

# Dealing With Failure in Pediatric Sports Surgery - Strategies for Revision

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MOVE.



TRAIN.



PLAY.



I have no conflicts of interest to  
disclose

# *Objectives*

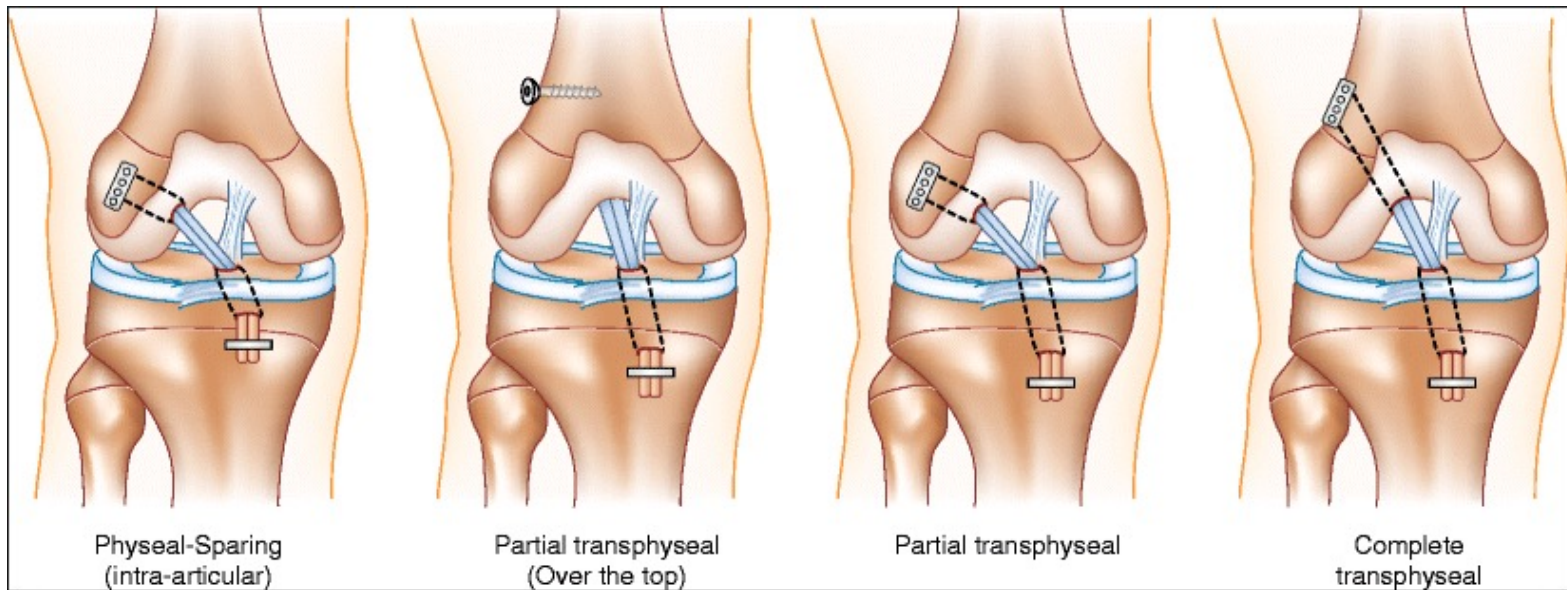
- Discuss the potential etiologies of ACL graft failure in the immature patient
- Presents a staged approach to management of revision surgery

OBJECTIVES



# *Surgical Dilemma*

## Balance the Risk of Growth Disturbance Versus Anatomic Reconstruction



ORIGINAL ARTICLE

## Complications After Pediatric ACL Reconstruction: A Meta-Analysis

*Stephanie E. Wong, MD, Brian T. Feeley, MD, and Nirav K. Pandya, MD*

**Results:** In total, 45 studies were included with 1321 patients and 1392 knees. The average age was 13.0 years, 67% were male, and mean follow-up was 49.6 months. There were 115 (8.7%) reruptures in the initial 160 studies reviewed. In total, 94.6% of patients with rerupture required revision ACL surgery. There were 58 total growth disturbances (16 required corrective surgery, or 27.6%). Eighteen knees (3.7%) developed angular deformity, most commonly valgus. There were 37 patients (7.5%) had at least a 1 cm limb-length discrepancy. A total of 23 studies reported International Knee Documentation Committee scores (range, 81 to 100, 88% grade A or B). In total, 20 studies reported excellent Lysholm scores with mean scores of 94.6.

**Conclusions:** Growth disturbance can occur with any of the reconstruction techniques. Proper surgical technique is likely more important than the specific reconstruction technique utilized. Patients with rerupture require surgery at much higher rates than those with growth disturbance. Although much attention has been focused on growth disturbance, we suggest that equal attention be given to the prevention of rerupture in this age group.

- 1392 ACL reconstructions
- 8.7% re-tear rate of which 94.6 % needed revision
- 4.1% growth disturbance rate of which 27.6 % needed correction
- Preventing re-tear is important!
  - Best treatment is to not re-tear!

# *This Family Is In Your Clinic: What Do You Do??*



*This Family Is In Your Clinic:  
What Do You Do??*

Recognize this a traumatic injury that  
has severe social-emotional  
consequences for the patient and  
family



## *Assess Obvious Reasons For Failure*

- Non-compliance with protocol
- Non-adherence to home exercises

**Delay reconstruction until family or  
patient mature**







## *Time for Revision: What To Do?*

- Assess and correct angular deformity (valgus) that needs to be corrected first and/or at the same time



# *Growth Disturbance Review*

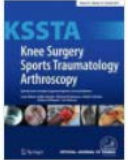
Author	Year	Growth Disturbance	Re-rupture
Higuchi et al.	2009	MRI narrowing in 8, frank closure in 2	0
Chotel et al.	2010	One with LLD 1.5cm, one with valgus deformity and 1cm LLD	0
Liddle et al.	2008	One with valgus deformity	1
McIntosh et al.	2006	One with LLD of 1.5cm	2
Koman et al.	1999	One with valgus deformity	0
Andrews et al.	1994	Two patients > 10 mm LLD	1
Lipscomb et al.	1986	One LLD 1.3cm, one LLD 2cm	2
Lemaitre et al.	2014	Two with valgus deformity	0
Kohl et al.	2014	One with valgus deformity	0
Kumar et al.	2013	One with valgus deformity	1
Lawrence et al.	2011	One with valgus deformity after revision ACL	1
Robert et al.	2010	One with valgus deformity	0
Zimmerman et al.	2015	One with LLD of 2.8cm	0
Rozbruch et al.	2013	One with varus, recurvatum, and LLD of 4.5 cm	0
Henry, et al.	2009	One with valgus deformity	0
Mauch et al.	2011	One with valgus-flexion deformity	0
Nathan et al.	2013	One with LLD of 2.7cm	0
Shifflett et al.	2016	Two with recurvatum, two with valgus deformity	0

Table 1. Individual Studies

- More likely to have valgus than LLD
- LLD is more likely overgrowth
- Recurvatum with tibial tubercle violation
- Patients with 2-4 years of growth remaining more likely to have disturbance than > 4 years
  - Physis ‘older’
  - Less chance to correct

## *Time for Revision: What To Do?*

- Possible correction of posterior tibial slope



[Knee Surgery, Sports Traumatology, Arthroscopy](#)

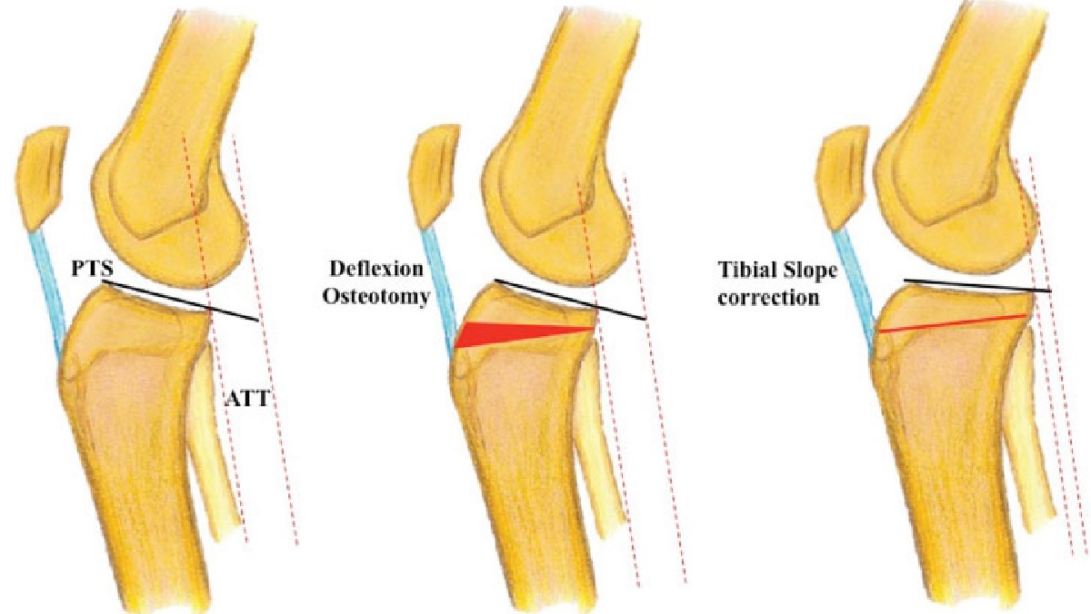
October 2015, Volume 23, [Issue 10](#), pp 2846–2852 | [Cite as](#)

Tibial slope correction combined with second revision ACL produces good knee stability and prevents graft rupture

Authors

Authors and affiliations

David Dejour, Mo Saffarini , Guillaume Demey, Laurent Baverel





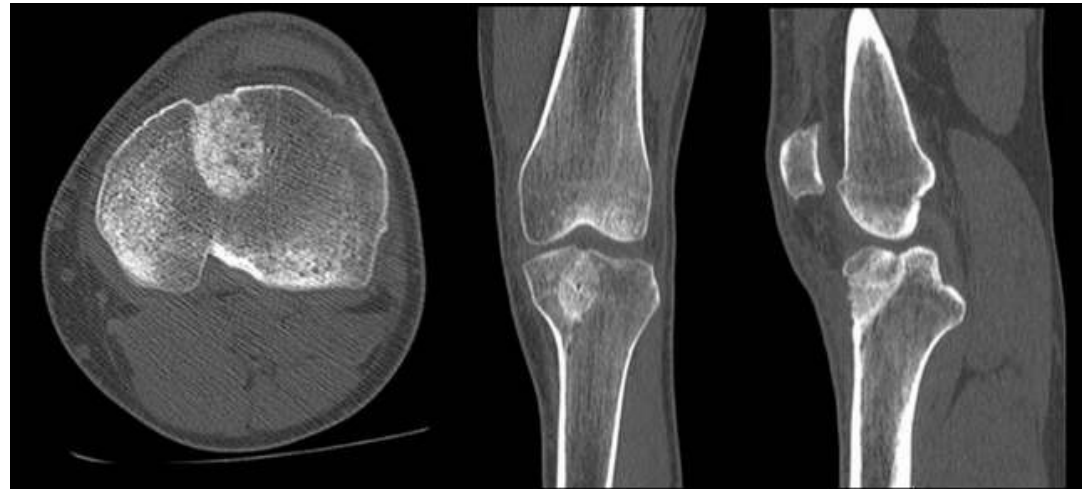
## *Time For Revision: Assess Surgical Technique*



- Assess Tunnel Position
  - *Non-anatomic*
    - Typically non-traumatic with chronic graft failure
    - Bucket handle medial meniscus with no lateral joint bone bruising
    - Assess if you can revise and not disrupt growth
  - *Anatomic (re-use)*
    - Assess for widening

Determine if you need to bone graft and stage!!

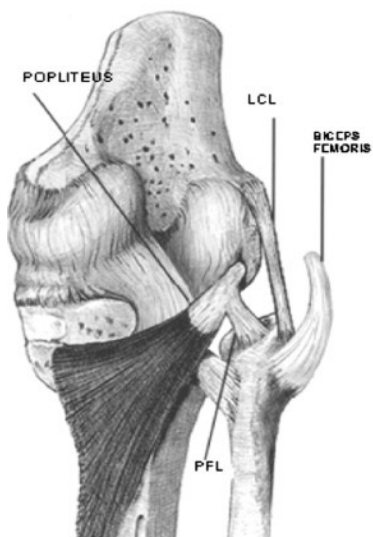
## *Time For Revision: Assess Surgical Technique*



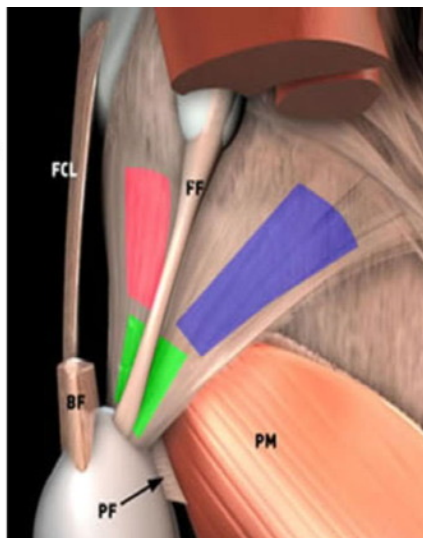
Determine if you need to bone graft and stage!!

## *Time For Revision: Assess Other Pathology*

- Missed PLC injury
- Missed MCL injury
- Meniscus Tear – preserve (transplant)
- OCD injury – aggressively treat with OATS



A



B





## *Time For Revision: Graft Choice*

If skeletally immature:

- Hamstring (contralateral)
  - Quad tendon



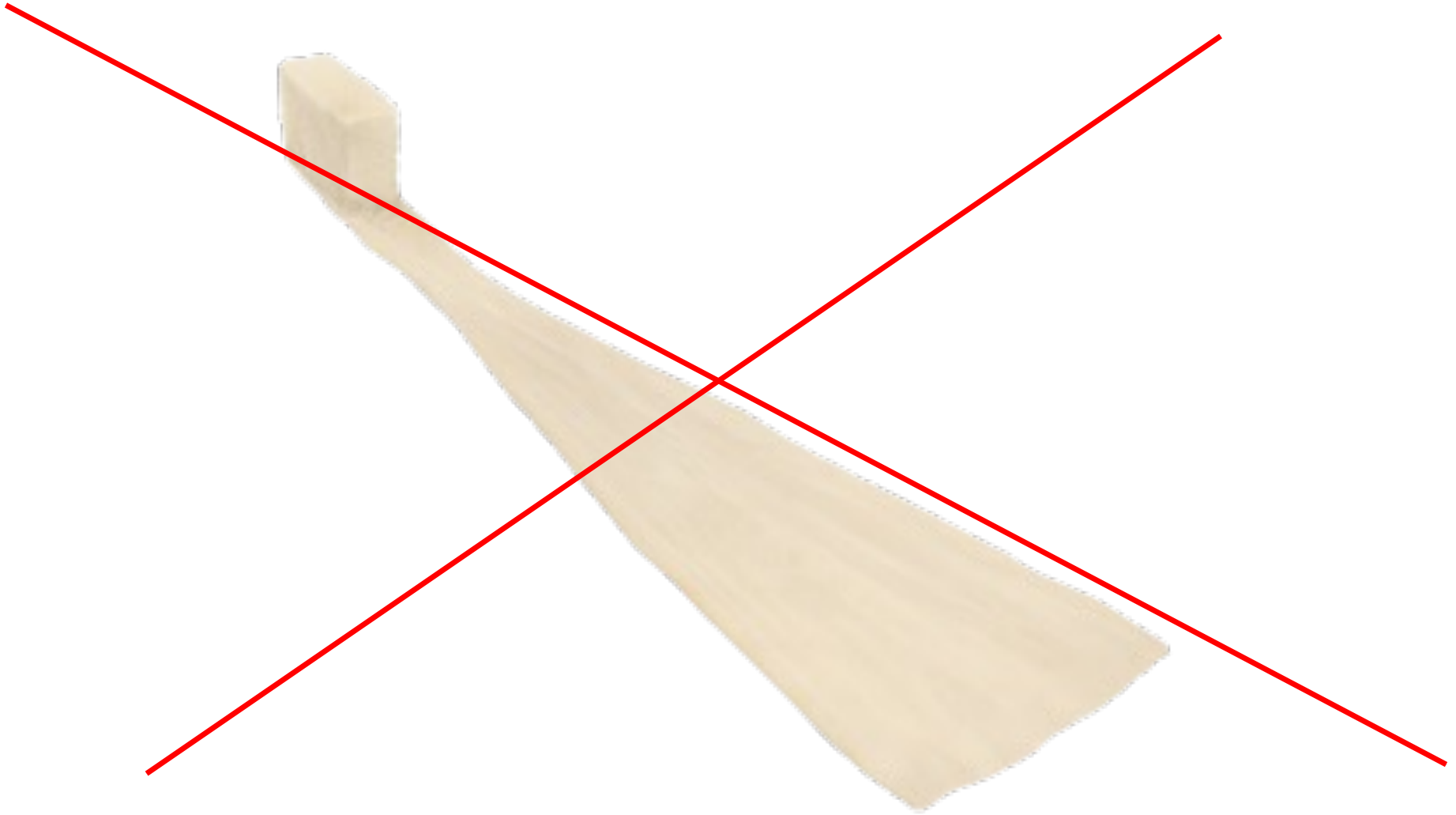
## *Time For Revision: Graft Choice*

If skeletally mature:

- Hamstring (contralateral)
  - Quad tendon
    - BTB



# *Time For Revision: Graft Choice*



## *Time For Revision: Graft Choice*

# **Mechanical and Microstructural Properties of Pediatric Anterior Cruciate Ligaments and Autograft Tendons Used for Reconstruction**

Elaine C. Schmidt,\* MS, Matthew Chin,\* BS, Julien T. Aoyama,<sup>†</sup> BA, Theodore J. Ganley,<sup>†</sup> MD, Kevin G. Shea,<sup>‡</sup> MD, and Michael W. Hast,\*<sup>§</sup> PhD

*Investigation performed at the Biedermann Laboratory for Orthopaedic Research, Department of Orthopaedic Surgery, University of Pennsylvania, Philadelphia, Pennsylvania, USA*

**Methods:** ACLs, patellar tendons, quadriceps tendons, semitendinosus tendons, and iliotibial bands (ITBs) were harvested from 5 fresh-frozen pediatric knee specimens (3 male, 2 female) and subjected to a tensile loading protocol. A subset of contralateral tissues was analyzed using bright-field, polarized light, and transmission electron microscopy.

**Results:** Patellar tendons exhibited values for ultimate stress ( $5.2 \pm 3.1$  MPa), ultimate strain ( $35.3\% \pm 12.5\%$ ), and the Young modulus ( $27.0 \pm 8.8$  MPa) that were most similar to the ACLs ( $5.2 \pm 2.2$  MPa,  $31.4\% \pm 9.9\%$ , and  $23.6 \pm 15.5$  MPa, respectively). Semitendinosus tendons and ITBs were stronger but less compliant than the quadriceps or patellar tendons. ITBs exhibited crimp wavelengths ( $27.0 \pm 2.9$   $\mu\text{m}$ ) and collagen fibril diameters ( $67.5 \pm 19.5$  nm) that were most similar to the ACLs ( $24.4 \pm 3.2$   $\mu\text{m}$  and  $65.3 \pm 19.9$  nm, respectively).

**Conclusion:** The mechanical properties of the patellar tendon were almost identical to those of the ACL. The ITB exhibited increased strength and a similar microstructure to the native ACL. These findings are not entirely congruent with studies examining adult tissues.

## *Time For Revision: Graft Choice*

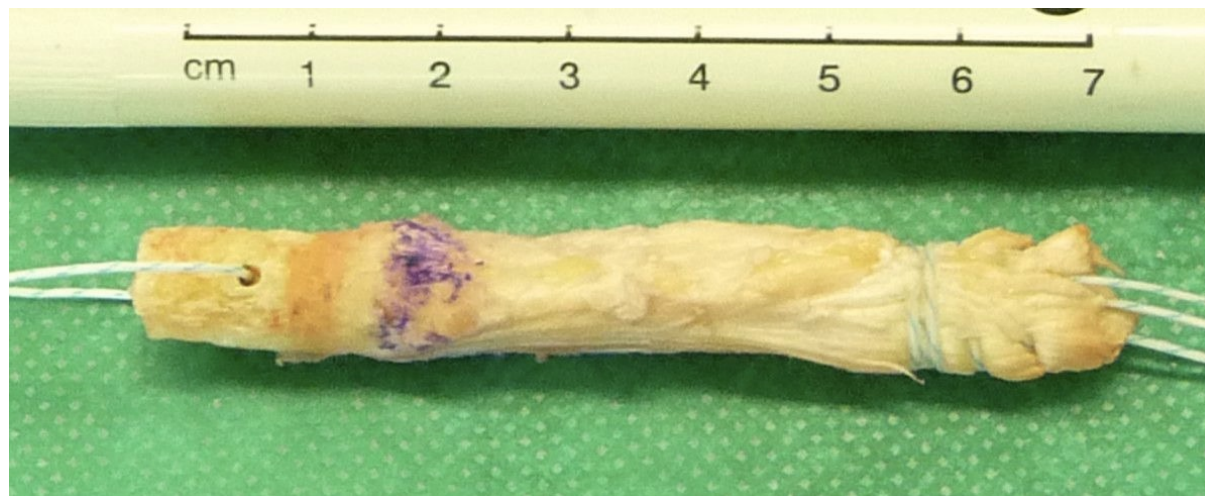
### **Anterior Cruciate Ligament Reconstruction in Pediatric and Adolescent Patients Using Quadriceps Tendon Autograft**

Albright, Jay MD; Lepon, Ariel Kiyomi BA; Mayer, Stephanie MD

Sports Medicine and Arthroscopy Review: December 2016 - Volume 24 - Issue 4 - p 159–169

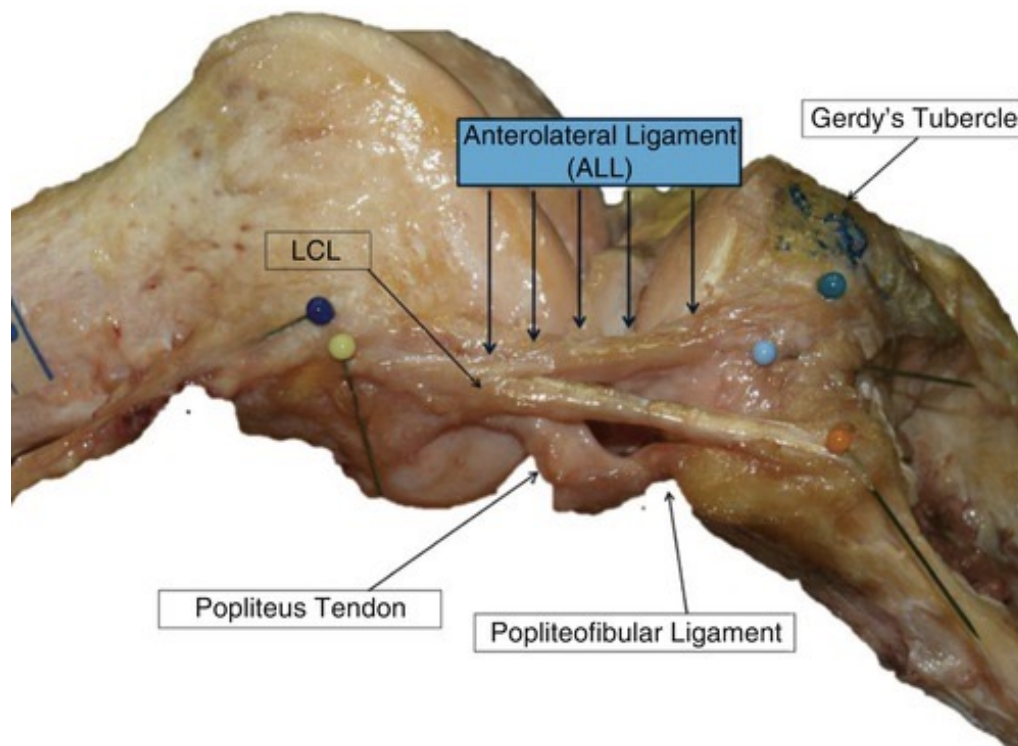
doi: 10.1097/JSA.0000000000000128

Review Articles



## *Time For Revision: ALL / IT Band Tenodesis*

- If ligamentously lax, maybe at primary
  - Definitely with all revision cases

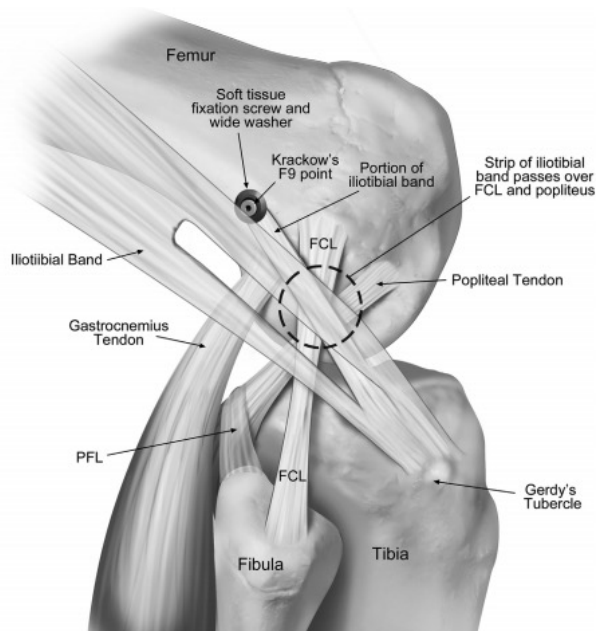


# *Time For Revision: ALL / IT Band Tenodesis*

## Systematic Review

### Biomechanical Results of Lateral Extra-articular Tenodesis Procedures of the Knee: A Systematic Review

Erik L. Slette, B.A., Jacob D. Mikula, B.S., Jason M. Schon, B.S., Daniel C. Marchetti, B.A.,  
Matthew M. Kheir, B.S., Travis Lee Turnbull, Ph.D., and Robert F. LaPrade, M.D., Ph.D.



Maximizes anterior tibial  
translation and rotatory  
stability

# *Time For Revision: ALL / IT Band Tenodesis*

Journal of Pediatric Orthopaedics. Publish Ahead of Print(), OCT 2017

DOI: 10.1097/BPO.0000000000001078, PMID: 29064870

Issn Print: 0271-6798

Publication Date: 2017/10/01



## **Biomechanical Evaluation of Pediatric Anterior Cruciate Ligament (ACL) Reconstruction Techniques With and Without the Anterolateral Ligament (ALL)**

Natasha Trentacosta;James Pace;Melodie Metzger;Max Michalski;Trevor Nelson;Landon Polakof;Bert Mandelbaum;

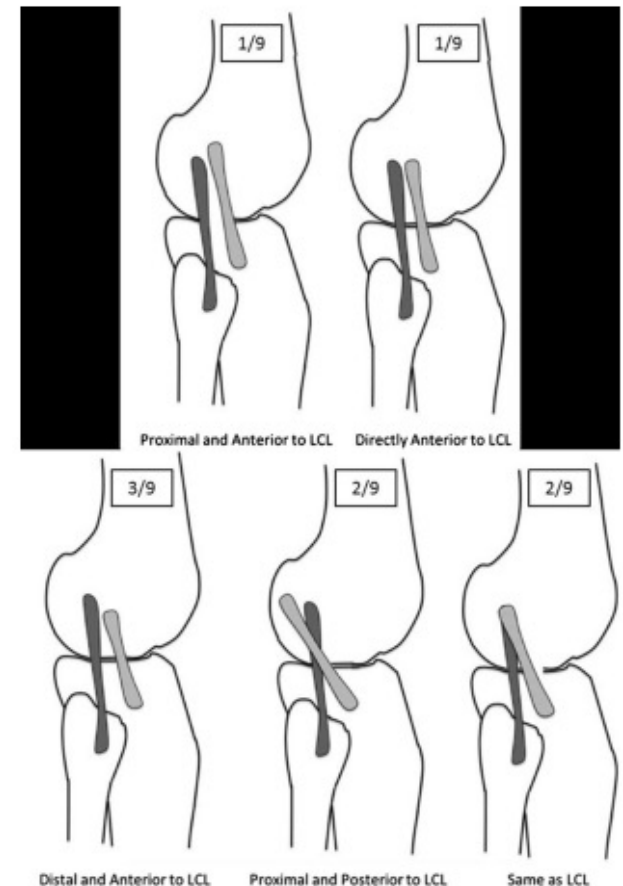
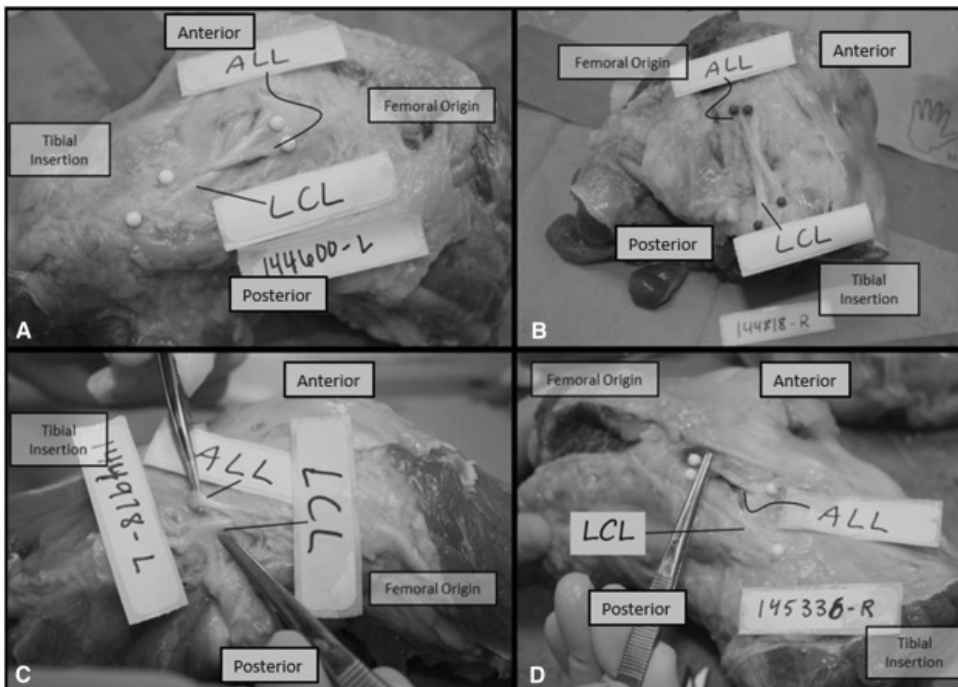
ALL deficiency in the knee  
increased anterior  
displacement and rotational  
moments in the ACL-  
deficient state



# *Time For Revision: ALL / IT Band Tenodesis*

## **Anterolateral Ligament of the Knee Shows Variable Anatomy in Pediatric Specimens**

Kevin G. Shea MD, Matthew D. Milewski MD, Peter C. Cannamela BS,  
Theodore J. Ganley MD, Peter D. Fabricant MD, Elizabeth B. Terhune BS,  
Alexandra C. Styhl BA, Allen F. Anderson MD, John D. Polousky MD



# *Time For Revision: Find Out What Equipment Used*

Don't depend on old operative notes!



## *Post-Op Considerations: Optimizing Revision Success*

- Extended Return to Play Timeline (12 – 18 months)



## *Post-Op Considerations: Optimizing Success*

- Change sport

The American Journal of Sports Medicine

### Revision Anterior Cruciate Ligament Reconstruction Outcomes in Younger Patients: Medial Meniscal Pathology and High Rates of Return to Sport Are Associated With Third ACL Injuries

Kate E. Webster, PhD\*, Julian A. Feller, FRACS, Alexander J. Kimp, DPT, more...

[Show all authors](#) ✓

Younger patients are at significant risk of having multiple ACL injuries. The high rate of third ACL injuries presents a significant issue for future knee health in these young athletes. Medial meniscal pathology **and returning to high-risk sport** are factors that are significantly associated with the high multiple ACL injury rate in the young

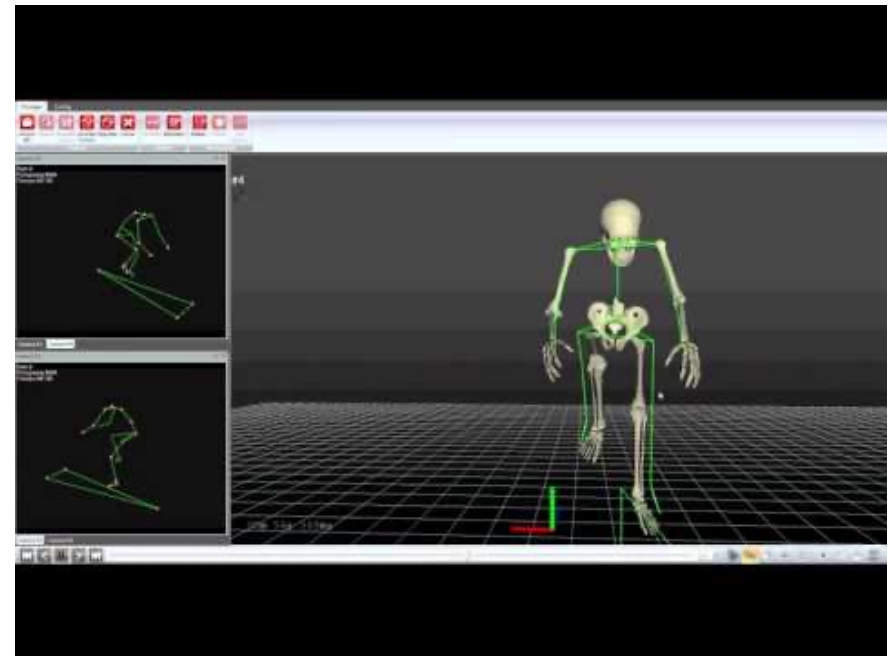
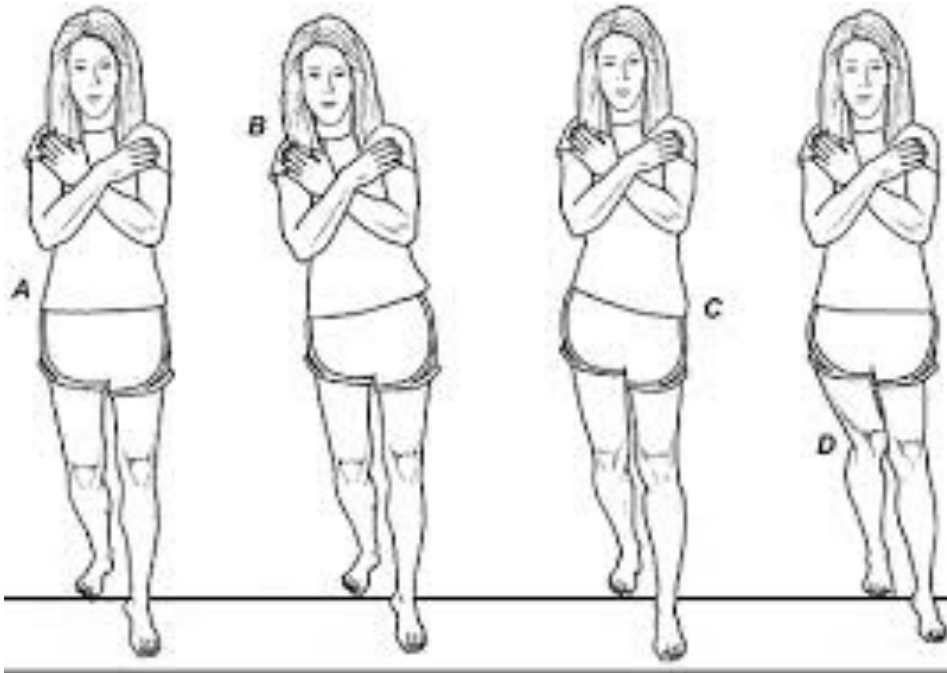
## *Post-Op Considerations: Optimizing Success*

- Address modifiable risk factors



## *Post-Op Considerations: Optimizing Success*

- Address modifiable risk factors



## *Limited Data on How Patients Do*

### **Revision ACL Reconstruction in Children and Adolescents**

Christino, Melissa A., MD<sup>†</sup>; Tepolt, Frances A., MD<sup>†</sup>; Sugimoto, Dai, PhD<sup>†,‡</sup>; Micheli, Lyle J., MD<sup>†,‡,§</sup>; Kocher, Mininder S., MD, MPH<sup>†,‡,§</sup>

Journal of Pediatric Orthopaedics: March 05, 2018 - Volume Publish Ahead of Print - Issue - p

- 90 revision ACL reconstructions
- 20% graft re-tear rate
- 25.5% subsequent surgery
- Pedi-IKDC 79.9, Lysol 84.5, and Tegner 9.0
- 69% returned to sports
- 55.2% returned to the same level of play.

## *Limited Data on How Patients Do*

### **Outcomes and Return to Sport After Revision Anterior Cruciate Ligament Reconstruction in Adolescent Athletes**

Michael Saper,<sup>\*†</sup> DO, ATC, CSCS, Stephanie Pearce,<sup>‡</sup> MD, Joseph Shung,<sup>‡</sup> MD,  
Robert Zondervan,<sup>§</sup> BS, Roger Ostrander,<sup>||</sup> MD, and James R. Andrews,<sup>||</sup> MD

*Investigation performed at the Andrews Institute for Orthopaedics & Sports Medicine,  
Gulf Breeze, Florida, USA*

- 21 revision ACL reconstructions
- 14% graft re-tear rate
- 25.5% subsequent surgery
- IKDC 87.5, Tegner 7.2, Lysholm 93.7
- 68.4% returned to sports



## *Summary*

1. Prep patients for high failure rate
2. Failure rate  $>$  operative growth disturbance rate
3. Late middle school / early high school group most susceptible
4. Post-op high-risk sporting activity is large factor
5. Assess reasons for failure extensively
6. If patient non-compliant, wait on revision
7. Correct growth disturbance / anatomy (valgus / tibial slope)
8. Assess tunnels (anatomic vs. non-anatomic)
9. Bone graft and stage if necessary
10. Choose graft based on skeletal maturity
11. Add ALL/IT band procedures
12. Post-op optimize success (delay RTS, change sports, biomechanics)

# Thank You