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The Clinical Significance of the Single Leg Hop in Qualifying Outcomes after ACL Reconstruction: Normative Study

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The Clinical Significance of the Single Leg Hop in Qualifying Outcomes after ACL Reconstruction: Normative Study

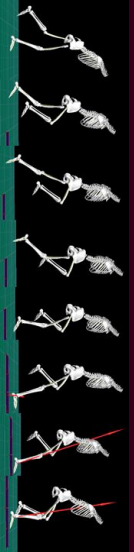
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Introduction

- Roughly 100,000 ACL reconstructions (ACLRs) are performed annually in the United States.¹
- Single leg hop for distance (SLHD) is the most common functional performance test after an ACLR.²
 - Measures horizontal distance hopped
 - Leg Symmetry Index
 - LSI = Hop Distance_{Involved} / Hop Distance_{Uninvolved}
- Uninvolved limb is commonly used as the “healthy” control despite bilateral muscle strength deficits have been reported after ACL injury.³
- Recent studies have indicated that common clinical thresholds don’t predict a secondary ACL injury.³



From: Finnes from Visual 3D-physion

Purpose

Compare the biomechanics of those who have undergone ACL reconstruction with an uninjured group to discern differences in kinetics and kinematics.

Hypothesis:

The quality of hop landing will serve as a more discerning metric of athlete recovery than the distance hopped when compared to their non-surgical limb or healthy norms.

Subjects

- Healthy Group: 28 subjects tested, 25 included in data set.
- ACL Group: Ongoing Research Project in the MSL

Inclusion Criteria

- 12-35 years old
- Physically active (Tegner ≥ 4)

	Uninjured Group	ACL Group
Age	22±3.7	22±4.8
Number	25	35
Gender	31% Male	34% Male

Exclusion Criteria

- History of prior lower extremity surgeries or lower extremity injury in last 6 mo that limits daily activities

Methods

PROCEDURES

Single-session laboratory study

- Warmup
- Strength Test
 - Maximum Quadriceps (90° Flexion)
 - and Hamstring (60° Flexion)
- Single Leg Hop for Distance
 - 2-3 practice trials: 2 recorded trials
 - Distance recorded bilaterally



Photo taken with consent during testing

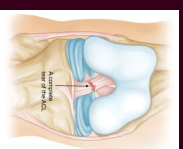
INSTRUMENTATION

3-Dimensional Motion Analysis

- 8-camera VICON system (sampled=200 Hz, filtered=12 Hz)
- 2 force plates (sampled=1200 Hz, filtered=50 Hz)
- Kin Com isometric dynamometer for strength tests

DATA ANALYSIS

- Forces and joint torques normalized to body weight
- Time normalized from initial contact to peak knee flexion
- Multiple regression of LSI on hip and knee joint angle and moment
 - Hip and knee kinetics/kinematics
- Compare means with independent and paired t-tests
- Pearson correlation of biomechanical measures with LSI
- Alpha level = 0.05



From: Anatomical Diagrams of the ACL

WHY LANDING PHASE

- Deficits in biomechanical performance are greater during eccentric contractions
- Most injuries occur during force absorption tasks
- Knee torque demands are generally much greater during landing.
 - Thus, we surmise landing performance is the main limiting phase of distance

Results

- No significant difference between the groups for joint angles in the hip, knee, or ankle during landing (p > .05)
- No changes in vertical ground reaction forces (LSI for Uninjured=100%±19%, ACL=98%±15%, p=0.47)

STRENGTH COMPARISON

The uninjured group had more symmetrical strength in major leg muscle groups. Quadriceps strength was correlated with farther hop distance (p < .05)

HOP DISTANCE

- 90% LSI clinical threshold met by both groups³

- The ACL group jumped a shorter distance compared to their non-surgical leg and height, unlike the normative group.

HOP LANDING JOINT TORQUES

Ankle and hip bending torques were not significantly different between groups whereas knee flexion torque was nearly 30% less in the surgical limb compared to uninjured & uninjured group’s legs

	Torques			
	Peak Joint Torque (Nm/kg of Involved Limb)	Uninjured Group	ACL Group	P Value
Ankle Plantar Flex	1.23±.32	1.2±.34	854	
Knee Extension	2.9±.47	2.12±.50	<0.001	
Hip Extension	3.87±1.22	3.57±.89	269	

Torques of all 60 Data Sets		
Peak Joint of Involved Limb Torque (Nm/kg of BW)	Value	P Value (difference between joints)
Ankle Plantar Flex	1.21±.33	<0.001
Knee Extension	2.5±.46	<0.001
Hip Extension	3.7±1.0	<0.001

Discussion

- Athletes that have undergone ACL reconstruction have long term strength and kinematic deficits
- SLHD should test knee performance, however the majority of torque is loaded on the hip during landing
- The failure of the SLHD to predict secondary ACL injuries may be because it doesn’t isolate knee function or stability
- While strength and hop distances exceed 90% LSI clinical thresholds for return to sport, knee joint kinetics still exhibit marked deficits in recovery long after surgery

Acknowledgements

- Ryan Mizner, PT, PhD
- University of Montana, School of Physical Therapy

References

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2. Logerstedt, David, Jodie McBeland, and Lynn Snyder-Mackler. "Establishing Performance-based Standards After ACL Reconstruction: A Systematic Review." *28151 - Medicine & Science in Sports & Exercise* 43 Suppl 1 (2011): S90-Web.
3. Weisandt, Elizabeth, Matthew J. Falla, and Lynn Snyder-Mackler. "Limb Symmetry Indexes Can Overestimate Knee Function After Anterior Cruciate Ligament Injury." *Journal of Orthopaedic & Sports Physical Therapy* (2017): 1-18 Web.