

**ACL reconstruction
Early Rehabilitation:
Are We Doing Enough?**

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ACL Injury and Reconstruction

- Long-term consequences
 - Re-injury 
 - Post-traumatic osteoarthritis 

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**Overall re-injury rates:
5 year follow-up**

- Risk of re-injury
 - Overall
 - 17% for patients <18 years old,
 - 7% for patients aged 18 to 25 years
 - 4% for patients older than 25 years
 - 5.3% injury to contralateral knee
 - 4.3% injury to reconstructed knee

Shelbourne, Gray and Haro . AJSM, 2009

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Overall re-injury rates:
1 year follow-up

- 16/63 individuals sustained another ACL injury within one year of their release to return to sports.
- Injury rate within 12 months of return to sports following ACLr is 15 times greater compared to controls.

Paterno, Rauh, Schmitt, Ford, Hewett. Clin J Sports Med, 2012, 22(2)

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Post-traumatic osteoarthritis

“Young person with the old knee”¹

- Risk of developing of post-traumatic knee OA is 2-5 times greater than in uninjured knees^{2,3}
- Lifetime risk of knee osteoarthritis of 57%. ⁴

1. Lohmander et al. Am J Sports Med. 2007;35(10)
2. Gelber et al. Ann Intern Med. 2009;151(5)
3. Roos. Curr Opin Rheumatol. 2005;17(2)
4. Lohmander et al. Arthritis Rheum. 2004;50(10)

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What contributes to poor outcomes?

- Severity of injury
- Age
- Surgery type
- Anatomy
- Pre existing mechanics

Residual impairments following rehabilitation

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Residual impairments

- Quadriceps weakness
- Altered gait mechanics
- Loading
 - Unloading behaviors
 - Limited “dynamic” loading

Goals of Early Rehabilitation

Post-op weeks 6-8

- Quadriceps strength
 - Greater than 80% of non-surgical limb
- Gait mechanics
 - Normal gait pattern
 - Walking with full knee extension ~ 2 weeks
- Loading
 - Initiate and progress single limb exercises
 - running and hopping

Adams et al. J Orthop Sport Phys Ther, 2012, 42(7)

Residual impairments

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Residual Quadriceps Weakness

- 14/18 studies assessing quadriceps strength at 6 months post ACLR ¹
 - deficits > 15 %
 - % deficits ranged from 24-37.5%
- 77 athletes at return to sport ²
 - Within 4 weeks of clearance
 - 37 < 10% deficit
 - 40 > 10% deficit
 - 31 > 15% deficit

1. Palmier-Smith et al. Clin Sports Med; 2008; 27
 2. Schmitt et al. Med Sci Sports Exerc; 2015; 47(7)

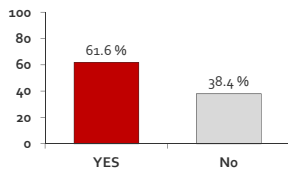
Residual Quadriceps Weakness

What do clinicians think?

- Online survey regarding quadriceps weakness and exercises
 - 750 Ortho/sports PT's
- For your patients following ACLr, is quadriceps weakness a concern?
 - YES 97.3%

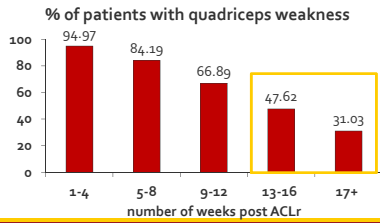
What do clinicians think?

- Do you find it difficult to restore **symmetrical** (compared to the uninvolved limb) quadriceps strength for your patients following ACLr?



What do clinicians think?

- Indicate the percentage of your patients who have quadriceps weakness (> 10% deficit) throughout the respective phases of rehabilitation.



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- Quad weakness is a problem
- It is related to
 - Poor function, bad mechanics....etc

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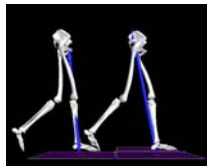
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Residual impairments

- Quadriceps weakness
- Altered gait mechanics
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Residual impairments

- Gait impairments
 - Decreased knee flexion and knee extensor moments and power absorption during gait have been found to persist up to **24 months** following reconstruction.



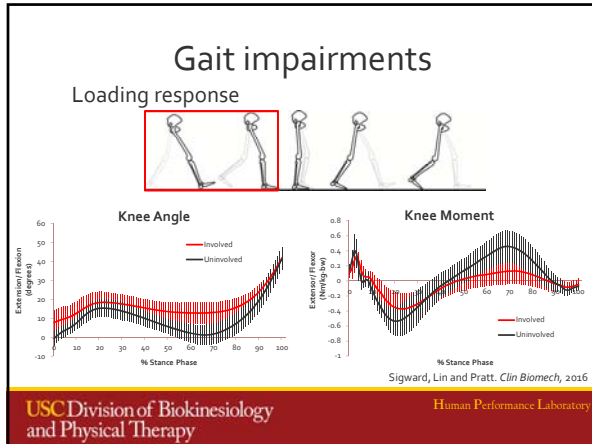
1. Roewer et al. *J Biomech.* 2011;44
2. Hart et al. *Clin Biomech.* 2010; 25
3. Webster et al. *Gait and Posture.* 2012; 36

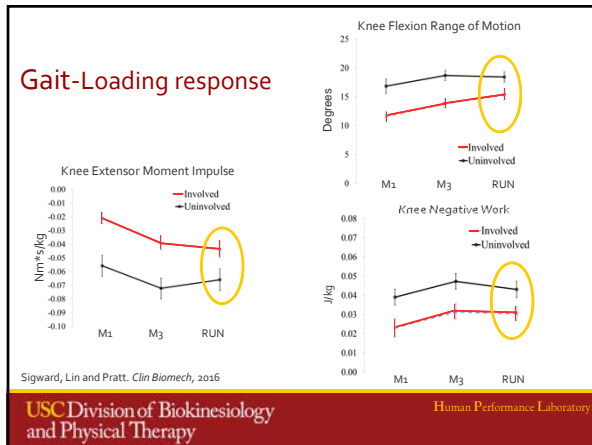
Goals of Early Rehabilitation

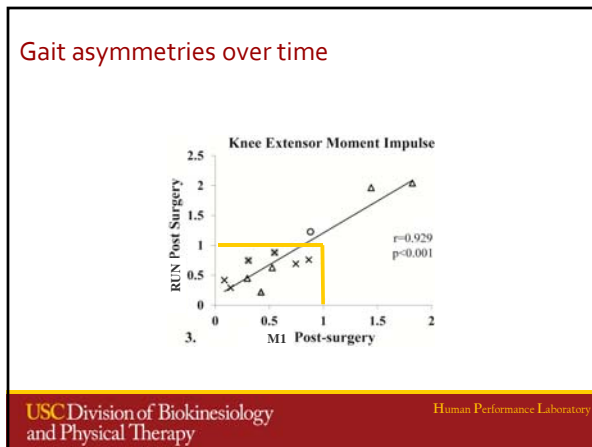
Post-op weeks 6-8

- Gait mechanics
 - Normal gait pattern
 - Walking with full knee extension ~ 2 weeks

Adams et al. *J Orthop Sport Phys Ther.* 2012, 42(7)

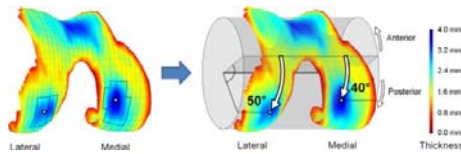






Implications of altered gait mechanics

- Post-traumatic osteoarthritis
 - Small changes in the loading environment can contribute to progression of OA



Scanlan et al. J Biomech. 2013; 46(5)

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Residual impairments

- Quadriceps weakness
- Altered gait mechanics
- Loading
 - Unloading behaviors
 - Limited “dynamic” loading

Residual impairments

- Loading asymmetry
 - Loading asymmetry at 6-9 months post-op during a bilateral drop land in athletes who are cleared to return to sports (n=56).

6-9 months post-op

Group	Peak Vertical GRF/BW
Involved	~1.8
Uninvolved	~2.2

6-9 months post-op

Group	Limb Loading Symmetry
ACLR	~84
Control	~98

Paterno, Schmitt, Ford, Rauh, Myer, Hewett. JOSPT, 2011, 41(8)

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Residual impairments

- Loading asymmetry
 - Loading asymmetry at 27.4 months post-op during a bilateral drop land in athletes who are cleared to return to sports (n=14, female athletes).

2 years post-op

Group	Peak Vertical GRF/BW
Involved	~1.2
Uninvolved	~1.5

Paterno et al. Clin J Sports Med; 2007, 17(4)

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Residual impairments

- Loading asymmetry
 - 13 months post-ACLR
 - bilateral body weight squat
 - no differences in quad strength

Group	Knee Extensor Moment
CONTROL	~0.06
ACLR	~0.05 (17% reduction)

Roos et al. J Neuroeng Rehabil; 2014, 11(19)

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Goals of Early Rehabilitation

Post-op weeks 6-8

- Loading
 - Initiate and progress single limb exercises
 - running and hopping

Adams et al. J Orthop Sport Phys Ther, 2012, 42(7)

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Loading asymmetry

- Bilateral tasks/ squat
 - Knee extensor moment deficits during an unweighted maximal depth squat at 1, 3 and 5 months post-op ACLr (n=11).

Knee ext mmt

GRF

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Loading

Normal gait, Full ROM,
Quadriceps strength >80%,
Begin running progression*

1 month

Agility exercises
Sports specific exercises*

3 months

5 months

1 to 2 years

Sit-to-stand
32% lower vGRF¹

Body weight squat
14% lower vGRF²

Body weight squat³
Drop land
17% lower knee extensor moment
19-20% lower vGRF^{4,5}

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1. Labanca et al. Am J Phys Med Rehabil, 2015

2. Chan et al. ACSM 59th annual meeting, 2016

3. Ross et al. J Neurology Rehabil, 2014

4. Baumgart et al. Knee Surgery Sports Traumatology, 2012

5. Paterno et al. JGSP, 2011

6. Adams et al. JGSP, 2012

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Residual impairments

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“Dynamic” loading

Running- 1st month

Knee flexion angle

Knee extensor moment

Sagittal plane knee power


Sigvard, Lin and Pratt. *Clin Biomech*, 2016

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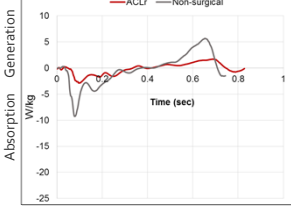
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"Dynamic" loading

Single loading task



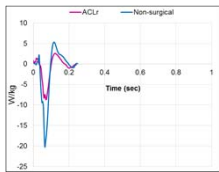
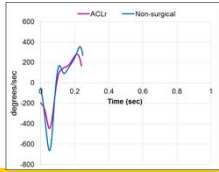
Sagittal plane knee power



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"Dynamic" loading


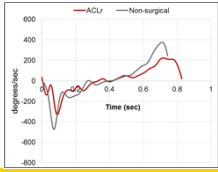
RUN

Knee Power

Knee angular velocity

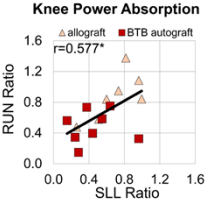
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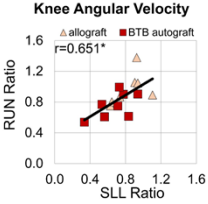
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"Dynamic" loading

Knee Power Absorption



Knee Angular Velocity



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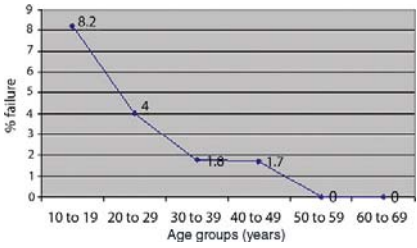
QUESTIONS?

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Percentage of graft failures: 2 year follow-up



Age groups (years)	% failure
10 to 19	8.2
20 to 29	4
30 to 39	1.8
40 to 49	1.7
50 to 59	0
60 to 69	0

Kaeding et al. Sports Health. 2011; 3

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