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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

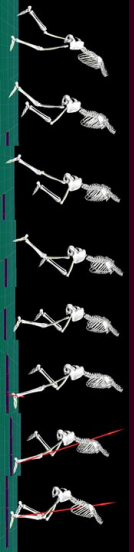
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Introduction

- 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: Fitness from Visual 3D-Application

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 \geq 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

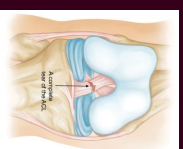
INSTRUMENTATION

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: Introduction to the Fundamentals of Biomechanics

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



From: Fitness from Visual 3D-Application

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 in 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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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.