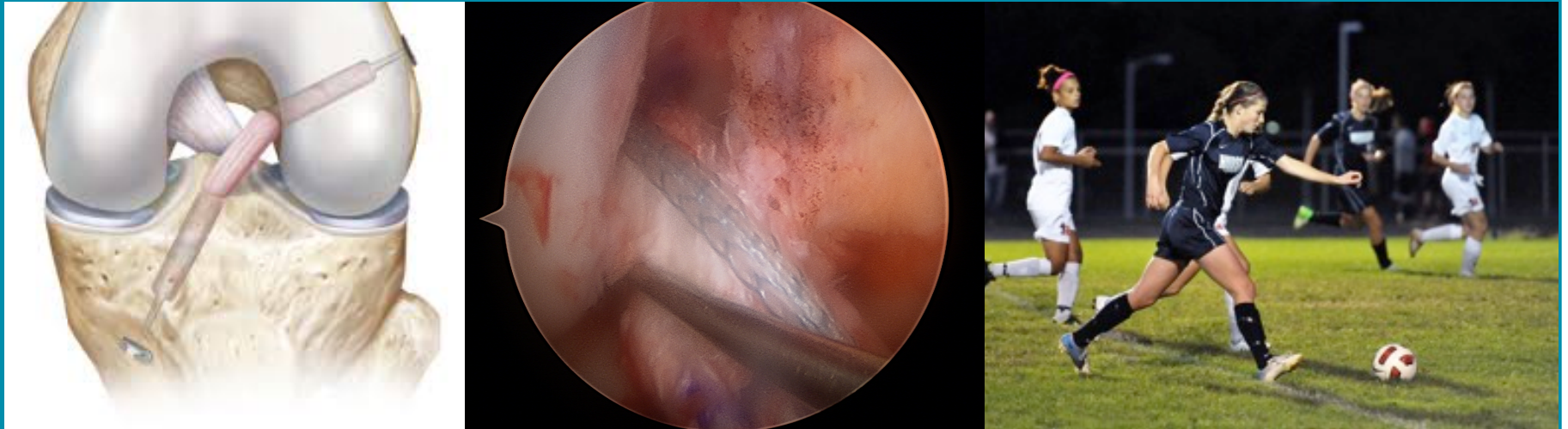


# Quad Tendon ACL Reconstruction in the Adolescent Patient

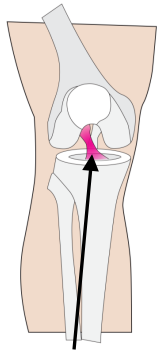


Michael Saper, DO, ATC, CSCS  
Assistant Professor, Orthopedics and Sports Medicine

# Which graft is best in teens?

## Graft Choices for ACL Surgery in Youth

A torn ACL in the knee can be reconstructed using tissue from other parts of the body or from a donor.



Anterior cruciate ligament (ACL) in knee



### What are the options for knee (ACL) reconstruction?

Anterior cruciate ligament (ACL) knee injuries are one of the most common injuries in orthopedics. During surgery, the torn ligament is replaced with a new tissue that will turn into ligament over time. This tissue (called a graft) is removed or "harvested" from another body site and transferred surgically to a new area in the same surgery.

There are two main types of graft tissues that can be used in ACL reconstruction surgery: autograft (from your child) or allograft (from a donor/cadaver). Your surgeon will discuss in detail the pros and cons of each graft during the pre-surgical office visit. At this visit, your surgeon will evaluate your child's specific injury, view diagnostic studies such as x-rays and MRI, and get a complete patient history. You can then talk together to decide which option best fits for your child. Factors include child's age, whether the growth plates are open or closed, any health risks your child may have, and what specific activities they will be returning to, i.e. sport position and participation level. Overall, each of the grafts is just as strong as another if your child follows the specific rehabilitation protocol associated with each graft type.

The different options for graft are discussed below.

### Autografts (tissue from your child)

#### Bone-Patellar Tendon-Bone (BPTB) autograft

The BPTB graft has been historically been considered the gold standard autograft for ACL reconstruction for high-level athletes. In this case, a piece of the patella (knee cap) the patellar tendon, and a piece of the tibia (shin bone) are taken from the injured knee.

- The presence of bone on both sides of the graft aids in quicker incorporation (healing) of the graft.
- Use is limited to an older child whose bones are done growing or close to being done growing.

Complications include patella fracture and rupture of the patellar tendon. This can complicate and prolong recovery. It is also associated with increased pain in the front of the knee, particularly with kneeling.

#### Hamstring tendon autograft

The hamstrings consist of a series of three muscles in the back of the thigh and their tendons. They function to both bend the knee and straighten the hip. The harvest procedure to remove the tendon involves a small incision just below and towards the inside of the injured knee.

- Autograft
  - Hamstring
    - 4 vs 5 vs 6 vs 8 strands?
  - Quad Tendon
    - All soft tissue
    - With bone block
  - Bone-Patellar Tendon-Bone
- Allograft

# Graft failure in kids is a big deal

## **Risk for Revision After Anterior Cruciate Ligament Reconstruction Is Higher Among Adolescents**

### **Results From the Danish Registry of Knee Ligament Reconstruction**

Peter Faunø,<sup>\*†</sup> MD, Lene Rahr-Wagner,<sup>†</sup> MD, and Martin Lind,<sup>†</sup> MD, PhD  
*Investigation performed at Department of Sports Traumatology,  
Aarhus University Hospital, Aarhus, Denmark*

- ~14,000 patients
- Increased risk of graft failure in patients between 13-20y (3.5x that of adults)

# Graft failure in adolescents

[J Am Acad Orthop Surg](#). 2015 Mar;23(3):154-63. doi: 10.5435/JAAOS-D-14-00005. Epub 2015 Feb 9.

## **The Impact of the Multicenter Orthopaedic Outcomes Network (MOON) Research on Anterior Cruciate Ligament Reconstruction and Orthopaedic Practice.**

[Lynch TS](#), [Parker RD](#), [Patel RM](#), [Andrish JT](#); MOON Group, [Spindler KP](#), [Amendola A](#), [Brophy RH](#), [Dunn WR](#), [Flanigan DC](#), [Huston LJ](#), [Jones MH](#), [Kaeding CC](#), [Marx RG](#), [Matava MJ](#), [McCarty EC](#), [Pedroza AD](#), [Reinke EK](#), [Wolf BR](#), [Wright RW](#).

[Am J Sports Med](#). 2015 Jul;43(7):1583-90. doi: 10.1177/0363546515578836. Epub 2015 Apr 21.

## **Risk Factors and Predictors of Subsequent ACL Injury in Either Knee After ACL Reconstruction: Prospective Analysis of 2488 Primary ACL Reconstructions From the MOON Cohort.**

[Kaeding CC](#)<sup>1</sup>, [Pedroza AD](#)<sup>2</sup>, [Reinke EK](#)<sup>3</sup>, [Huston LJ](#)<sup>3</sup>; MOON Consortium, [Spindler KP](#)<sup>4</sup>.

- Graft rupture (13%)
- *Contralateral* ACL injury (14%)
- *Total* re-injury (25%)
  - 1<sup>st</sup> 2 years highest risk
  - 50% decrease for every month after 6 months



# Which graft is best in young patients?

- In general.....
  - **BPTB auto** (↑ risk of growth disturbance if open growth plates, anterior knee pain, cosmesis)
  - **Hamstring auto** (↑ failure)
  - **Allograft** (↑ failure)



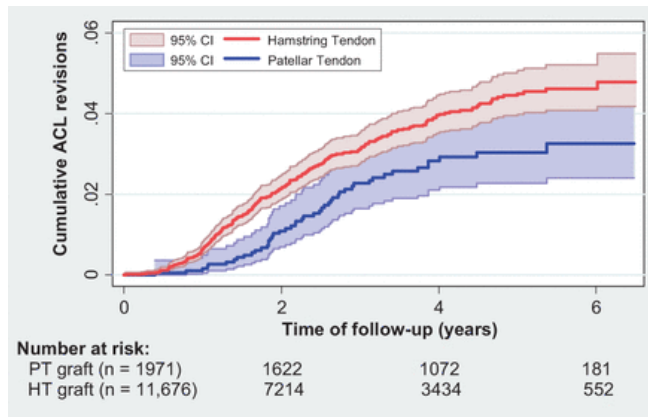
# Should we be using hamstring autograft?

Am J Sports Med. 2014 Feb;42(2):278-84. doi: 10.1177/0363546513509220. Epub 2013 Nov 25.

**Comparison of hamstring tendon and patellar tendon grafts in anterior cruciate ligament reconstruction in a nationwide population-based cohort study: results from the danish registry of knee ligament reconstruction.**

Rahr-Wagner L<sup>1</sup>, Thillemann TM, Pedersen AB, Lind M.

- Hamstring autografts had a 4x greater risk of revision in year one and 1.5x at 5 years compared to BPTB grafts



**LEVEL 2**

# Should we be using hamstring autograft?

Clin Orthop Relat Res (2017) 475:2459–2468  
DOI 10.1007/s11999-017-5278-9

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SYMPOSIUM: IMPROVING CARE FOR PATIENTS WITH ACL INJURIES: A TEAM APPROACH

## **Hamstring Autograft versus Patellar Tendon Autograft for ACL Reconstruction: Is There a Difference in Graft Failure Rate? A Meta-analysis of 47,613 Patients**

Brian T. Samuelsen MD, MBA, Kate E. Webster PhD,  
Nick R. Johnson BS, Timothy E. Hewett PhD, Aaron J. Krych MD

- Hamstring autografts had a higher rate of revision compared to BPTB grafts

**LEVEL 3**

# What about HS grafts in adolescents?

Am J Sports Med. 2016 Feb;44(2):331-6. doi: 10.1177/0363546515614813. Epub 2015 Dec 4.

**Age-Related Risk Factors for Revision Anterior Cruciate Ligament Reconstruction: A Cohort Study of 21,304 Patients From the Kaiser Permanente Anterior Cruciate Ligament Registry.**

Maletis GB<sup>1</sup>, Chen J<sup>2</sup>, Inacio MC<sup>2</sup>, Funahashi TT<sup>3</sup>.

- Patients <21 years old with hamstring autografts had a 1.61 times higher risk of revision than did patients with BPTB autografts

**LEVEL 2**

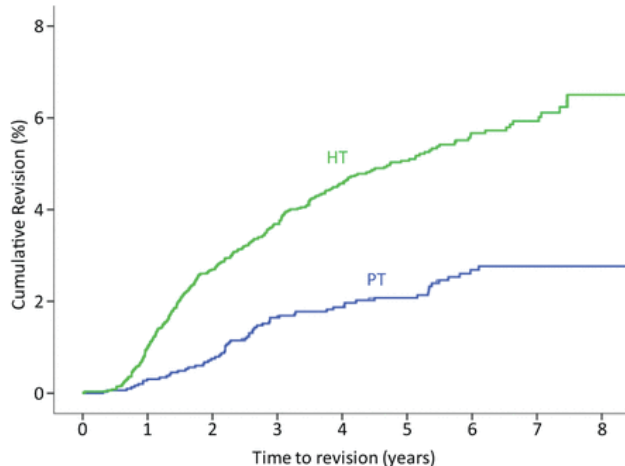
# What about HS grafts in adolescents?

Am J Sports Med. 2014 Feb;42(2):285-91. doi: 10.1177/0363546513511419. Epub 2013 Dec 9.

**Increased risk of revision with hamstring tendon grafts compared with patellar tendon grafts after anterior cruciate ligament reconstruction: a study of 12,643 patients from the Norwegian Cruciate Ligament Registry, 2004-2012.**

Persson A<sup>1</sup>, Fjeldsgaard K, Gjertsen JE, Kjellsen AB, Engebretsen L, Hole RM, Fevang JM.

- ~3x greater risk of revision when using hamstring for patients ages 15-19



**LEVEL 2**

# What about HS grafts in adolescents?

## Anterior Cruciate Ligament Reconstruction in Young Female Athletes

### Patellar Versus Hamstring Tendon Autografts

Hytham S. Salem,\* MD, Vahe Varzhapetyan,\* MD, Nimit Patel,\* MD,  
Christopher C. Dodson,\* MD, Fotios P. Tjoumakaris,\* MD, and Kevin B. Freedman,\*<sup>†</sup> MD  
*Investigation performed at Rothman Institute, Philadelphia, Pennsylvania, USA*

- Girls 15-20 years old: BPTB auto failed at 6.4% compared to HS auto failing at 15.6%
- HS more than twice as likely to fail

**LEVEL 3**



# What about HS grafts in adolescents?

## Risk Factors for Early ACL Reconstruction Failure in Pediatric and Adolescent Patients: A Review of 561 Cases

*Brian Ho, BA,\* Eric W. Edmonds, MD,\*† Henry G. Chambers, MD,\*† Tracey P. Bastrom, MA,†  
and Andrew T. Pennock, MD\*†*

- BPTB auto failed at 5.5% compared to HS auto failing at 12.5%
- HS more than twice as likely to fail

# What about HS grafts in adolescents?

**GRAFT CHOICE FOR ADOLESCENT ATHLETES RETURNING TO HIGH-RISK SPORTS: A MATCHED COHORT ANALYSIS OF PATELLAR TENDON AND HAMSTRING AUTOGRAFTS**

Crystal Perkins, MD<sup>1</sup>, Michael Busch, MD<sup>2</sup>, Melissa Christino, MD<sup>3</sup>, Belinda Schaafsma, BS<sup>4</sup>, S. Clifton Willimon, MD<sup>5</sup>

- BPTB auto failed at 8.5% compared to [HS auto failing at 12.3%](#)
- HS more likely to fail

**LEVEL 3**

# What about HS grafts in adolescents?

## Anterior Cruciate Ligament Reconstruction in Young Female Athletes

### Patellar Versus Hamstring Tendon Autografts

Hytham S. Salem,\* MD, Vahe Varzhapetyan,\* MD, Nimit Patel,\* MD,  
Christopher C. Dodson,\* MD, Fotios P. Tjoumakaris,\* MD, and Kevin B. Freedman,\*<sup>†</sup> MD  
*Investigation performed at Rothman Institute, Philadelphia, Pennsylvania, USA*

Girls 15-20 years old:

Higher incidence of meniscal repair failure with  
HS grafts

# What about HS grafts in adolescents?

ACL Reconstruction In High School and College-aged Athletes: Does Autograft Choice Affect Recurrent ACL Revision Rates?

**Christopher C. Kaeding, MD<sup>1</sup>**, Kurt P. Spindler, MD<sup>2</sup>, Laura J. Huston, MS<sup>3</sup>, Alex Zajichek, MS<sup>4</sup>, MOON Knee Group<sup>3</sup>.

<sup>1</sup>The Ohio State University, Columbus, OH, <sup>2</sup>Cleveland Clinic Sports Health Center, Garfield Hts, OH,

<sup>3</sup>Vanderbilt Orthopaedic Institute, Nashville, TN, <sup>4</sup>Cleveland Clinic, Cleveland, OH

HS grafts more than twice as likely to fail

**LEVEL 3**

# Should we be using hamstring autograft?

## The Effect of Hamstring Tendon Autograft Harvest on the Restoration of Knee Stability in the Setting of Concurrent Anterior Cruciate Ligament and Medial Collateral Ligament Injuries

Thomas J. Kremen,<sup>\*†</sup> MD, Landon S. Polakof,<sup>†</sup> MD, Sean S. Rajaei,<sup>†</sup> MD,  
Trevor J. Nelson,<sup>†‡</sup> BS, and Melodie F. Metzger,<sup>†‡</sup> PhD  
*Investigation performed at the Orthopaedic Biomechanics Laboratory,  
Cedars-Sinai Medical Center, Los Angeles, California, USA*

- HS harvest increases valgus motion

# What about Quadriceps Tendon Autograft?

Am J Sports Med. 2017 May;45(6):1326-1332. doi: 10.1177/0363546516688665. Epub 2017 Mar 8.

## **Is Quadriceps Tendon Autograft a Better Choice Than Hamstring Autograft for Anterior Cruciate Ligament Reconstruction? A Comparative Study With a Mean Follow-up of 3.6 Years.**

Cavaignac E<sup>1,2</sup>, Coulin B<sup>1,2</sup>, Tscholl P<sup>1,2</sup>, Nik Mohd Fatmy N<sup>1,2</sup>, Duthon V<sup>1,2</sup>, Menetrey J<sup>1,2</sup>.

- Quadriceps tendon autograft leads to equal or better functional outcomes than does the use of a hamstring autograft
- No affect on morbidity

**LEVEL 3**



# Quadriceps Tendon Autograft

*Arthroscopy*. 2018 May;34(5):1690-1698. doi: 10.1016/j.arthro.2018.01.046. Epub 2018 Apr 5.

## **Quadriceps Tendon Autograft in Anterior Cruciate Ligament Reconstruction: A Systematic Review.**

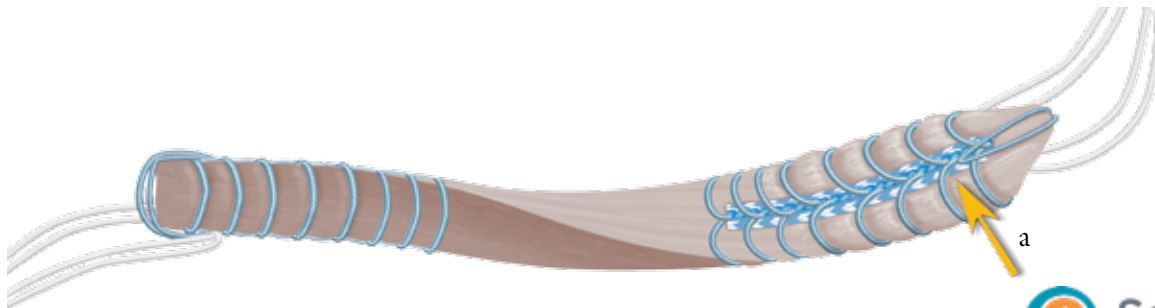
Hurley ET<sup>1</sup>, Calvo-Gurry M<sup>2</sup>, Withers D<sup>3</sup>, Farrington SK<sup>2</sup>, Moran R<sup>3</sup>, Moran CJ<sup>4</sup>.

© Author information

*Arthroscopy*. 2018 May;34(5):1699-1707. doi: 10.1016/j.arthro.2018.01.047. Epub 2018 Apr 5.

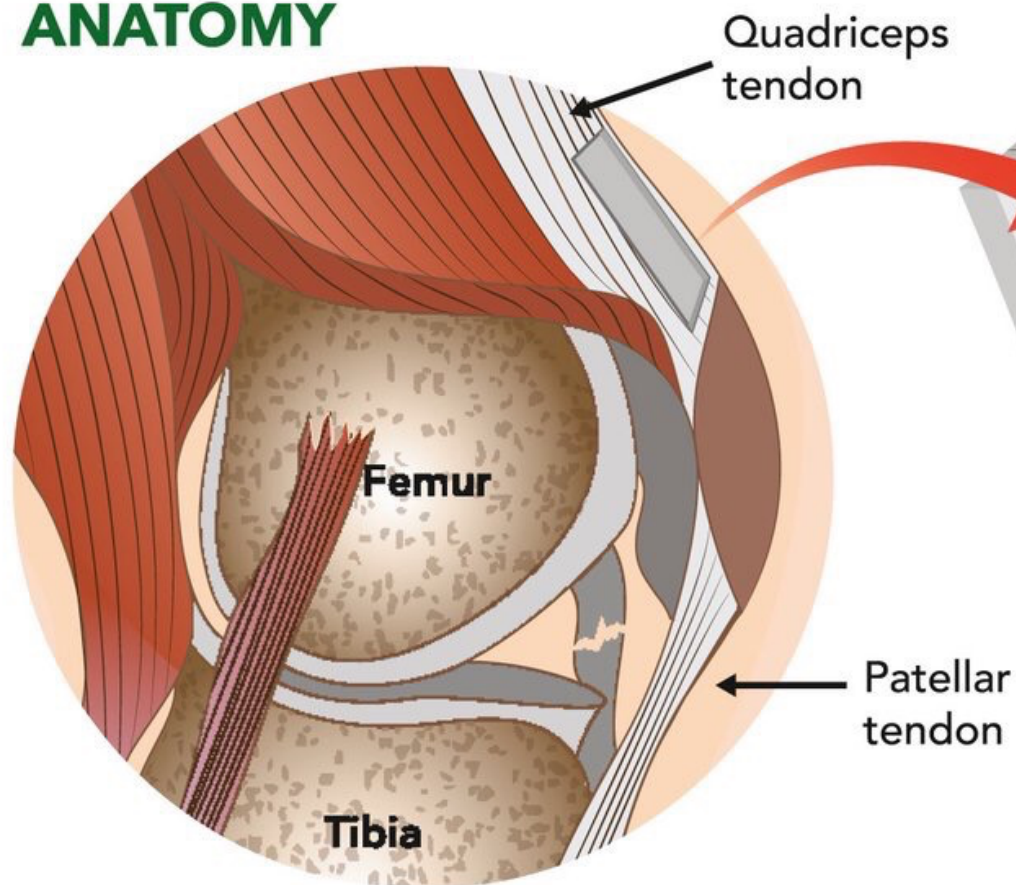
## **Quadriceps Tendon Autograft for Primary Anterior Cruciate Ligament Reconstruction: A Systematic Review of Comparative Studies With Minimum 2-Year Follow-Up.**

Belk JW<sup>1</sup>, Kraeutler MJ<sup>2</sup>, Marshall HA<sup>1</sup>, Goodrich JA<sup>3</sup>, McCarty EC<sup>1</sup>.



# Quadriceps Tendon Autograft

## ANATOMY



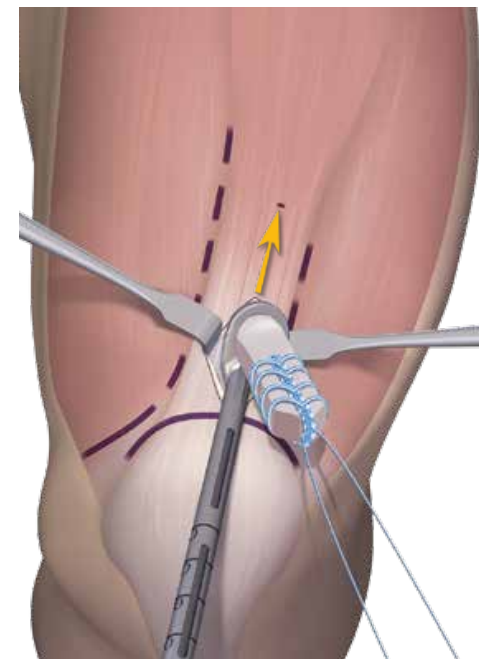
## Quadriceps Tendon Graft

## vs. Patellar Tendon

- 88% > intra-articular graft volume
- 20% > collagen
- 72% > load to failure
- 80% > post harvest strength of residual quadriceps tendon

# Quadriceps Tendon Autograft

- >8.5 mm grafts easily obtained
- Minimal acute postoperative pain
- Less kneeling pain, less graft site pain
- Does NOT affect strength
- Similar stability, patient satisfaction, and patient-reported outcomes to other grafts
- ? Lower failure rates compared to HS



- Failure rate (15-20 years of age) = 8%

# My Preferred Technique

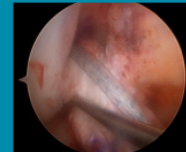
## Technical Note

### Quadriceps Tendon Autograft Anterior Cruciate Ligament Reconstruction With Independent Suture Tape Reinforcement



Michael G. Saper, D.O., A.T.C., C.S.C.S.

### Quadriceps Tendon Autograft ACL Reconstruction with Independent Suture Tape Reinforcement

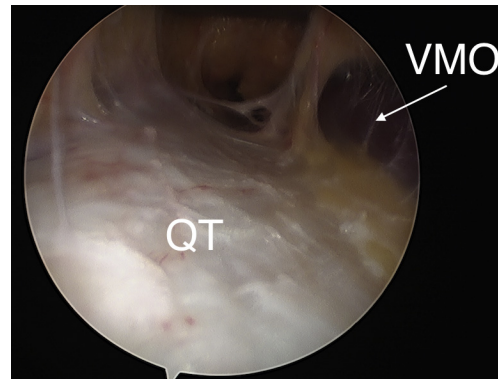
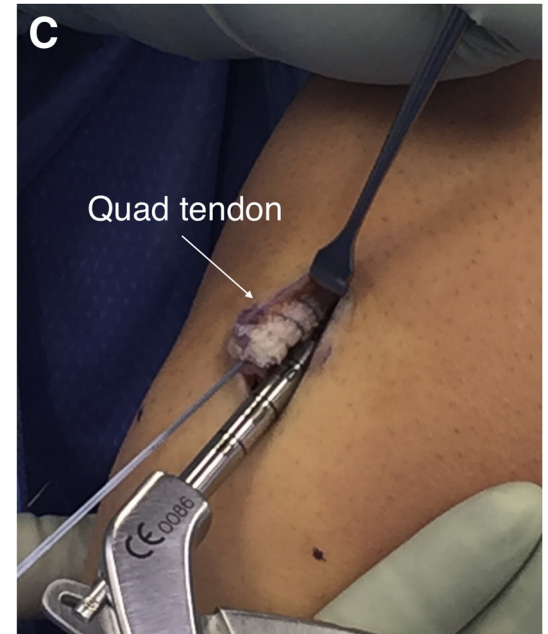
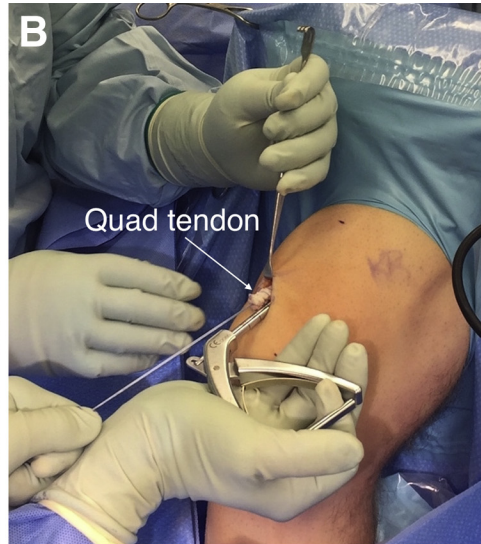
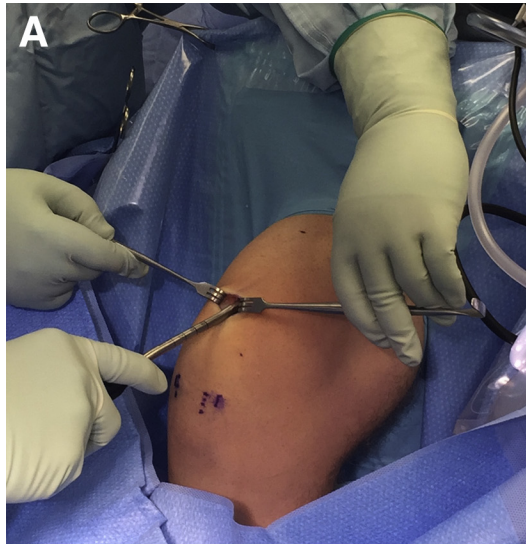


As presented by:  
Michael Saper, DO, ATC, CSCS  
Seattle, WA





# My Preferred Technique



# Does it matter if you take the whole quad tendon?

*Knee Surg Sports Traumatol Arthrosc.* 2018 Jul 4. doi: 10.1007/s00167-018-5042-z. [Epub ahead of print]

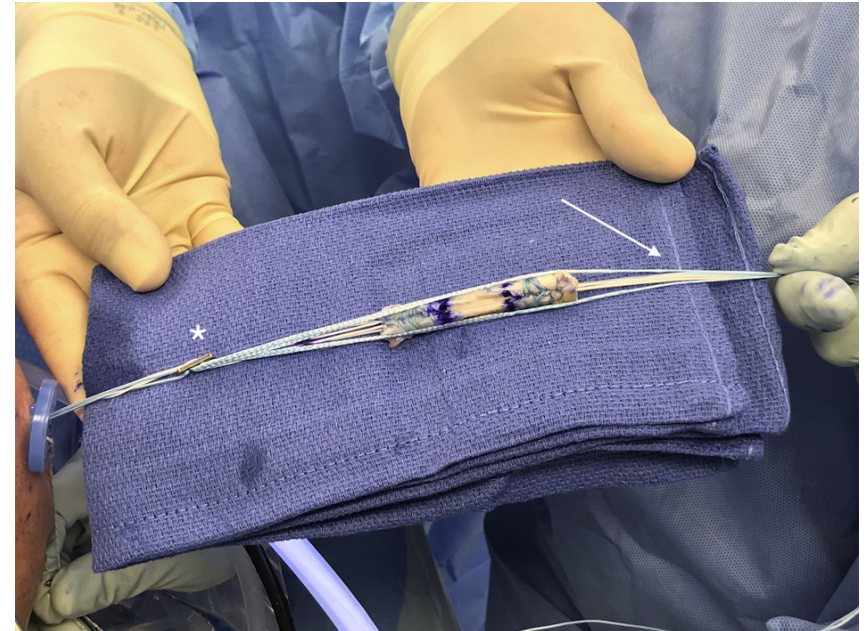
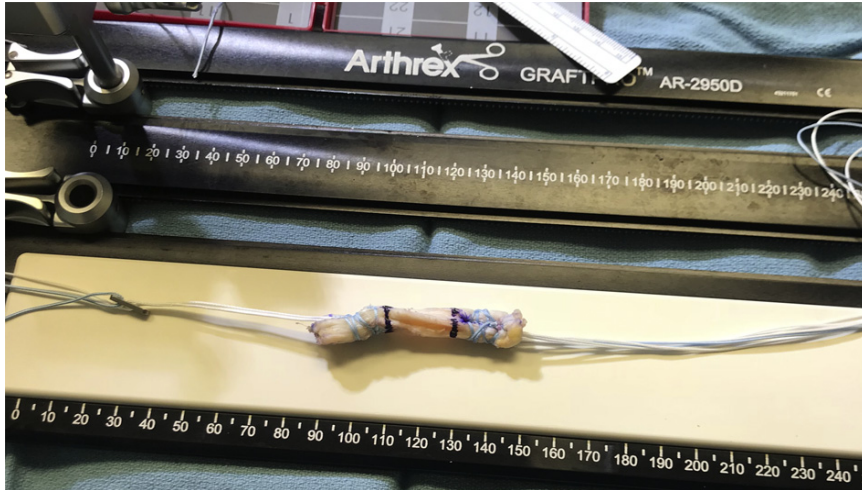
**No difference between full thickness and partial thickness quadriceps tendon autografts in anterior cruciate ligament reconstruction: a systematic review.**

Kanakamedala AC<sup>1</sup>, de Sa D<sup>1</sup>, Obioha OA<sup>1</sup>, Arakgi ME<sup>2</sup>, Schmidt PB<sup>3</sup>, Lesniak BP<sup>1</sup>, Musahl V<sup>4</sup>.

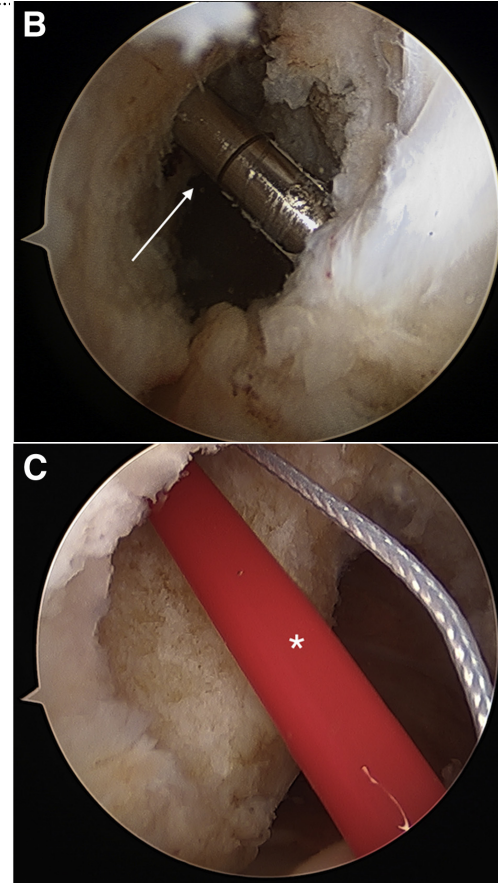
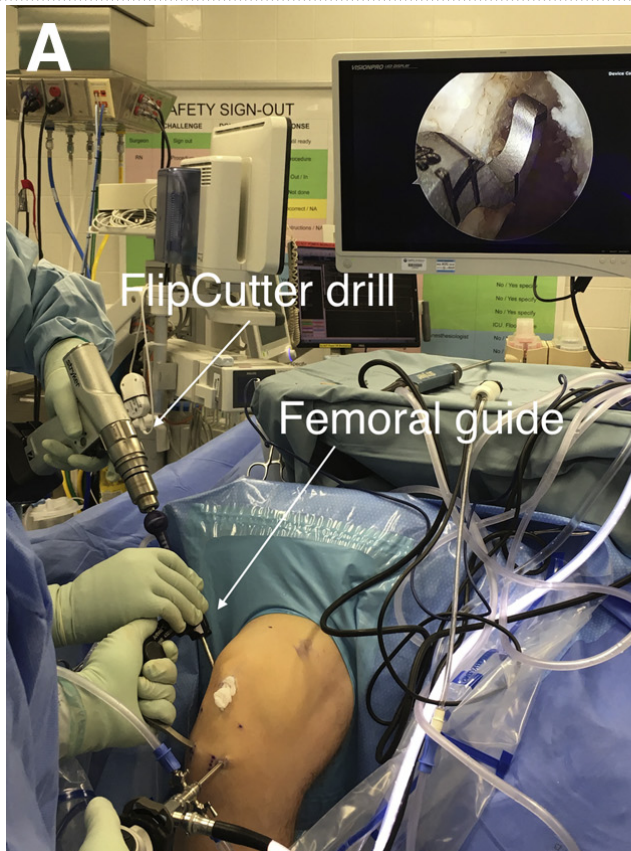
- No difference in outcomes or complications between full-thickness and partial thickness



# My Preferred Technique

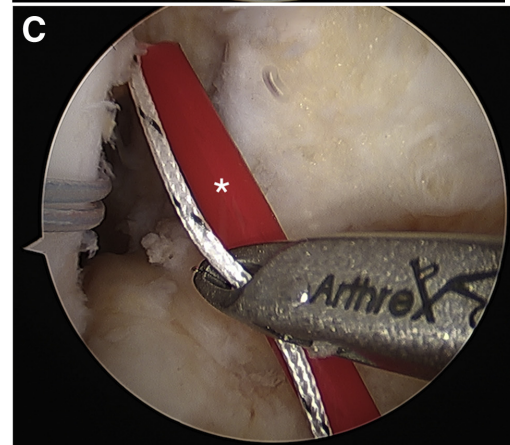
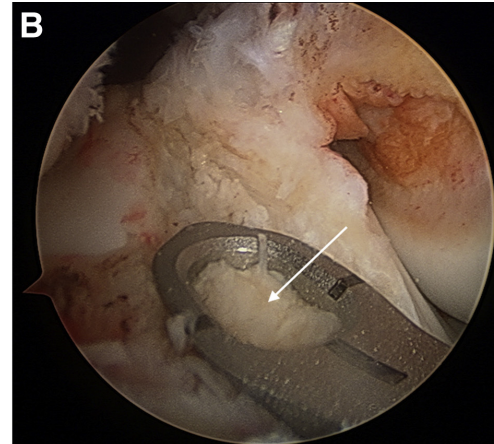


# My Preferred Technique

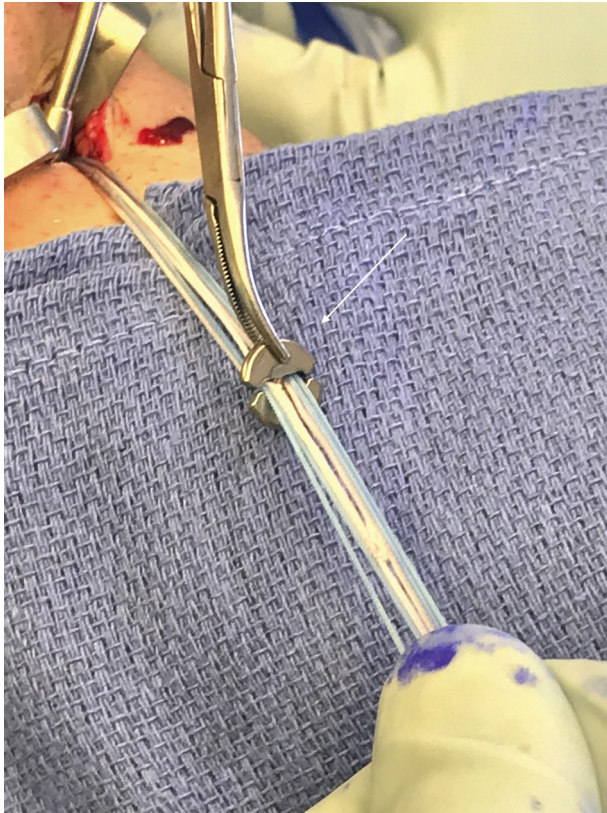




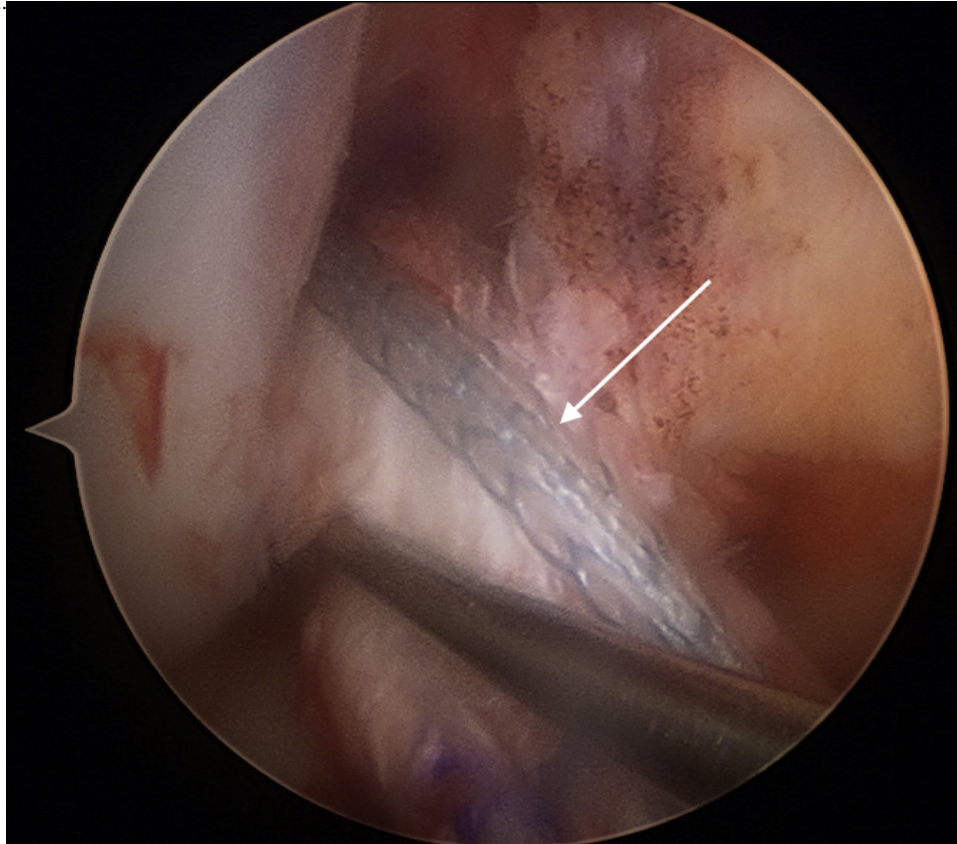
# My Preferred Technique



# My Preferred Technique



# My Preferred Technique





# Suture Tape Reinforcement

## Independent Suture Tape Reinforcement of Small and Standard Diameter Grafts for Anterior Cruciate Ligament Reconstruction: A Biomechanical Full Construct Model

Samuel Bachmaier, M.Sc., Patrick A. Smith, M.D., Jordan Bley, B.A., and Coen A. Wijdicks, Ph.D.

- Significantly reduced elongation and higher ultimate failure load without stress-shielding



# 9-month Outcomes and RTS Results

## 9-month data

Pedi-IKDC 92.1

Lysholm 97.2

Tegner 7.1

Isometric (Q) 93.1%

Isometric (HS) 98.2%

Isokinetic 60 deg (Q) 82.8%

Isokinetic 60 deg (HS) 104.4%

Isokinetic 180 deg (Q) 84.6%

Isokinetic 180 deg (HS) 94.7%

## Lower Quarter Y Balance Test

LQYBT comp (surg) 106.5

LQYBT comp (non-surg) 105.3

LQYBT ant reach 2.3cm

## Hop Tests

SLH 95.1%

TLH 96.6%

Crossover hop 97.3%

Timed hop 98.4%



# Strength recovery

Knee. 2018 Aug;25(4):704-714. doi: 10.1016/j.knee.2018.03.011.

**Strength recovery after anterior cruciate ligament reconstruction with quadriceps tendon versus hamstring tendon autografts in soccer players: A randomized controlled trial.**

Martin-Alguacil JL<sup>1</sup>, Arroyo-Morales M<sup>2</sup>, Martín-Gomez JL<sup>3</sup>, Monje-Cabrera IM<sup>3</sup>, Abellán-Guillén JF<sup>4</sup>, Esparza-Ros F<sup>5</sup>, Lozano ML<sup>6</sup>, Cantarero-Villanueva I<sup>7</sup>.

- Quad tendon has *better isokinetic H/Q ratio* compared to HS

**LEVEL 1**

# Thank you for your attention!



Contact:

[www.sapersportsmed.com](http://www.sapersportsmed.com)

@DrMichaelSaper

