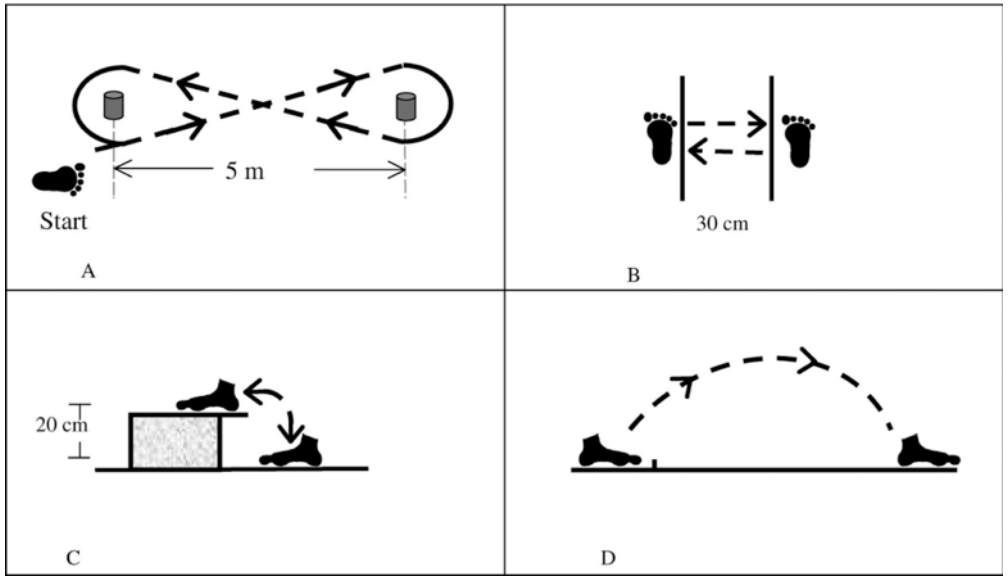
- Y Balance
  - Dynamic measure of single leg ROM, strength, and stability
- Role in Decision Making:
  - Loss of proprioception is a risk factor for re-injury
  - Requires strength, flexibility, and proprioception
- Recommendation:
  - Anterior: < 4cm
  - Posterior-medial: < 6cm
  - Posterior-lateral: < 6cm



Clanton, Thomas O., et al. “Return to Play in Athletes Following Ankle Injuries.” *Sports Health: A Multidisciplinary Approach*, vol. 4, no. 6, 2012, pp. 471–474, https://doi.org/10.1177/1941738112463347.

Hop Testing

- 60 healthy college students & 42 age matched participants with functional ankle instability (FAI)
- Complete 4 hop tests: Figure 8, side hop test, up down hop test, single hop for distance

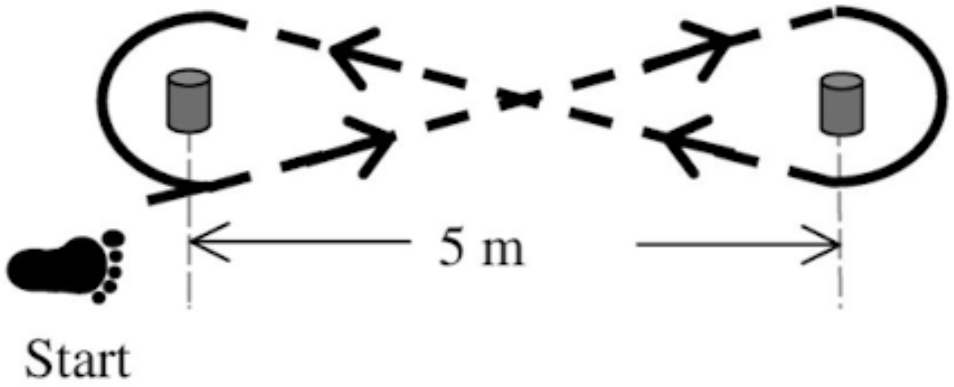


- Significant relationship between FAI and figure 8 hop test and lateral hop test but not up down hop test or single hop for distance
- Take Away:
  - Figure 8 and lateral hop test require lateral and rotational forces
  - Up down hop and single hop for distance require force in sagittal plane

Docherty, Carrie L., et al. "Functional Performance Deficits in Volunteers With Functional Ankle Instability" *Journal of Athletic Training*, vol. 40, no. 1, pp. 30-34

Hop Testing

- Figure 8 Hop test:
  - Dynamic assessment of straight line, lateral, and rotational ankle performance



- Role in decision making:
  - Athletes with functional ankle stability demonstrate deficits with rotational agility tasks
  - Grade B evidence to assess performance with lateral movements, diagonal movements, and directional changes, such as single-limb hop tests
- Recommendation:
  - >95% LSI

Docherty, Carrie L., et al. “Functional Performance Deficits in Volunteers With Functional Ankle Instability” *Journal of Athletic Training*, vol. 40, no. 1, pp. 30-34

Hop Testing

- Side Hop Test:
  - Dynamic assessment of straight line, lateral, and rotational ankle performance

- Role in decision making:
  - Athletes with functional ankle stability demonstrate deficits with rotational agility tasks
  - Grade B evidence to assess performance with lateral movements, diagonal movements, and directional changes, such as single-limb hop tests
- Recommendation:
  - >95% LSI

Docherty, Carrie L., et al. “Functional Performance Deficits in Volunteers With Functional Ankle Instability” *Journal of Athletic Training*, vol. 40, no. 1, pp. 30-34

Resources: Background/ACL

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Resources: Hamstring

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Resources: Ankle

- Delahunt, Eamonn, et al. “Clinical Assessment of Acute Lateral Ankle Sprain Injuries (Roast): 2019 Consensus Statement and Recommendations of the International Ankle Consortium.” British Journal of Sports Medicine, vol. 52, no. 20, 2018, pp. 1304–1310, https://doi.org/10.1136/bjsports-2017-098885.
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Thank you

Mark Karam PT, DPT, CSCS
Mkaram9@gmail.com

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What's Next?

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Management of Lower Extremity Disorders

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In order to become a productive member of a sports medicine team, the sports physical therapist needs to be versed in many facets of athlete care. EIM's evidence-based Sports Competencies course will cover many of these facets, including: preventive and supportive taping, pre-participation screenings, functional movement screenings including corrective exercise prescription, evaluation, instruction and treatment of athletic movement, late-phase ACL rehabilitation, and injury prevention programs.

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EIM Evidence In Motion

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May 21 | Sports | Carley Greenawalt

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Almost 20% of households in the US have someone who rides a horse. The most common riders are recreational, show, racing, and for work such as farming or policework. Based on these statistics, it is likely that all rehab professionals will at some point treat someone who rides a horse and needs to get back in the saddle. In this webinar, we will discuss common injuries and muscular imbalances that are seen in equestrian athletes. We will introduce best rehabilitative practices for treatment and prevention, as well as a guide for returning to riding.

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