

Return to Sport following ACL Reconstruction



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Mitigating Potential Bias

- Not applicable

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Acknowledgements



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Anterior Cruciate Ligament Injury

- The ACL is the most commonly reconstructed ligament.¹
- 200,000 - 250,000 ACL injuries each year in Canada and the US.²
- Incidence of ACL reconstruction in Manitoba in 2013.³
 - 46.6/100,000
 - Approximately 600

Buller et al. Orthop J Sports Med. 2015
Campbell et al. Clin J Sport Med 2014
Zhang et al. Canadian Orthopaedic Association Annual Meeting 2017

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Return to Sport

- Systematic review by Ardern et al 2011.⁴
 - 63% of patients returned to their pre injury level of participation.
 - 90% had "normal" impairment based function with regards to laxity and strength.

Ardern CL, Webster KE, Taylor NF, Feller JA, Victoria O. Return to sport following anterior cruciate ligament reconstruction surgery: systematic review and meta-analysis of the state of play. Br J Sports Med. 2011;45:596-606.

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Decisions

- Risk of re-injury
- Risk of future OA
- External pressures
 - patient / family
 - team pressure

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(Source - Mark Beatty's Student Card 1997)
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Not all the same

- Not all ACL injuries are the same
- Consider
 - Gender
 - Age
 - Contact vs non-contact
 - Activity expectations

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What are the Re-injury risks?

- Systematic review and meta-analysis by Wiggins et al 2016.⁵
- The secondary ACL injury rate was 15%
 - ipsilateral 7%
 - Contralateral 8%
- Patients younger than 25 returning to high level pivotal sport
 - secondary ACL injury rate was 23%

Wiggins AJ, Grandhi RK, Schneider DK, Stanfield D, Webster KE, Myer GD. Risk of secondary injury in younger athletes after anterior cruciate ligament reconstruction: a systematic review and meta-analysis. *Am J Sports Med.* 2016 Jul;44(7):1861-76.
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What factors do we use to determine return to sport?

- 264 studies met the inclusion criteria
- 105 studies (40%) fail to provide any criteria
- 84 studies (32%) time post operatively
- 35 studies (13%) noted objective criteria
 - muscle strength or thigh circumference (28)
 - general knee examination (15)
 - single-leg hop tests (10)
 - Lachman's (1)
 - Validated questionnaires

Barber-Westin SD, Noyes FR. Factors used to determine return to unrestricted sports activities after anterior cruciate ligament reconstruction. *Arthroscopy. J of Arthroscopic and Rel Surg.* 2011;27(12):1697-705.
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The Pendulum Swings

- A move from a calendar decision to criteria based decision making.

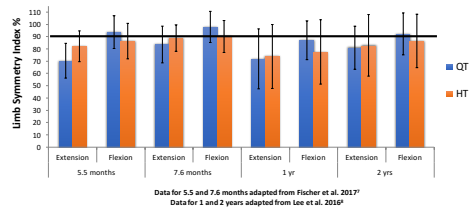
What if we delay RTS?

- Commentary by Nagelli and Hewitt 2017
- Advocates for a RTS at 2 years post surgery
- Ligamentization
- Recovery of strength
- Neuromuscular control
- Proprioception
- Bone bruises

Nagelli CV, Hewitt TE. Should return to sport be delayed until 2 years after anterior cruciate ligament reconstruction? biological and functional considerations. Sports Med. 2017 Feb;47(2):221-32.

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Isokinetic Peak Torque Values (60°/sec)
Post-Operative ACLR with Quadriceps Tendon (QT) vs Hamstring Tendon (HT) Autograft



Data for 5.5 and 7.6 months adapted from Fischer et al. 2017
Data for 1 and 2 years adapted from Lee et al. 2016

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Arthrogenic Muscle Inhibition

<http://www.phdworkandplay.com/one-month-post-surgery/>

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Quantitative Measures

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What can be measured?

- Manual muscle testing
 - Criteria based progression
- Hand held dynamometry
- Isokinetic dynamometry
- Functional Testing

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Hop Testing

- Described by Noyes et al. 1991.
- Commonly used functional tests for return to sport.
- Some correlation with Quadriceps strength
- Some correlation with hip ER strength
- Does not determine if a knee is functionally stable.

(Source - Noyes FR, Barber SD, Mangione FE. Abnormal lower limb symmetry determined by function hop tests after anterior cruciate ligament rupture. *Am J of Sport Med.* 1991;19(2):154.)

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Hop Testing

- Score is based on a Liimb Symmetry Index (LSI).
- Evaluated using the uninjured leg.
- When possible it is more accurate to compare with pre -injury measures.
- Reid et al. 2007
 - A reliable and valid outcome measure during and after ACL rehabilitation.
 - MCID was a change in LSI of 7% or more.

(Source - Noyes FR, Barber SD, Mangione PE. Abnormal lower limb symmetry determined by function hop tests after anterior cruciate ligament rupture. Am J of Sport Med. 1991;19(3):313-8.)

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Fatigue

- Side hop testing as a measure of fatigue

(Source - Gustavsson et al. Knee Surg Sports Traumatol Arthrosc. 2008

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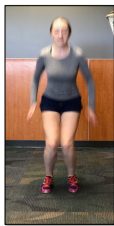
Qualitative Measures

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Modifiable Risk Factors

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Modifiable Risk Factors



Source: Author

Ligament Dominance

- relying on passive knee structures to prevent valgus instead of active
- Hewitt et al 2005. Prescreen of female athletes
- Increase in knee valgus and knee abduction moment in those that went on to ACL injury.

Hewitt TE, Myer GD, Ford KR, Heid RS, Colakova AJ, McLean SG, et al. Biomechanical measures of neuromuscular control and valgus loading of the knee predict anterior cruciate ligament injury risk in female athletes. *Am J Sports Med.* 2005 Apr;33(4):492-501(9).

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Modifiable Risk Factors



Source: Author

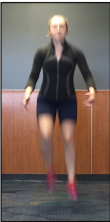
Quadriceps Dominance

- Reduction in knee flexion angle with landing and loading
- Reliance on the quads without adequate posterior chain contribution.
- Lack of co-contraction and control of tibial shear

Myer GD, Ford KR, Fouse KR, Liu C, Mack TG, Hewitt TE. The relationship of hamstrings and quadriceps strength to anterior cruciate ligament injury in female athletes. *Clin J Sport Med.* 2008;18(1):3-8.

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Modifiable Risk Factors



Source: Author

Limb Dominance

- Asymmetrical landing strategy.
- May be a significant factor in contralateral knee injury

Paterno MV, Schmitt LC, Ford KR, Ruan MJ, Myer GD, Huang B, et al. Biomechanical measures during landing and postural stability predict second anterior cruciate ligament injury after anterior cruciate ligament reconstruction and return to sport. *Am J Sports Med.* 2010 Oct 1;38(10):1968-74.

Modifiable Risk Factors



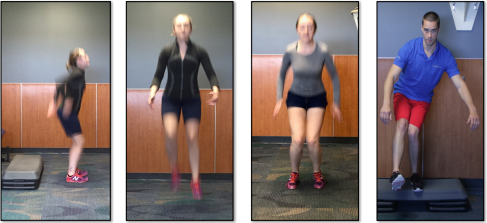
Source: Author

Trunk Dominance

- Trunk Dominance

Zacarias RT, Hewitt TE, Reeves NP, Goldberg B, Cholewicki J. Deficits in neuromuscular control of the trunk affect knee injury risk: a prospective biomechanical-epidemiologic study. *Am J Sports Med.* 2007 Mar 6;35(7):1125-30.

Modifiable Risk Factors



Source: Author

Source: Author

Source: Author

Source: Author

Hewitt TE, Ford KR, Hoogenboom BJ. Invited Clinical Commentary understanding and preventing ACL injuries: Considerations - Update 2010. *North Am J of Sports Phys Ther.* 2010;5(4): 234-51.

Observation of motion

- A scoring system for control of the trunk, and lower extremity.

(Source - Herrington L, Myer G, Horsley I. Task based rehabilitation protocol for elite athletes following Anterior Cruciate ligament reconstruction: a clinical commentary. *Phys Ther Sport*. 2013 Nov;14(4):188-98.

Tuck Jump

(Source -Myer GD, Ford KR, Hewett TE. Tuck jump assessment for reducing anterior cruciate ligament injury risk. *Athl Ther Today*. 2008;13(5):38-44.)

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Just because you can hop or jump...

- Kristianslund et al compared loads on the knee during 2 foot drop landing and a simulated sidestep cutting movement.
- Knee abduction moments were 6 times greater during a side step cutting motion.

Kristianslund E, Krosshaug T. Comparison of deep jumps and sport-specific sidestep cutting: implications for anterior cruciate ligament injury risk screening. *Am J Sports Med*. 2013;41(10):2444.

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“Has anybody seen my patient?”

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Compliance

- 111 Patients post ACLR
- Completed hop tests
- isokinetic strength testing

Ebert JR, Edwards P, Yi L, Joss B, Ackland T, Carey-Smith R, et al. Strength and functional symmetry is associated with post-operative rehabilitation in patients following anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc* [Internet]. 2017 Sep 15 [cited 2017 Oct 17]; Available from: <http://link.springer.com/10.1007/s00167-022-4712-6>

Compliance

REHAB DESCRIPTION	N (111)	PERCENTAGE
NO REHABILITATION	4	3.6%
NO SUPERVISED REHABILITATION SELF-MANAGED TO LIGHT ACTIVITY	6	5.4%
SUPERVISED PT FOR 3 MONTHS SELF-MANAGED HOME EXERCISES/LIGHT ACTIVITY	12	10.8%
SUPERVISED PT FOR 3 MONTHS INDEPENDENT RETURN TO STRUCTURED GYM EXERCISES/RETURN TO ACTIVITY	28	25.2%
SUPERVISED PT FOR 6 MONTHS INDEPENDENT RETURN TO STRUCTURED GYM EXERCISES/RETURN TO ACTIVITY	28	25.2%
SUPERVISED PT FOR 6 MONTHS INCLUDING AGILITY AND LANDING EXERCISES FOLLOWED BY STRUCTURED RETURN TO GYM EXERCISES/ACTIVITY	27	24.4%
SUPERVISED PT >6 MONTHS AS ABOVE WITH SUPERVISED FULL RETURN TO SPORT	6	5.4%

(Source - Ebert JR, Edwards P, Yi L, Joss B, Ackland T, Carey-Smith R, et al. Strength and functional symmetry is associated with post-operative rehabilitation in patients following anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc* [Internet]. 2017 Sep 15 [cited 2017 Oct 17]; Available from: <http://link.springer.com/10.1007/s00167-022-4712-6>)

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Research

- Better data collection
- Patient compliance and base line data
- Equipment - force plates, dynamometry, acclerometry
- Time

Clinical

- Limited funding for the average patient.
- Space limitations
- Time constraints
- Lack of equipment
- PHIA concerns with collecting data like video

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So what's the best test...

There is an absence of evidence that a specific test or combination of tests can predict those at risk for injury

It has been suggested to perform a number of tests, looking for both quantity and quality of movement.

Van Melick N, van Cingel RE, Broeze J, van't Hof-Grootenboer AE, van't Hof-Maat C, van't Hof-Maat T, Huijsga W et al. Evidence-based clinical practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. *BJJ*. 2016;50:1596-16.

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Return to Sport Criteria

- 1) No effusion
- 2) Stable ligament stress tests (Lachman's and pivot shift tests), no subjective complaints of giving way
- 3) >90% limb symmetry index on single leg hop tests (single leg hop for distance, triple hop for distance, cross over hop for distance, and 6 meter timed hop)
- 4) Side hop testing within 90% of the uninvolved leg
- 5) Symmetrical mechanics jumping and landing tuck jump without knee valgus, hip adduction, and internal rotation
- 6) Single leg hop and land for distance; with assessment of movement quality
- 7) Observation of symmetrical cutting strategies, both planned and unexpected (adequate knee flexion without valgus)

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Injury Reduction?

A prospective cohort of 158 male professional athletes after ACLR
ACL re-injury rates in patients who had successfully completed a series of six return to play performance tests

Approximately **10%** of those patients who completed all six criteria suffered an ACL graft injury, compared to **33%** of those who did not complete all six criteria.

Kybbeli P, Bahv R, Lindroos P, Mäkelä R, Wiltonen E. Likelihood of ACL graft rupture: not meeting an clinical discharge criteria before return to sport is associated with a four times greater risk of rupture. Br J Sports Med. 2016 Aug;50(13):946-51.

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Injury Reduction?

- 106 patients who participated in pivoting sports
- Criteria for RTS
 - >90% quads strength, hop symmetry KOS - ADLs, Global rating scale of function.

Grindem H, Snyder-Mackler L, Moksnes H, Engebretsen L, Risberg MA. Simple decision rules can reduce reinjury risk by 84% after ACL reconstruction: the Delaware-Oslo ACL cohort study. Br J Sports Med. 2016 Jul;50(13):804-8.

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Injury Reduction?

- Increase in re-injury rate with return to level 1 sports (4.32 times higher)
- Reinjury rate was reduced for each month RTS was delayed until 9 months
- 38.2% of those who failed RTS criteria suffered reinjuries vs 5.6% who passed

Grindem H, Snyder-Mackler L, Moksnes H, Engebretsen L, Risberg MA. Simple decision rules can reduce reinjury risk by 84% after ACL reconstruction: the Delaware-Oslo ACL cohort study. Br J Sports Med. 2016 Jul;50(13):804-8.

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Take home points

- Recovery of quadriceps function is imperative but that alone does not guarantee success

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Take home points

- Not all ACL rehabs are the same
- Consider those at high risk
- We must develop a movement based skill set that begins with minimal risk, and is progressive to meet the needs of the athlete
- Educate patients early on what their rehab timelines will look like.
- Emphasis on late stage rehab needs to change
- Quantitative and qualitative assessment needs to happen prior to return to sport.

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