

# ACL Graft Choices

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Evidence-Based Medicine  
Orthopedic Sports Medicine

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## Introductions

- ◆ Indications → Young
  - High demand athletics
  - Symptoms of instability

Clinical Sports Medicine by Johnson & Mair 1st Ed 2006  
OKU 10

## Introductions

- ◆ Indications
- ◆ Single bundle / double bundle → **Controversial**

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## Introductions

- ◆ Indications
- ◆ Single bundle / double bundle
- ◆ Anatomy → **Graft position**  
Navigation

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## Introductions


- ◆ Indications
- ◆ Single bundle / double bundle
- ◆ Anatomy
- ◆ Graft
  - autograft
    - BPTB
    - Hamstring
    - Achillis
    - Tibialis A/P
  - allograft

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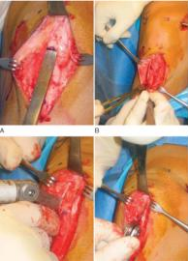
## OKU 10 about graft choices

- ◆ Variety of outcomes
- ◆ Some showing similar failure rates
- ◆ Some Higher percentages of failure in allograft group
- ◆ Unclear which graft is best
- ◆ Autograft choices do not consistently favor one over another
- ◆ 4-strand hamstring vs. PTBT: similar function outcome

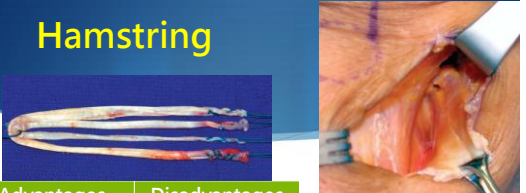
## BPTB



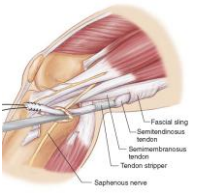
Advantages	Disadvantages
Rigid fixation	Anterior knee pain
Bone-to-bone healing	Extensor mechanism change
Initial graft strength	Loss of quadriceps strength
Durable stability	Patellar fracture




## Hamstring




Advantages	Disadvantages
Highest strength and stiffness	Fixation
Like native ACL	Tunnel widening
Less morbidity	Unpredictable size
Spare physis	Hamstring weak



## Quadriceps



Advantages	Disadvantages
Similar strength	Decrease of up to 20% of quadriceps strength
Less knee pain	Extensor mechanism change
Kneeling	Risk of entering the suprapatellar pouch
For revision	Patellar fracture

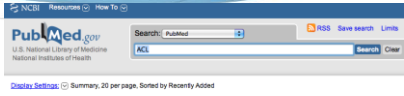


## Graft strength

Graft	Ultimate Strength (N)	Stiffness (N/mm)	Cross-sectional area (mm <sup>2</sup> )
Intact ACL	2160	242	44
BTB	2376	812	35
Quadruple hamstring	4108	776	53
Quad tendon	2352	463	62
Anterior tibialis	3412	344	38
Posterior tibialis	3391	302	48


ACL, anterior cruciate ligament; BTB, bone-patellar tendon-bone; N, Newtons.  
 (Adapted from Miller SL, Gladstone JN. Graft selection in anterior cruciate ligament reconstruction. Orthop Clin North Am 2002;33:675-683.)

## Analyzing results




- ◆ Difficult
- ◆ PubMed
- ACL: 7138
- ACL Reconstruction: 3044
- ACL Graft: 1495
- ACL Meta-Analysis: 43

## Autograft Results



Hamstring

g



BPTB

# Early study 2001

## Patellar Versus Hamstring Tendons in Anterior Cruciate Ligament Reconstruction: A Meta-analysis

Michael Yunes, M.D., John C. Richmond, M.D., Eric A. Engels, M.D., M.P.H., and Leo A. Pinczewski, F.R.A.C.S.

- 4 studies: 1980 to 1997
- Conclusion
  - Patellar tendon: higher post-operative activity levels
  - Patellar tendon: greater static stability

Patellar Versus Hamstring Tendons in Anterior Cruciate Ligament Reconstruction: A Meta-analysis

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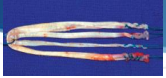
2001

*Am J Sports Med.* 2003 Jan-Feb;31(1):12-11.  
**Arthroscopic anterior cruciate ligament reconstruction: a metaanalysis comparing patellar tendon and hamstring tendon autografts.**  
 Freedman KB, O'Amara MJ, Hedeff DD, Katz A, Bach BR, Jr.  
 Sports Medicine Section, Department of Orthopaedic Surgery, Rush Medical College, Rush-Presbyterian-St.Luke's Medical Center, Chicago, Illinois, USA. 2003

*Am J Sports Med.* 2004 Dec;32(12):1965-66.  
**Anterior cruciate ligament reconstruction autograft choice: bone-tendon-bone versus hamstring: does it really matter? A systematic review.**  
 Saitoh M, Naito J, Fumimasa SB, Matsuda LC, Oka SS, Hamai H, et al.  
 Vanderbilt University Medical Center, Nashville, Tennessee, USA. autograft@questedista.com 2004

*Orthopedics.* 2005 Jul;21(7):791-803.  
**Reconstruction of the anterior cruciate ligament: meta-analysis of patellar tendon versus hamstring tendon autograft.**  
 Goldblatt JF, Fitzsimmons SE, Balk E, Richmond JC.  
 Department of Orthopaedics, University of Rochester, Rochester, New York 14642, USA. jgoldblatt@yahoo.com 2005

# Meta-Analysis Conclusions



Hamstring

- ◆ Lower rate of anterior knee pain
- ◆ Less extension loss
- ◆ Less need for manipulation



Patellar tendon

- ◆ Better stability
- ◆ Lower graft failure
- ◆ More likely to have normal Lachman, KT-1000, Pivot

# Contralateral Autograft

*Am J Sports Med.* 2000 Sep-Oct;28(5):651-8.  
**Primary anterior cruciate ligament reconstruction using the contralateral autogenous patellar tendon.**  
 Shelbourne KD, Urich SE.  
 Methodist Sports Medicine Center, Indianapolis, Indiana, USA.

- ◆ Faster return to unrestricted sports
  - 4.1months vs. 5.5 months
- ◆ Same stability as ipsilateral
- ◆ Better early strength

# Contralateral Autograft

*Am J Sports Med.* 2009 Jan;33(1):85-93.  
**Donor site morbidity and return to the preinjury activity level after anterior cruciate ligament reconstruction using ipsilateral and contralateral patellar tendon autograft: a retrospective, nonrandomized study.**  
 Mastroianni DS, Sancher J, Stebbins R, Passateri HS.  
 ATOS Clinic, Center for Knee and Foot Surgery, Sport Surgery, Heidelberg, Germany.

- ◆ Similar ipsilateral results
- ◆ Donor site morbidity transfer to other knee
- ◆ Not statistically faster return to sports: 7.4 months vs. 7.8 months

# Allograft indication

- ◆ Revision surgery
- ◆ Multiple ligament: PCL, PLC, collateral ligament
- ◆ Primary ACL reconstruction in the older patient
- ◆ Patient preference (cosmetics, decreased postoperative pain)

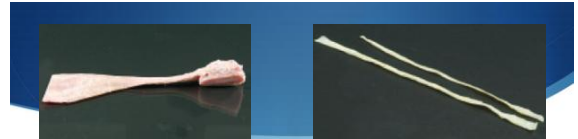
# Allografts

## Advantages

- ◆ Quicker surgical techniques
- ◆ No morbidity associated with graft harvest
- ◆ Cosmetics

## Disadvantages

- ◆ Small risk of viral transmission (1/1.6 million)
- ◆ Costs
- ◆ Slower graft incorporation
- ◆ Higher rate of graft failure



Achilles tendon  
\$ 1550  
NTD 150000

Semi-T / Gracillis  
\$ 1250  
NTD 90000



BPTB  
\$ 2500  
NTD 270000



Tibialis Anterior  
\$ 1500  
NTD 90000

# Sterilization of Allograft

- ◆ Chemical: Ethylene Oxide
- ◆ Radiation: <2.5 Mrad vs. ≥4 Mrad

Knee Surg Sports Traumatol Arthrosc. 2009 May;17(5):464-74. Epub 2009 Jan 13.  
**Anterior cruciate ligament reconstruction with BPTB allograft, irradiated versus non-irradiated allograft: a prospective randomized clinical study.**  
 Sun K, Tian S, Zhang J, Xia G, Zhang C, Yu T.  
 Department of Orthopaedics, The Affiliated Hospital of Medical College, Qingdao University, Qingdao, Shandong, China. sunkang\_qy@yahoo.com.cn

- ◆ Autograft failure: 6.1%
- ◆ Allograft non-irradiated failure: 8.8%
- ◆ Allograft irradiated (2.5 Mrad) failure: 34.4%

Knee Surg Sports Traumatol Arthrosc. 2008 Sep;14(9):885-90. Epub 2008 Feb 25.  
**Does irradiation affect the clinical outcome of patellar tendon allograft ACL reconstruction?**  
 Shin JS, Kwanag JJ, Chhabra A, Fu FH, Isamail CD.  
 Division of Sports Medicine, Department of Orthopaedic Surgery, UPMC Center for Sports Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA 15263, USA.

- 2.5 Mrad
- Irradiated allograft BPTB had similar clinical outcomes compared to those reconstructed with autograft BPTB

# Meta-analysis and systemic reviews Autograft vs. Allograft

Knee Surg Sports Traumatol Arthrosc. 2007 Jul;15(7):851-6. Epub 2007 Apr 17.  
**A meta-analysis of stability of autografts compared to allografts after anterior cruciate ligament reconstruction.**  
 Prodromou C, Joyce B, Shi K.  
 Illinois Sports Medicine and Orthopaedic Centers, Rush University Medical Center, 1720 N. Milwaukee, Glenview, IL 60025, USA. research@ismoc.net

2007

Arthroscopy. 2008 Mar;24(3):292-4. Epub 2007 Nov 5.  
**A meta-analysis of patellar tendon autograft versus patellar tendon allograft in anterior cruciate ligament reconstruction.**  
 North AJ, Jackson JD, Hsueh TL, Dahm DL.  
 Department of Orthopaedic Surgery, Mayo Clinic, Rochester, Minnesota 55905, USA.

2008

J Bone Joint Surg Am. 2009 Sep;91(9):2242-50.  
**A systematic review of the clinical outcomes of anterior cruciate ligament reconstruction with autograft compared with allograft.**  
 Carey JJ, Durrant JH, Durrant JH, Durrant JH, Durrant JH, Durrant JH.  
 Department of Orthopaedics and Rehabilitation, Vanderbilt University Medical Center, Nashville, TN 37232, USA. james.carey@vanderbilt.edu

2009

# Meta-analysis Autograft vs. Allograft

- ◆ Autograft had better stability and lower failure rates
- ◆ Exclusion of chemical treatment or irradiated grafts: no difference

## Study design

### The American Journal of Sports Medicine

**Does the Graft Source Really Matter in the Outcome of Patients Undergoing Anterior Cruciate Ligament Reconstruction? A Evaluation of Autograft Versus Allograft Reconstruction Results. A Systematic Review**  
 Timothy E. Foster, Brian L. Wahl, Scott Fagan, Lorenzo Stearns and Elizabeth Krul Kaye  
 DOI: 10.1177/0363546510382838

The online version of this article can be found at  
<http://ajs.sagepub.com/journalsPermissions.nav>

- ◆ Meta-analysis to compare the outcome of autograft tissue versus allograft tissue in ACL reconstruction
- ◆ Ovid MEDLINE and PubMed for ‘ (anterior cruciate ligament reconstruction AND allograft) OR (anterior cruciate ligament AND autograft). ’

## Inclusion Criteria

- ◆ English-language articles
- ◆ Prospectively collected data
- ◆ Arthroscopic intra-articular ACL reconstruction procedures
- ◆ Average follow-up of a minimum of 2 years
- ◆ Minimum follow-up of 70% of the patients within the study
- ◆ Minimum patient age of 14 years
- ◆ Follow-up evaluation of at least 1 of the following primary outcome measures: instrumented side-to-side joint laxity, pivot shift, final International Knee Documentation Committee (IKDC) score, and Lysholm scores

## Exclusion Criteria

- ◆ Retrospectively collected data
- ◆ Less than average 2-year follow-up
- ◆ Extra-articular procedure
- ◆ Graft augmentation
- ◆ Autograft and allograft sources other than hamstring
- ◆ or patellar tendon grafts
- ◆ Open or mini-open arthrotomy included in the surgical procedure
- ◆ Less than 70% participant follow-up
- ◆ Use of high-dose radiation in allografts
- ◆ Use of ethylene glycol in allografts
- ◆ Concomitant posterior cruciate ligament injury
- ◆ Previous ACL reconstruction
- ◆ Concomitant collateral ligament injury greater than grade II

## Conclusions

- ◆ The outcome from ACL surgery of each individual graft source that was studied is relatively equivalent
- ◆ There are some differences between the grafts
  - Allograft tissue and autograft BTB grafts having a better KT-1000 arthrometer score compared with autograft hamstrings
  - Allograft tissue and autograft hamstring had better IKDC results when compared with autograft BTB

## Graft choices consideration

- ◆ Patient dependent
  - Lifestyle
  - Sports activity
  - Age
- ◆ Technique dependent
  - Single / double bundle
- ◆ Pre-existing comorbidities
- ◆ Costs
- ◆ Availability
- ◆ Biocompatibility
- ◆ Safety
- ◆ Donor site morbidity

Clinical Sports Medicine by Johnson & Mair 1st Ed.2006

## Graft choice

Knee, 2011 Jan 4; (Epub ahead of print)

### Patients' attitudes and factors in their selection of grafts for anterior cruciate ligament reconstruction.

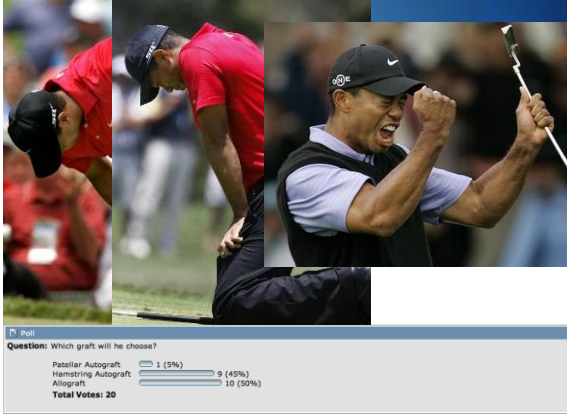
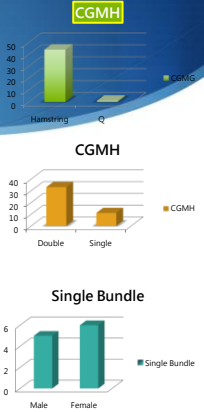
Cheung SC, Allen CB, Gallo RA, Ma CB, Feeley BT.

Department of Orthopaedic Surgery, Sports Medicine and Shoulder Surgery, University of California, San Francisco, United States.

- ◆ Primary factor: surgeon recommendation
- ◆ Older patients: concerned with autograft donor site morbidity
- ◆ Patients with a higher level of education: less averse to allograft

# CGMH Experience

- ◆ 2010/07 to 2010/12
- ◆ 45 ACL reconstruction
- ◆ 44 ipsilateral Hamstring tendon
- ◆ 1 ipsilateral Q-tendon
- ◆ Double bundle : Single bundle: 3:1



# Conclusions

- ◆ Variety of grafts
- ◆ Advantages and disadvantages
- ◆ Highly individualized patient' s condition
- ◆ Doctor' s preference
- ◆ Successful ACL reconstruction: multifactorial