ACTIVFORCE | webinar

Investigating Injuries

ACL Injury & Return to Sport

Should HHD be used with Return to Sport testing?

Introductions

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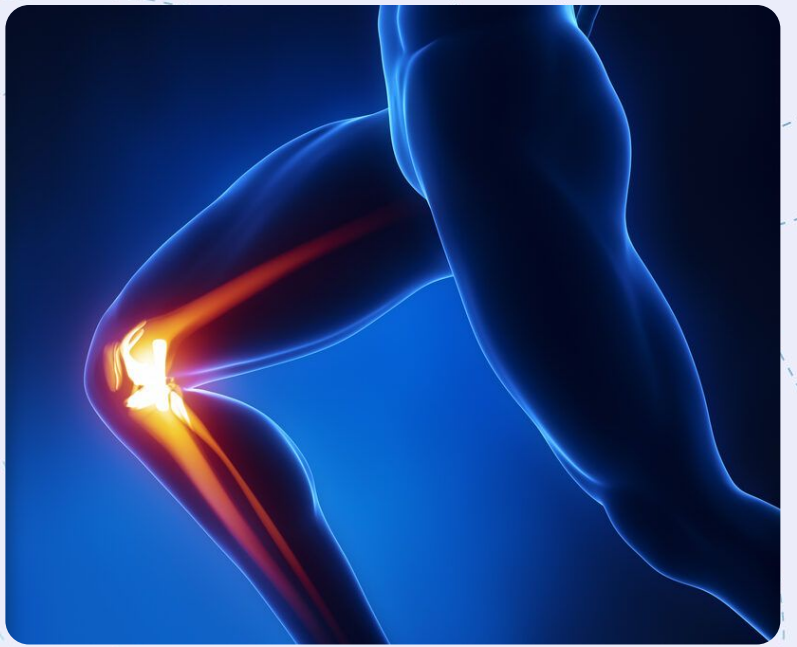
Agenda

- Introduction
- Understanding ACL Injury:
  - Clinical Presentations and Mechanism of Injury
  - Common Causes and Risk Factors
- Common Ways for Performing Return to Sport Screens
  - Functional testing: Squats and Single Limb Squats
  - Dynamic Testing: Single Limb Jump Assessment
- HHD Assessment:
  - Peak Force Data
  - Rate of Force Development
- Discussion on Treatment and Rehabilitation Strategies
- Q&A

ACL Injury

What is an ACL Injury?

- Tear or sprain of the Anterior Cruciate Ligament, a key stabilizer of the knee
- ACL prevents anterior translation of tibia and provides rotational stability
- Injury often results in knee instability, especially during cutting or pivoting movements



Mechanism of Injury

- Non-contact (most common): sudden deceleration, pivoting, or cutting
- Contact: direct blow to lateral knee causing valgus + rotation stress
- Often occurs during sports involving jumping, pivoting, or rapid changes in direction

Common Causes & Risk Factors

- Sports participation (soccer, basketball, skiing): high pivot/cutting demands
- Female sex: ↑ risk due to biomechanics, hormonal influences, wider pelvis
- Poor neuromuscular control: weak hip/knee stabilizers → abnormal movement patterns
- Previous ACL injury: reinjury risk high even with rehab or bracing
- Environmental factors: playing surface, footwear traction

So, after rehab the athletes are good to go right?

One in 5 Athletes Sustain Reinjury Upon Return to High-Risk Sports After ACL Reconstruction: A Systematic Review in 1239 Athletes Younger Than 20 Years

Sue Barber-Westin [1], Frank R Noyes [1] Sports Health. Nov/Dec 2020;12(6):587-597.

Conclusion: A high percentage of athletes returned to sport, but 1 in 5 suffered reinjuries to either knee. Male patients were more likely to reinjure the ACL graft. Objective criteria for RTS were rarely mentioned or not detailed. The need for testing of knee stability, strength, neuromuscular control, agility, and psychological measures before RTS remains paramount in young athletes.

Why do we perform pre-season and return to sport screens?

- To determine whether an athlete is ready to “safely” return full competition after an injury
- To determine any deficits an athlete has that need to be addressed during the off season
- Determine the effects of a training program?
- Prevent lower extremity injuries?

Functional Movement Screens

Other Functional Tests

Failed Single Limb Squat

Functional Screens

- Do they provide specific detail on the athletes' deficit?
- We grade them as pass or fail, but do these tests inform the health care provider what to specifically address?
- When using Functional Screens, is there an "assumption" that the athlete is weak?

Why HHD Should Be Used with Return to Sport Testing?

Things to Consider When Using HHD

- Tool being used
  - Comfort level
- Strength of the Tester
  - Belt usage
- Keeping tool in place
  - Maintaining perpendicular alignment
- Maximum value for the tool itself
  - Quads
- Positioning of patient
  - Comparison to norms
  - Against gravity?
- Make-test vs. Break-test

What information do you obtain with dynamometry?

Hip Abduction

Peak Force (lb)	
Left	62.77 lb
Right	66.45 lb
Strength Difference	3.68 lb
Percentage Difference	5.69%

PT’s like symmetry!

What other clinical information do you obtain?

Force to Weight Ratio

Weight	200 lb
Left	31.39%
Right	33.22%
F/W Difference	1.84%

This is the same patient, how do you feel about them now?

Normative values for 40-49 year old's

Motion/Muscle	Sex	Pound-Force (average)	Force/body weight (%)	Position
Shoulder Abduction	Male Female	55 lbs. 31 lbs.	29% 22%	Supine. Shoulder abducted 45 degrees; elbow extended
Shoulder ER	Male Female	42 lbs. 25 lbs.	22% 19%	Supine. Shoulder abducted 45 degrees; elbow at 90 degrees
Elbow Flexion	Male Female	60 lbs. 34 lbs.	33% 25%	Supine. Shoulder neutral, elbow at 90 degrees, forearm supinated
Knee Extension	Male Female	131 lbs.** 85 lbs.	70% 62%	Sitting. Hips and knees flexed to 90 degrees
Hip Abduction	Male Female	70 lbs. 49 lbs.	37% 36%	Supine. Hips neutral, knees extended
*Shoulder Flexion (Age 50-59)	Male Female	60 lbs. 36 lbs.	32% 24%	Supine. Shoulder flexed to 90 degrees, elbow extended
*Shoulder IR (Age 50-59)	Male Female	43 lbs. 22 lbs.	23% 15%	Supine. Shoulder abducted 45 degrees; elbow at 90 degrees

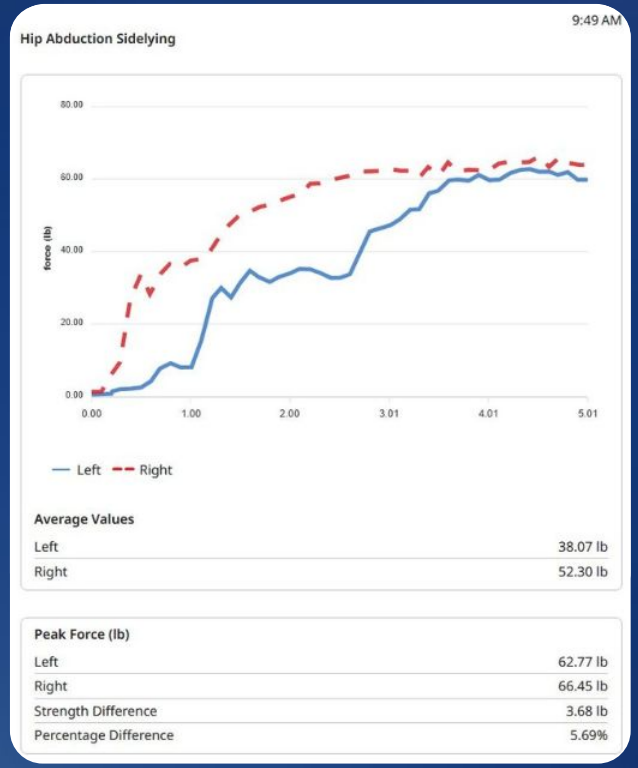
Values are from: Bohannon, R. Reference values for extremity muscle strength obtained by hand-held dynamometry from adults aged 20-79 years. Arch Phys Med Rehabil 1997; 78: 26-32.

*Values are from: Andrews AW., Thomas MW, Bohannon RW. Normative Values for Isometric Muscle Force Measurements Obtained with Hand-held Dynamometers. Phys Ther. 1996; 76(3); 248-259.

The ‘Picture’ tells so much more

- Poor recruitment of Gluteus Medius with delayed RFD on left side (blue)
- Knowing this, would you change their exercise program?

Would you have come to the same conclusion using 0-5 MMT or a Functional Screen?



What is Rate of Force Development (RFD)?

- Maximal voluntary contraction (MVC) measures the peak force a muscle can achieve
- Rate of force development (RFD) refers to the speed at which a muscle generates force during contraction
- RFD is a vital indicator of neuromuscular performance, encompassing both the mechanical capacity of the muscle to generate force and the neural processes necessary for the muscle contraction

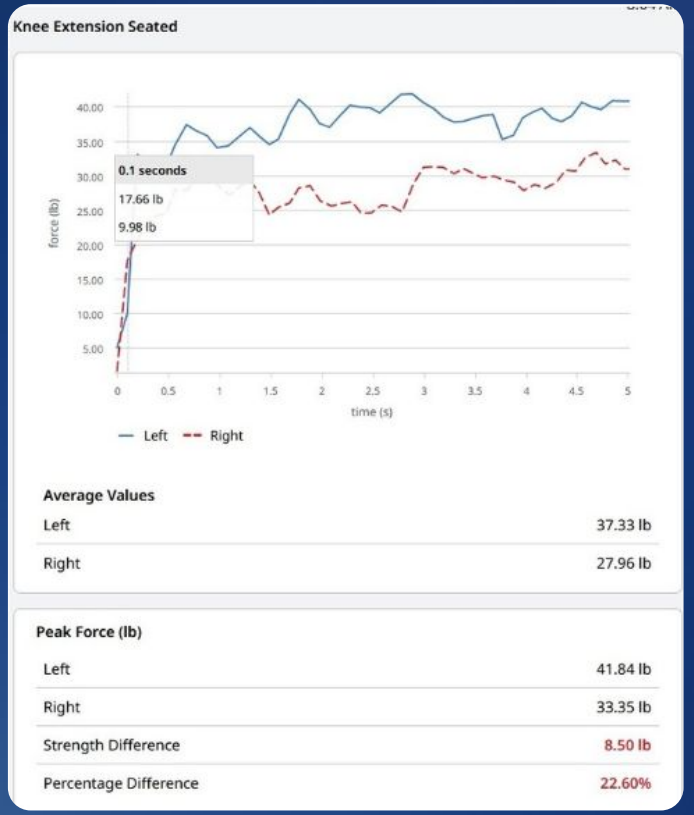
Key Factors that Influence RFD

1. **Motor Unit (MU) Recruitment:** the speed at which motor units are recruited. Faster recruitment allows for a more rapid increase in force.
2. **Motor Unit Discharge Rate (Rate Coding):** the frequency at which motor neurons discharge action potentials. Higher discharge rates enable rapid summation of motor unit activity, leading to quicker and more forceful contractions.
3. **Neural Drive:** the central nervous system's ability to transmit strong and rapid signals to muscles.
4. **Muscle-Tendon Unit Properties and Muscle Architecture:** The intrinsic properties of muscles and tendons, such as stiffness and elasticity, fiber type composition, fascicle length, etc. can all have an influence on RFD
5. **Maximal Strength:** There is a relationship between maximal strength and RFD, suggesting that individuals with greater maximal strength may achieve higher RFD values.
6. **Training Adaptations:** Both explosive-type and heavy-resistance strength training can improve RFD across different populations. These improvements are mainly attributed to enhanced rapid muscle activation.

RFD in Return to Sport

- Evaluating RFD can be crucial in sports activities requiring rapid force production, such as sprinting, jumping, and balance corrections.
- It has been found that injuries such as anterior cruciate ligament (ACL) tears occur within 50 ms after ground contact, therefore, evaluating early-phase RFD (25–50 ms) may be of great importance in preventing injuries.
- Angelozzi et al. investigated RFD as an adjunctive metric for evaluating return-to-sport readiness in professional soccer players following ACL reconstruction. Despite near-full recovery of MVC strength at six months post-surgery, significant deficits in RFD remained. These deficits were only resolved at 12 months, following an additional rehabilitation program focused on muscle power development

High School Girls Soccer Player
10 months post ACLR



Knee Extension

The time has come to incorporate a greater focus on rate of force development training in the sports injury rehabilitation process

- RFD is considered functionally more relevant than maximal muscle strength during certain very fast actions including rapid joint stabilization following mechanical perturbation.
- Deficits in RFD are reported following conventional rehabilitation programs despite full restoration of maximal strength, which may contribute to the less than satisfactory RTS outcomes reported in the literature.
- Conventional resistance training using moderate loads typical of most rehabilitation programs is insufficient at restoring or enhancing RFD, thus incorporating periodized resistance training programs and explosive training techniques in the final stages of rehabilitation prior to RTS is recommended.

Matthew Buckthorpe 1,2,3, ✉, Giulio Sergio Roi 1,4
Muscles Ligaments Tendons J
2018 Jan 10;7(3):435–441. doi: 10.11138/mltj/2017.7.3.435

Could this be used in fall prevention?

Neuromuscular rate of force development discriminates fallers in ambulatory persons with multiple sclerosis - an exploratory study

Nick M Kristensen [a,1], Laurits Taul-Madsen [a,1], Tobias Gaemelke [a], Morten Riemenschneider [a,b], Ulrik Dalgas [a], Lars G Hvid [a,b,*]

[a] *Exercise Biology, Department of Public Health, Aarhus University, Denmark*
[b] *The Danish MS Hospitals, Ry and Haslev, Denmark*

Conclusion: In this exploratory study, knee extensor neuromuscular function was able to discriminate fallers from non-fallers in pwMS, with RFD being superior to Fmax. Routine assessment of lower extremity neuromuscular function (RFD_{50ms} in particular) may be a helpful tool in identifying pwMS at future risk of falling.

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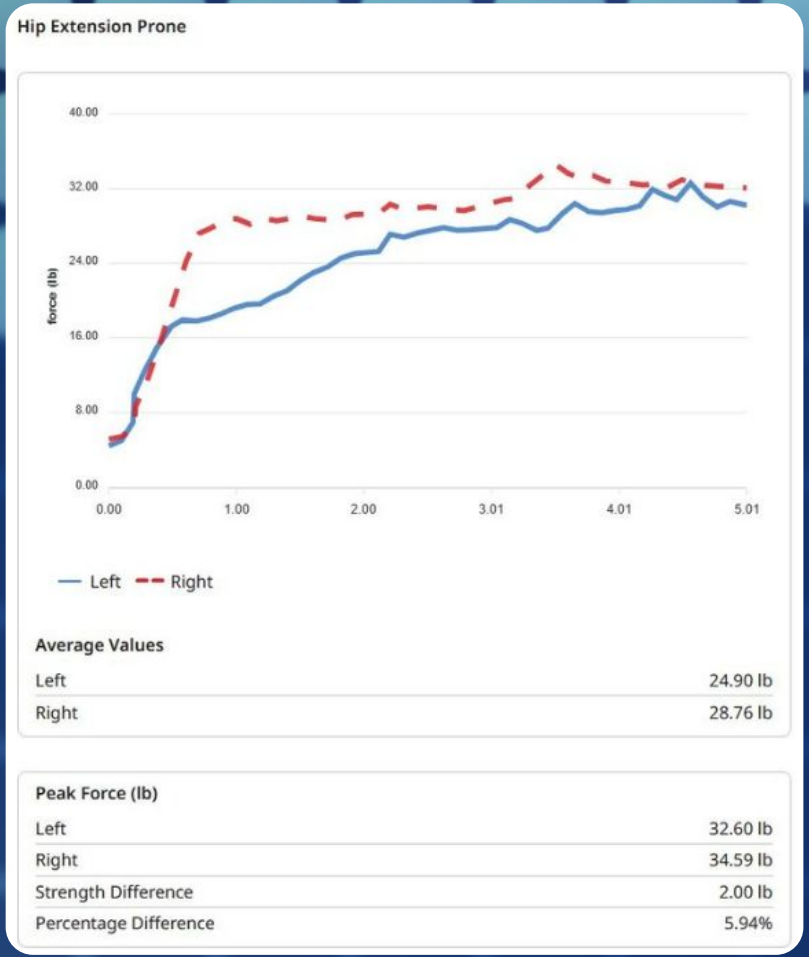
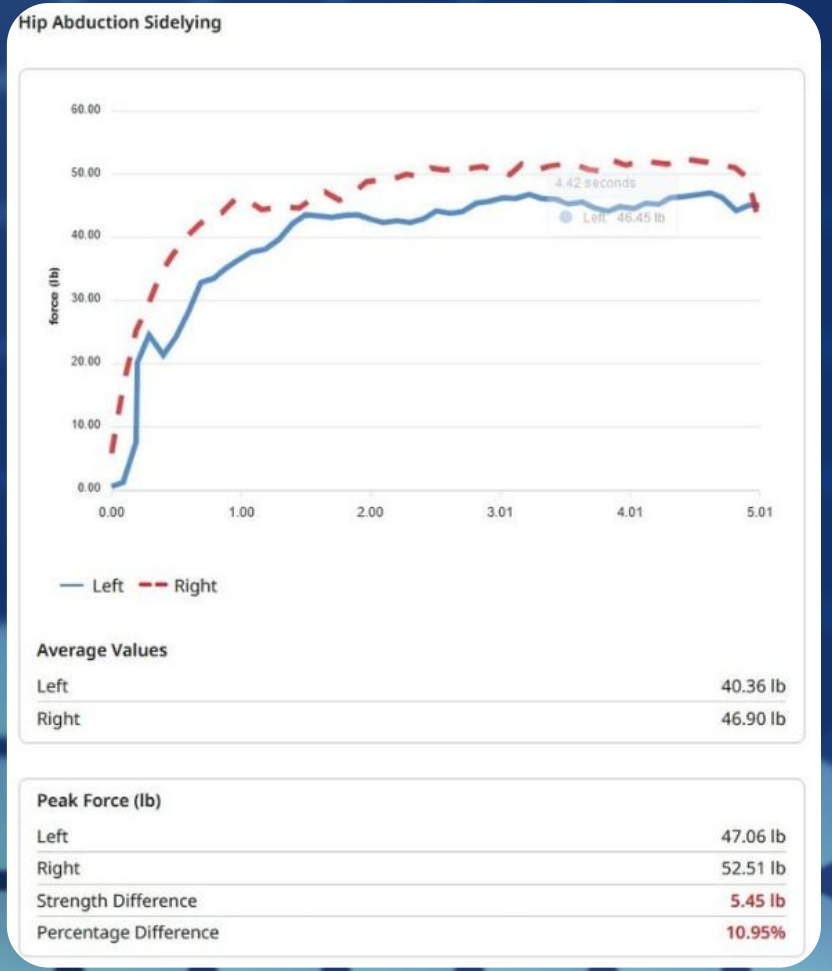
Rate of Force Development

Hip Extension



Typical curves for Weakness with Similar RFD slope

Hip Extension



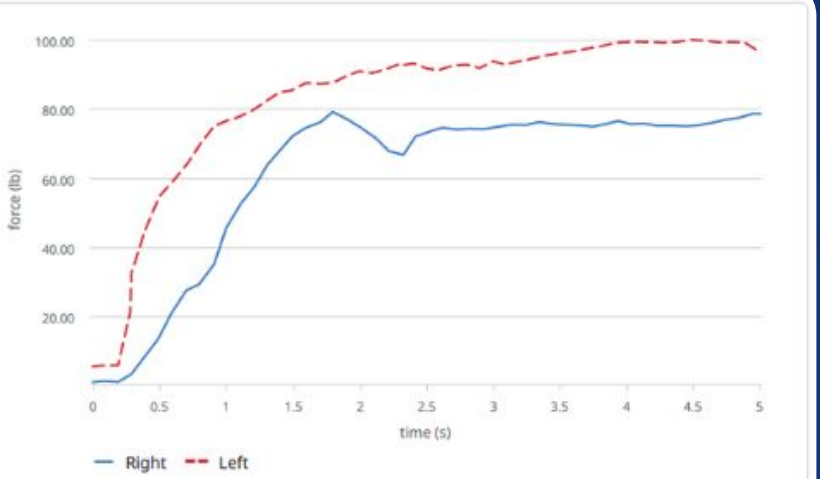
Examples of Patient Data

Data from a Return to Sport Assessment 17 year old, post Right ACL, Basketball.

This is a motor recruitment issue so our focus would be on rate of recruitment, not just strength.

Could this be a reason for the high re-injury rate following ACL repairs?

Knee Extension Seated



Average Values	
Right	62.55 lb
Left	84.29 lb

Peak Force (lb)	
Right	79.17 lb
Left	100.10 lb
Strength Difference	20.92 lb
Percentage Difference	23.34%

This clinic data shows the value and clinical application of HHD with strength assessment. I feel that as clinicians, we “over”estimate the patients’ strength using a 0-5 MMT.

I also feel we are missing valuable clinical data on rate of force development. How many times have you thought the patient was weak and it was poor muscle recruitment?

Questions?

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