



Re-rupture and contralateral rupture

Prof. F. Benazzo

REVIEW PAPER

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Minimizing the risk of graft failure after anterior cruciate ligament reconstruction in athletes. A narrative review of the current evidence

Giuseppe Gianluca Costa^{1,2*} , Simone Perelli^{2,3}, Alberto Grassi⁴, Arcangelo Russo¹, Stefano Zaffagnini⁴ and Juan Carlos Monllau^{2,3}

- Predisposing factors to ACL reconstruction failure
- Surgical aspects which may have significant impact on outcomes, and
- Current criteria regarding safe return to sport after ACL reconstruction

Predisposing factors: Age

Risk graft failure:

< 20y x3 vs 20-30y

< 20y x4 vs 30-40y

< 20y x8 vs >40y

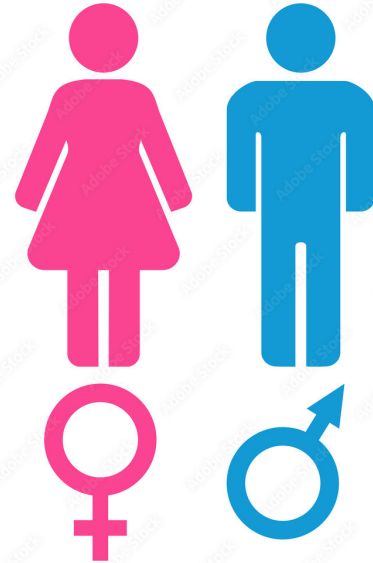


Rahardja R, Zhu M, Love H, Clatworthy MG, Monk AP, Young SW (2020) Factors associated with revision following anterior cruciate ligament reconstruction: a systematic review of registry data. *Knee* 27(2):287–299

Predisposing factors: Sex

Re-rupture

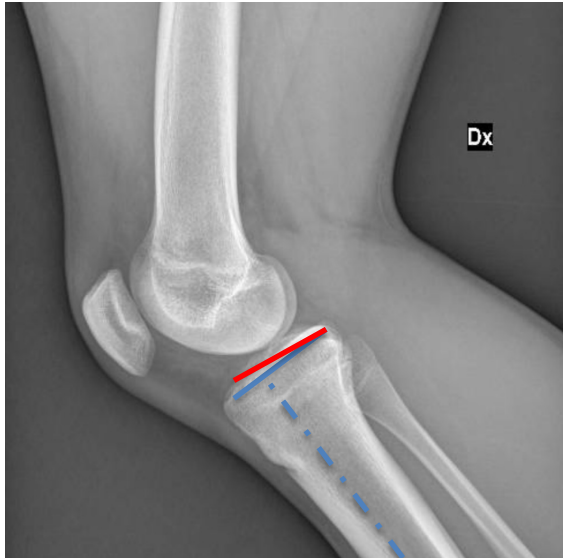
No differences between
male or female





Tan SH, Lau BP, Khin LW, Lingaraj K (2016) The importance of patient sex in the outcomes of anterior cruciate ligament reconstructions: a systematic review and Meta-analysis. *Am J Sports Med* 44(1):242–254

Predisposing factors: Anatomical factors

- high value of lateral tibial slope
- small intercondylar notch (parameter discussed)



The Role of the Posterolateral Tibial Slope in the Rotational Instability of the Knee in Patients Affected by a Complete Isolated Anterior Cruciate Ligament Injury: Its Value in the Decision-Making Process during the Anterolateral Ligament Reconstruction

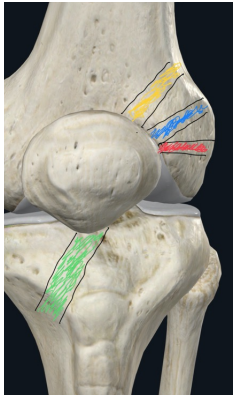
Marco Bargagliotti¹ Francesco Benazzo² Johan Bellemans³ Jan Truijen³ Luigi Pietrobono⁴
Mario Formagnana⁵ Enrico Zero⁶ Giacomo Zanon²

Joins 2019;7:78–83.

Conclusion Our study indicates that an increased PLTS is associated with an increased incidence of ALL injury and an increased grade of pivot shift in patients with ACL tear. Assessment of posterolateral tibial slope on MRI can therefore play a key adjunct role in the surgical planning of ALL reconstruction, especially in cases when ALL damage is radiologically difficult to detect or doubtful.

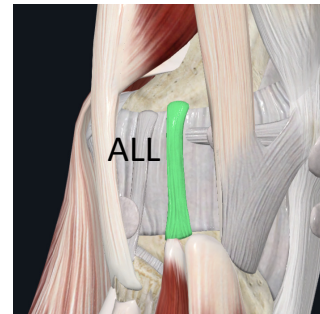
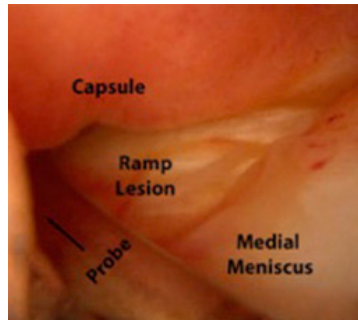
Surgical factors

- Technical errors (improper tunnel placement, inadequate ACL graft, insufficient graft tensioning)
- Missing diagnosis or improper management of concomitant lesions/laxity (15% ACL failure; Samitier G et al, 2015)



Concomitant lesions

- Ramp lesion
- Posterior root tear of lateral meniscus
- ALL repair / Lateral Extra-articular Tenodesis (LET) procedures
- Management of MCL and PLC injury
- Other tears of lateral and medial meniscus repair



Concomitant lesions

Re-rupture

Predictors of Graft Failure in Young Active Patients Undergoing Hamstring Autograft Anterior Cruciate Ligament Reconstruction With or Without a Lateral Extra-articular Tenodesis

The Stability Experience

Andrew D. Firth, MSc, Dianne M. Bryant, MSc, PhD, Robert Litchfield, MD, Robert G. McCormack, MD, Mark Heard, MD, Peter B. MacDonald, MD, Tim Spalding, FRCS, Peter C.M. Verdonk, MD, PhD, Devin Peterson, MD, Davide Bardana, MD, Alex Rezasoff, MD, STABILITY Study Group, and Alan M.J. Getgood,* MD
Investigation performed at the Fowler Kennedy Sport Medicine Clinic, Western University, London, Ontario, Canada

The American Journal of Sports Medicine
2022;50(2):384–394
DOI: 10.1177/03635465211061150
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Technical Note

Lateral Meniscal Posterior Root Repair With Anterior Cruciate Ligament Reconstruction Better Restores Knee Stability

Xin Tang,** MD, Brandon Marshall,† MS, Joon Ho Wang,* MD, Junjun Zhu,‡ MS, Jian Li,† MD, Patrick Smolinski,** PhD, and Freddie H. Fu,**§ MD, DSc (Hon), DPs (Hon)
Investigation performed at the Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, Pennsylvania, USA

The American Journal of Sports Medicine
2019;47(1):59–65
DOI: 10.1177/0363546518808004
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Concurrent Repair of Medial Meniscal Ramp Lesions and Lateral Meniscus Root Tears in Patients Undergoing Anterior Cruciate Ligament Reconstruction. The “New Terrible Triad”



Christopher M. LaPrade, M.D., Morgan D. Homan, D.O., Jay Moran, B.S., Nicholas I. Kennedy, M.D., and Robert F. LaPrade, M.D., Ph.D.

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**Predictors of Graft Failure in Young Active
Patients Undergoing Hamstring Autograft
Anterior Cruciate Ligament Reconstruction
With or Without a Lateral Extra-articular
Tenodesis**

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568 with a mean age of 18.8 years (292 female; 51.4%)

Graft rupture in 43 (7.6%)

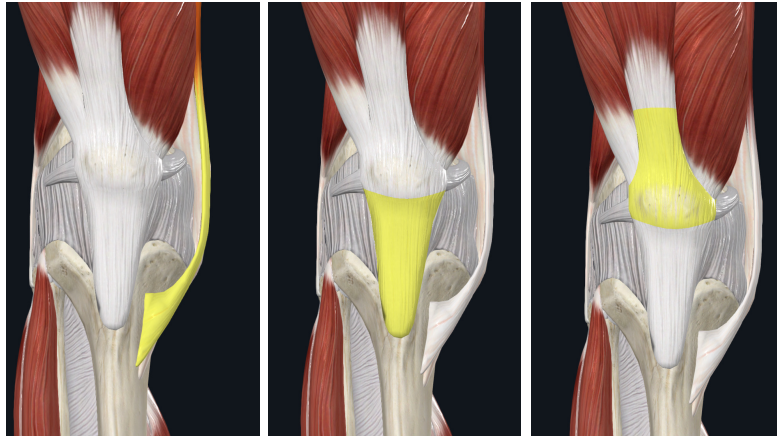
1. The addition of a LET and larger graft diameter were significantly associated with reduced odds of asymmetric pivot shift.
2. Younger age, greater posterior tibial slope, high-grade knee laxity, and earlier return to sport were associated with increased odds of graft rupture.
3. Adding a LET was protective of graft rupture

Graft choice

Re-rupture

The available evidence in literature is mixed on which graft type is associated with a higher risk of graft failure and revision ACL reconstruction

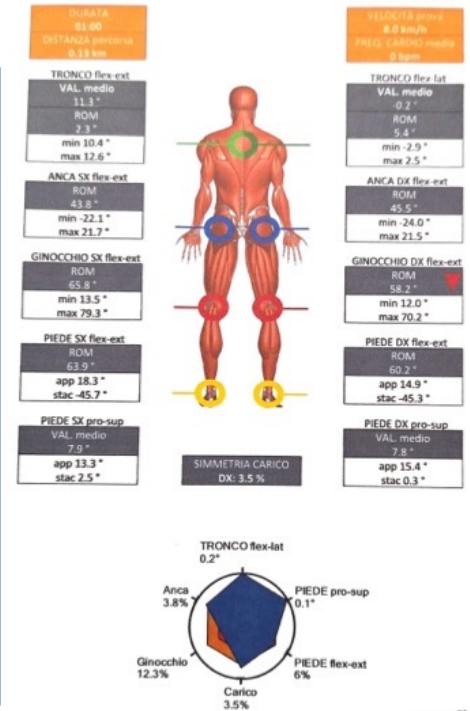
- Similar failure rates between BPTB (2.2%) and hamstring autografts (2.5%) (DeFazio MW et al, 2020)
- QT grafts have comparable graft survival rate to BPTB and hamstring (Mouarbes D et al, 2019)



Safe return to sport

- The risk of sustaining a second ACL injury is highest during the early period after return to sport (RTS), especially during the first year after the index reconstruction
- Delaying RTS at 9 months after ACL reconstruction may reduce reinjury risk by 84% (specifically, the reinjury rate was reduced by 51% for every month delay for up to 9 months, beyond which no further risk reduction was observed)
- To be considered all the criteria for RTS (stability, strength, etc.)

Re-rupture



Grindem H, Snyder-Mackler L, Moksnes H, Engebretsen L, Risberg MA (2016) Simple decision rules can reduce reinjury risk by 84% after ACL reconstruction: the Delaware-Oslo ACL cohort study. Br J Sports Med 50(13):804–808

Re-rupture & Contralateral rupture

Sports Medicine (2022) 52:2657–2668
<https://doi.org/10.1007/s40279-022-01711-1>

SYSTEMATIC REVIEW



Familial Predisposition to Anterior Cruciate Ligament Injury: A Systematic Review with Meta-analysis

Sara Hasani¹  · Julian A. Feller^{1,2} · Kate E. Webster¹

“Objective: We aimed to systematically review family history (in athletic population) as a risk factor for sustaining a primary ACL injury and the impact it has on ACL graft rupture or contralateral ACL injury in male and female individuals.”

Key Points

Having a family history of an anterior cruciate ligament (ACL) injury increases the odds of sustaining a primary ACL compared with those without a family history by 2.5 times.

Female and male individuals with a family history are at the same increased odds for primary ACL injury.

The risk of sustaining a subsequent ACL injury are increased by 2.4 odds for those with a family history of ACL injury.

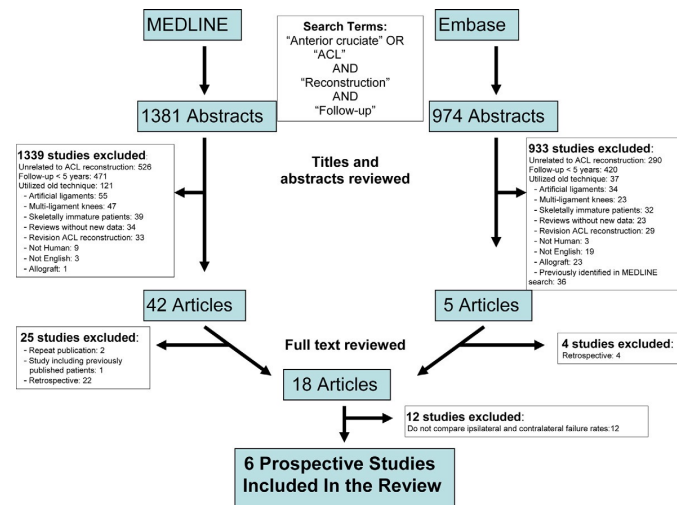
This increased risk is the same for ACL graft ruptures and contralateral ACL injuries.

Ipsilateral Graft and Contralateral ACL Rupture at Five Years or More Following ACL Reconstruction

A Systematic Review

Rick W. Wright, MD, Robert A. Magnussen, MD, Warren R. Dunn, MD, and Kurt P. Spindler, MD

Minimum of five years of follow-up
Contralateral ACL tear rate is double (11.8%) that of the risk of ACL graft rupture in the ipsilateral knee (5.8%)



Pediatric patients: Re-rupture & Contralateral rupture

Following ACLR, injuries to the contralateral ACL have been reported to occur in 4 to 42% of pediatric patients

Cordasco FA, Mayer SW, Green DW. All-inside, all-epiphyseal anterior cruciate ligament reconstruction in skeletally immature athletes: return to sport, incidence of second surgery, and 2-year clinical outcomes. *Am J Sports Med.* 2017;45:856–63 Case series suggesting targeted rehabilitation of over a year for contralateral strength and neuromuscular control deficiencies after ACLR to decrease instances of contralateral tear in pediatric athletes who have remaining growth.

Placella G, Bartoli M, Peruzzi M, Speziali A, Pace V, Cerulli G. Return to sport activity after anterior cruciate ligament reconstruction in skeletally immature athletes with manual drilling original all inside reconstruction at 8 years follow-up. *Acta Orthop Traumatol Turc.* 2016;50:635–8.

Patient Age: 1415 patients with minimum 5-year follow-up following ACLR found contralateral tear:

- 8.7% in pediatric patients (age < 18)
- 4% in adult patients aged 18 to 25
- 2.8% in patients > 25 years of age

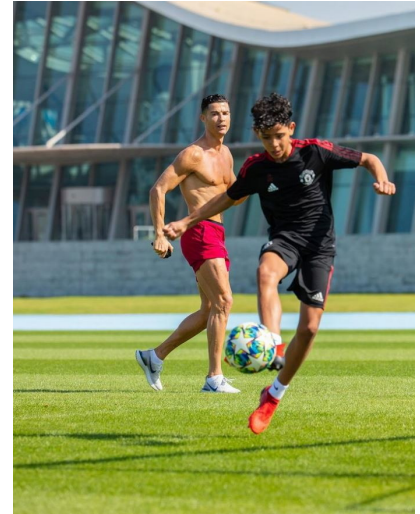
No difference in different age <18 y, or between male and female

Shelbourne KD, Gray T, Haro M. Incidence of subsequent injury to either knee within 5 years after anterior cruciate ligament reconstruction with patellar tendon autograft. *Am J Sports Med.* 2009;37(2):246–51

Pediatric patients: Re-rupture & Contralateral rupture

ANATOMICAL FACTORS

1. Relationship between the ACL and the femoral notch width index (ratio of the intercondylar width to the bicondylar width) has been shown to increase with increasing age.
2. Presence of greater posterior tibial slope in pediatric patients has been associated with an increased risk of ACL injury
3. Patients sustaining ACL injuries possessed significantly higher mean posterior tibial slope ($10.0^{\circ} \pm 3^{\circ}$) when compared with a non-injured control group ($8.5^{\circ} \pm 3^{\circ}$) ($p = 0.128$)

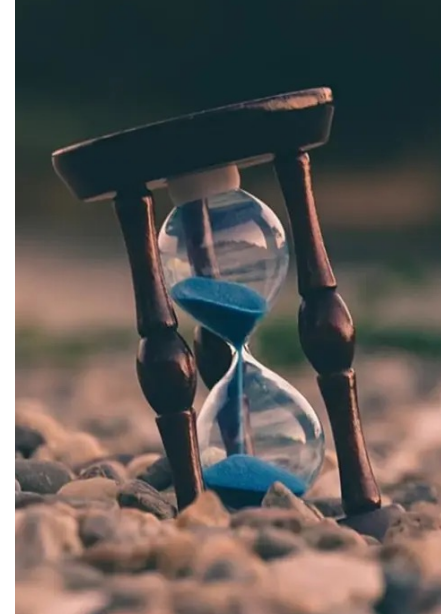


O'Malley, MP, Milewski MD, Solomity MJ, Erwtaman AS, Nissen CW. The association of tibial slope surgery 2015; 31(1) 7–82.

Pediatric patients: Re-rupture & Contralateral rupture

TIMING FOLLOWING INDEX ACLR

- Contralateral ACL tears have been shown to occur further out from index ACLR in pediatric patients when compared with ACL graft re-ruptures following ACLR
- Contralateral ACL injury incidence of 20% (mean age 16 years, range 13–18 years) occurring at a mean of 71 months following index surgery, compared with a graft rupture rate of 17% (n = 42 of 242) at a mean of 51 months



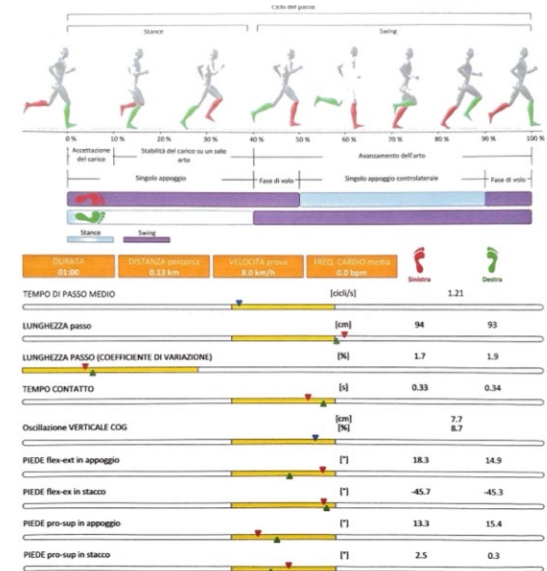
Morgan MD, Salmon LJ, Waller A, Roe JP, Pinczewski LA. Fifteen-year survival of endoscopic anterior cruciate ligament reconstruction in patients aged 18 years and younger. *Am J Sports Med.* 2016;44(2):384–92.

Pediatric patients: Re-rupture & Contralateral rupture

NEUROMUSCULAR AND BIOMECHANICAL CHANGES IN THE PEDIATRIC KNEE FOLLOWING ACLR

- Alterations in gait kinematics, limb symmetry, and quadriceps strength have been reported in the operative knee. These changes increase the forces placed across the ACL graft, increasing the risk for subsequent graft failure
- In the contralateral knee, these alterations in strength and neuromuscular control deficiencies in the operative knee have been reported to affect transverse hip moments, frontal plane knee angles, sagittal plane moments, and postural stability up to 2 years after the surgery

RUN ANALYSIS



Pediatric patients: Re-rupture & Contralateral rupture




TIMING TO RTP AND RISK TO CONTRALATERAL ACL INJURY

- Early return to sport prior to adequate graft incorporation and healing following ACLR has been cited as a substantial risk for athletes sustaining a contralateral ACL injury
- Strength and functional deficits in the operative knee and their subsequent impact in the contralateral knee following ACLR have been shown to persist for up to 2 years following surgery in pediatric athletes
- Multiple studies have proposed delaying return to sport for up to 2 years following ACLR to allow for complete biological recovery, minimizing the risk for ACL re-rupture and contralateral ACL injury

Dekker TJ, Godin JA, Dale KM, Garrett WE, Taylor DC, Riboh JC. Return to sport after pediatric anterior cruciate ligament reconstruction and its effect on subsequent anterior cruciate ligament injury. *J Bone Joint Surg Am.* 2017;99(11):897–904 Cohort study finding that the only protective factor for contralateral tear in pediatric athletes is delayed return-to-sport, suggesting a role for timed biological recovery that is independent of strength and neuro-muscular control benchmarks.

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

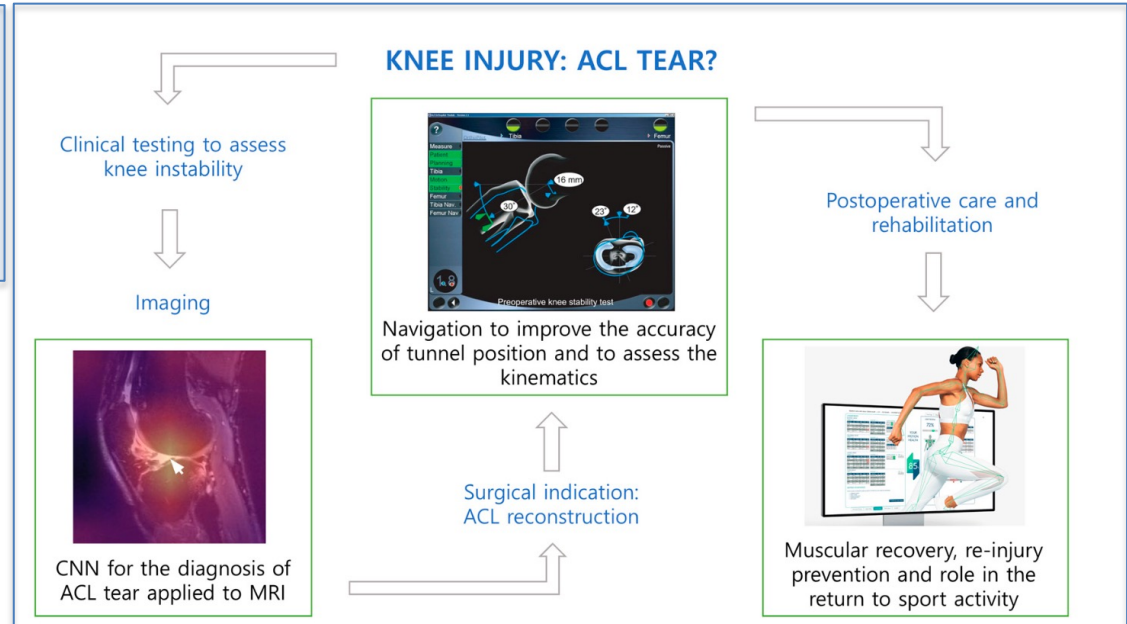
The Role of Artificial Intelligence in Anterior Cruciate Ligament Injuries: Current Concepts and Future Perspectives

Luca Andriollo ^{1,2,*}, Aurelio Picchi ^{3,†}, Rudy Sangaletti ¹, Loris Perticarini ¹, Stefano Marco Paolo Rossi ¹, Giandomenico Logroscino ³ and Francesco Benazzo ^{1,4}

Healthcare 2024, 12, 300. <https://doi.org/10.3390/healthcare12030300>

Prediction (DL)

The AI prediction model for primary ACL injury achieved a testing accuracy of over 90%.



Conclusions

To be considered:

- age and patients/athlete
- predisposing anatomical factors and family history
- Surgeon's skills: avoid technical error, treatment of concomitant lesions, choice of the graft and associated procedure in specific cases
- RTP controlled
- Role of new technology?

Nuova rottura del crociato per Ebosese, il difensore operato nel pomeriggio

