



11th

Advanced Course
on Knee Surgery

ACL-R: Is DB still valid?



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Disclosures



- No relevant disclosures

An aerial photograph of Pittsburgh, Pennsylvania, featuring a red trolley on a track in the foreground, a frozen river with ice floes in the middle ground, and the city skyline with various skyscrapers in the background. The word "YES" is overlaid in large white letters across the center of the image.

YES

10 Tips to make it work

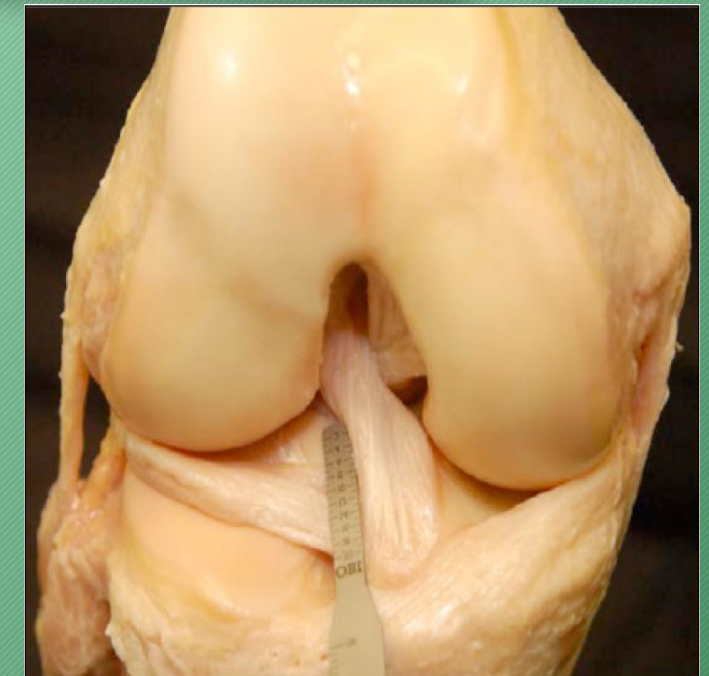
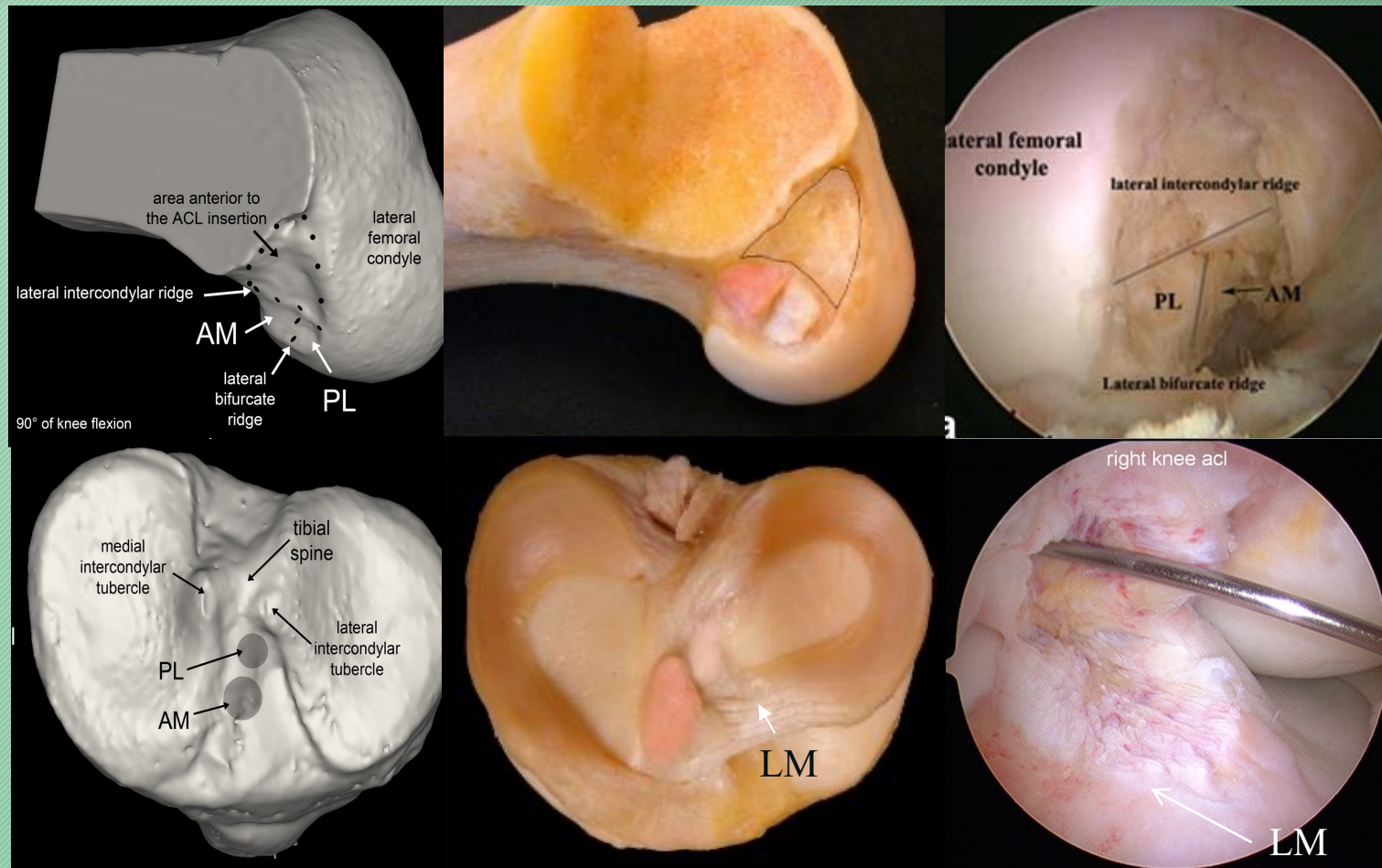
1. Anatomic ACL
2. Individualized
3. Top evaluation (KSSTA 04/2012)
4. Graft choice
5. Timing (...is everything)
6. Location (location, location)
7. Meniscus (don't be a dinosaur)
8. Rehabilitation
9. The comeback
10. No complications!



Musahl, Karlsson NEJM 2019



1. Anatomic ACL



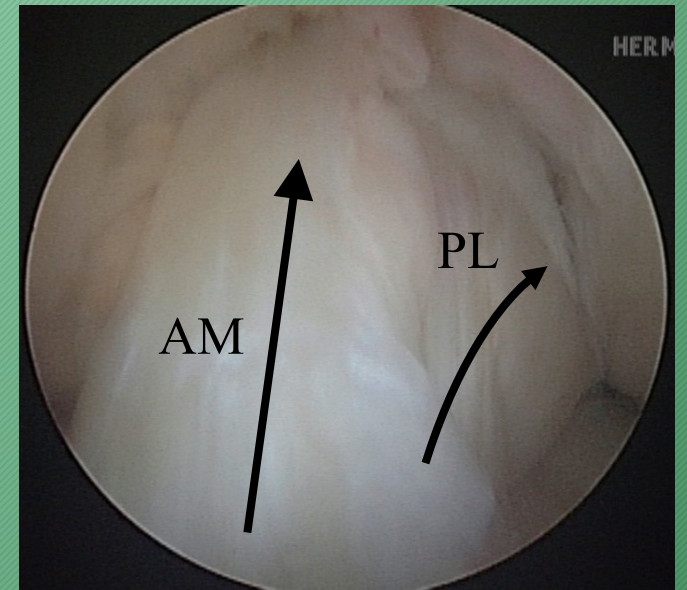
Courtesy Pau Golano/Freddie Fu

van Eck, Musahl, Fu, JBJS, 2013
Kopf, Musahl, Fu, KSSTA, 2009

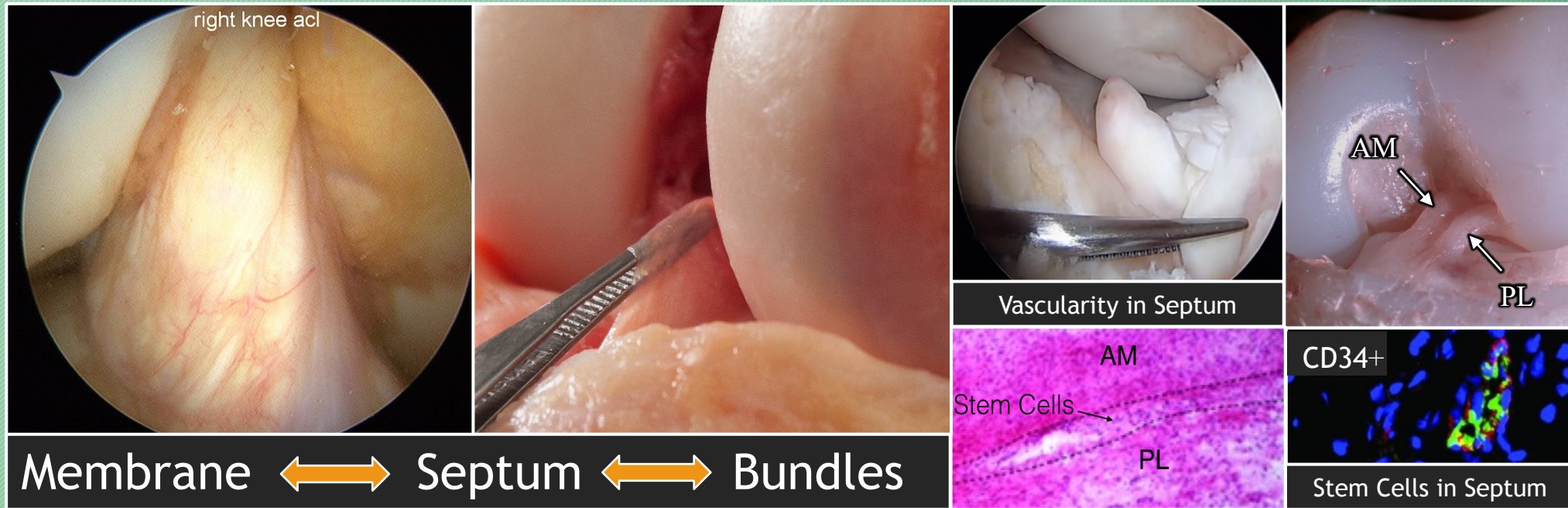
1. Anatomic ACL ... is better



- Anatomic, individualized ACL surgery
Fu JBJS 2011
- Anatomic approach should be used (A)
Shea, Musahl AAOS Clinical Practice Guideline JBJS 2015
- Lower revision risk in anatomic db ACLR
Svantesson, Musahl, Samuelsson, Swedish Knee Ligament Register KSSTA 2016

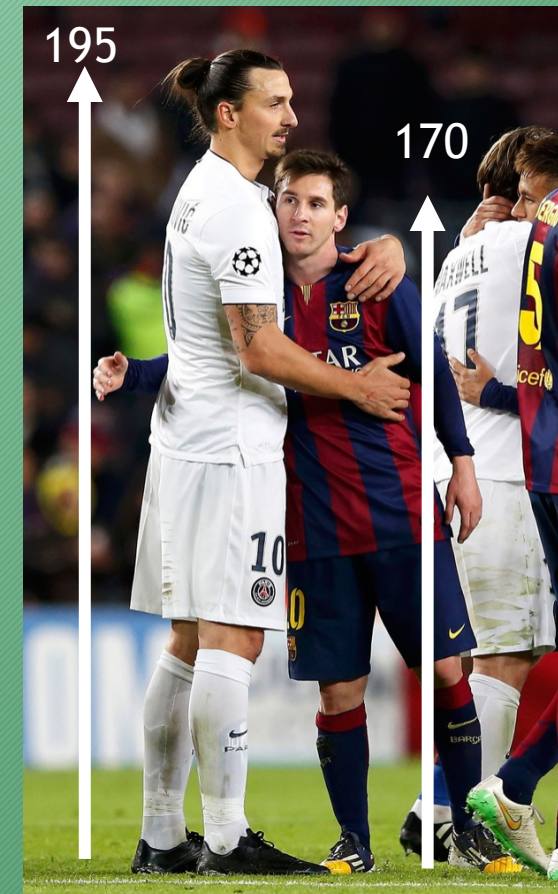
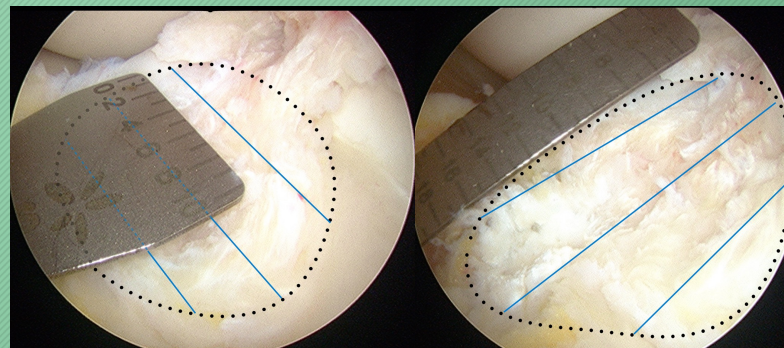
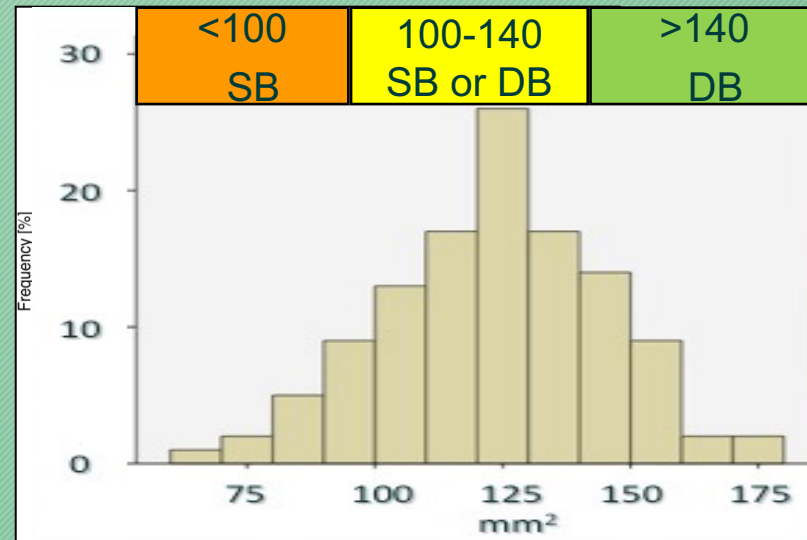
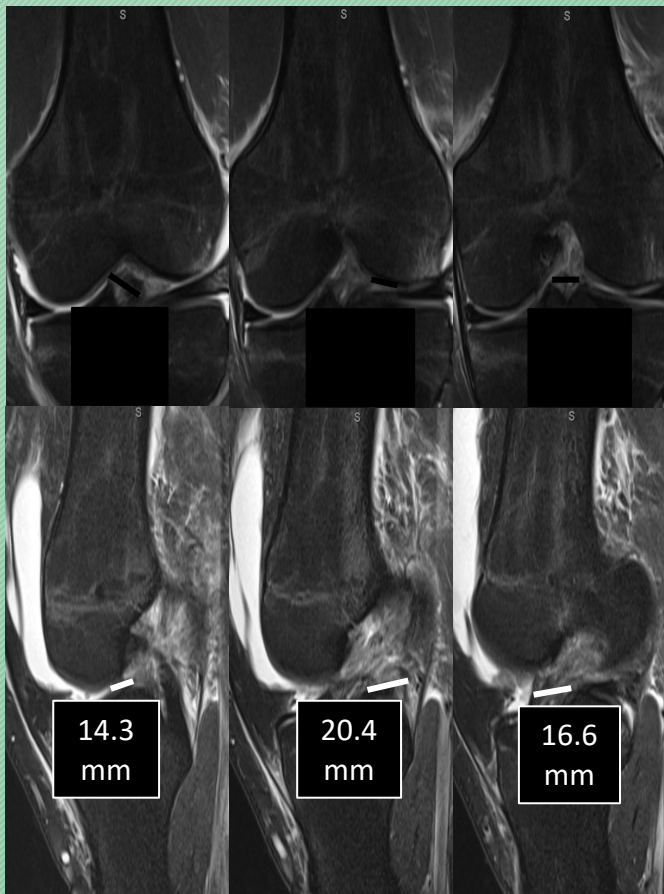


1. Preserve biology whenever possible



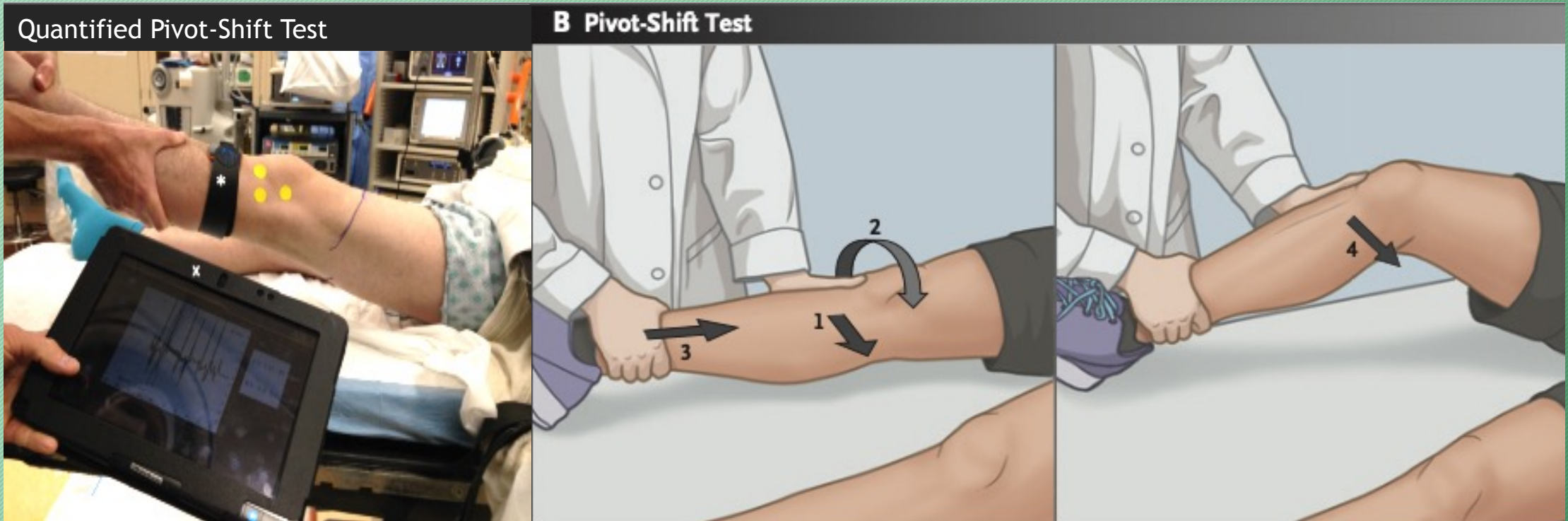
Viable

2. Respect Individual Variation



Guenther, Musahl, Fu, KSSTA, 2016; Kopf, Fu, AJSM, 2011

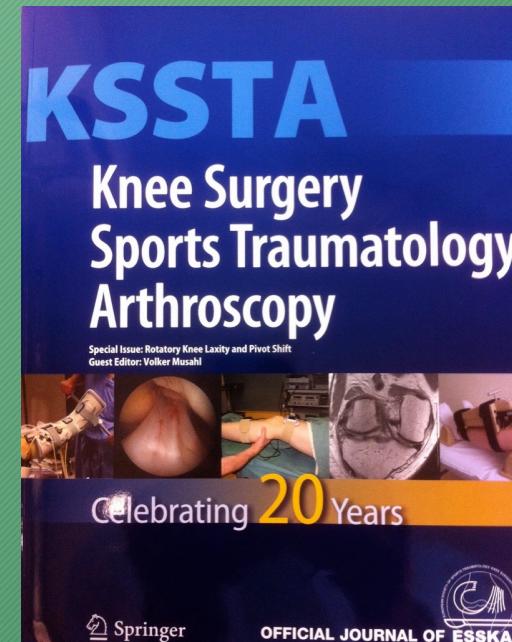
3. Learn how to exam and grade



3. What does it take to have high grade PS

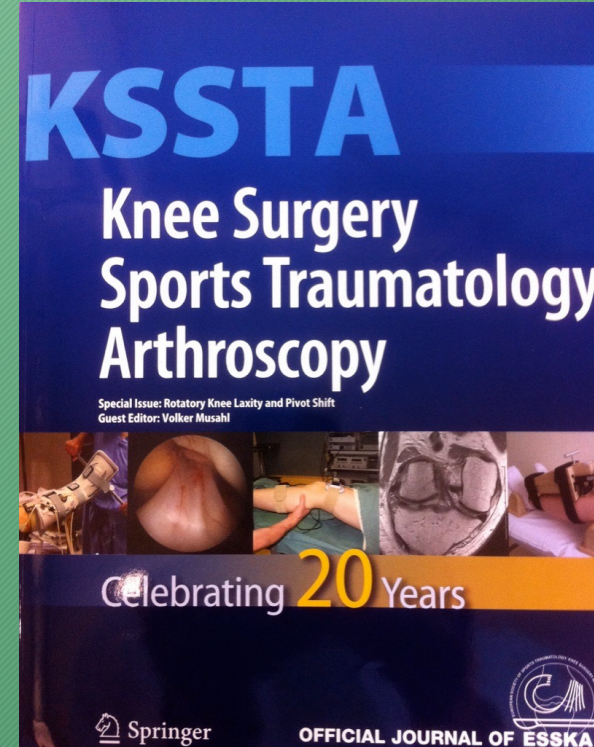
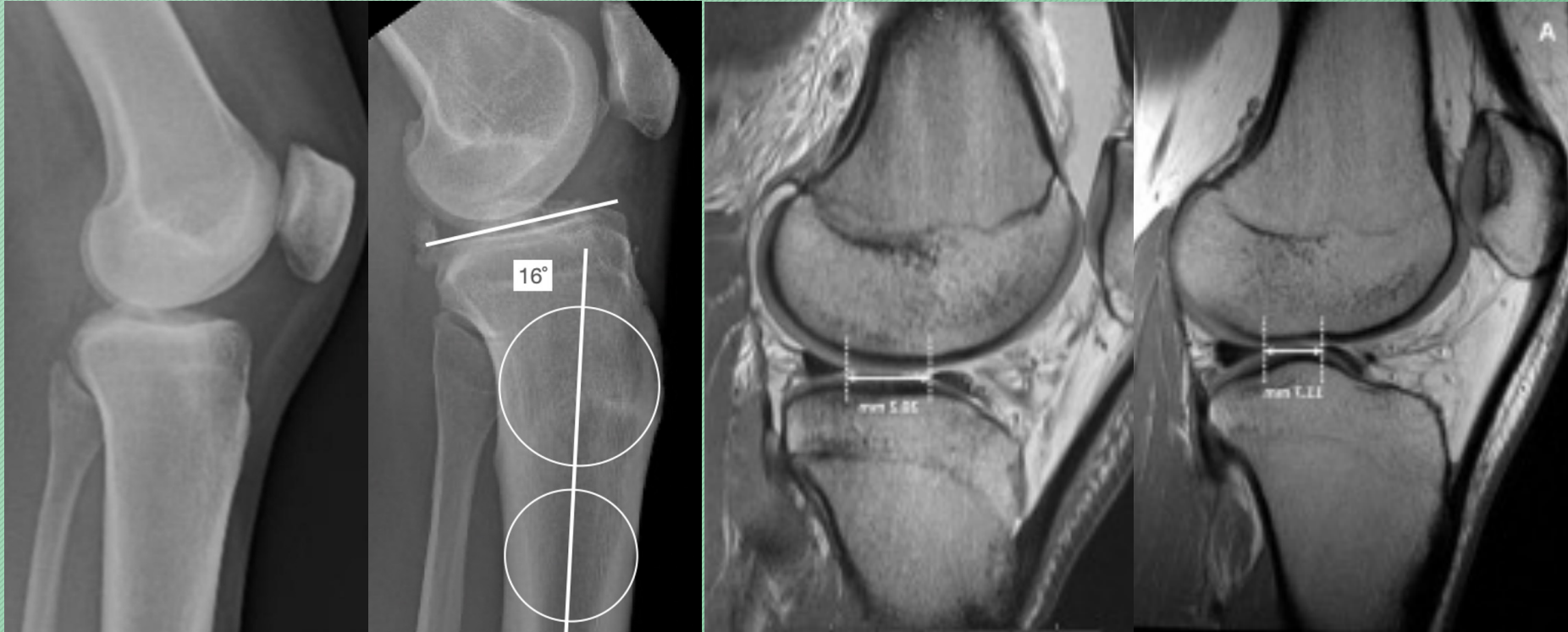


- | | |
|-------------------------|-------------------------------|
| 1. Lateral meniscus | Musahl, PIVOT KSSTA 2018 |
| 2. Lateral root | Hoshino, Kuroda KSSTA 2019 |
| 3. ALC | Claes J Anatomy 2013 |
| 4. ITB | Azar, Musahl AJSM 2016 |
| 5. Hyperlaxity | Sundemo, Musahl KSSTA 2018 |
| 6. High slope | Azar, Musahl JBJS 2016 |
| 7. Small LFC | Musahl, Wickiewicz KSSTA 2010 |
| 8. Large femoral offset | Pfeiffer, Musahl JBJS 2018 |
| 9. Small LCAD | Dadoo, Musahl KSSTA 2023 |



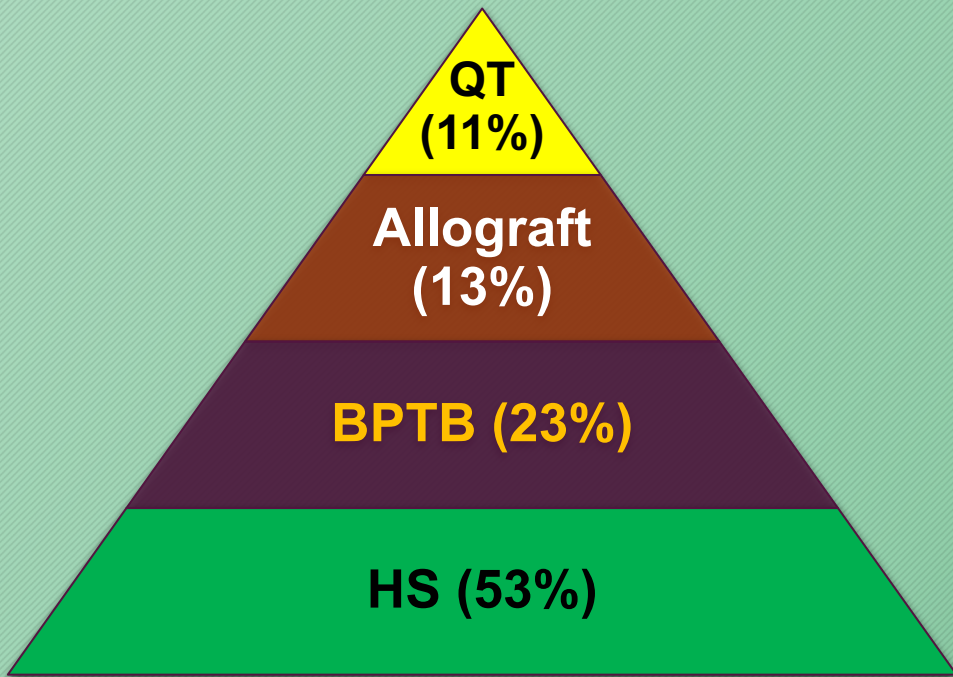
Tanaka, Musahl KSSTA 2012
Dadoo, Musahl KSSTA 2023

3. **HIGH** grade pivot shift ... Run away !



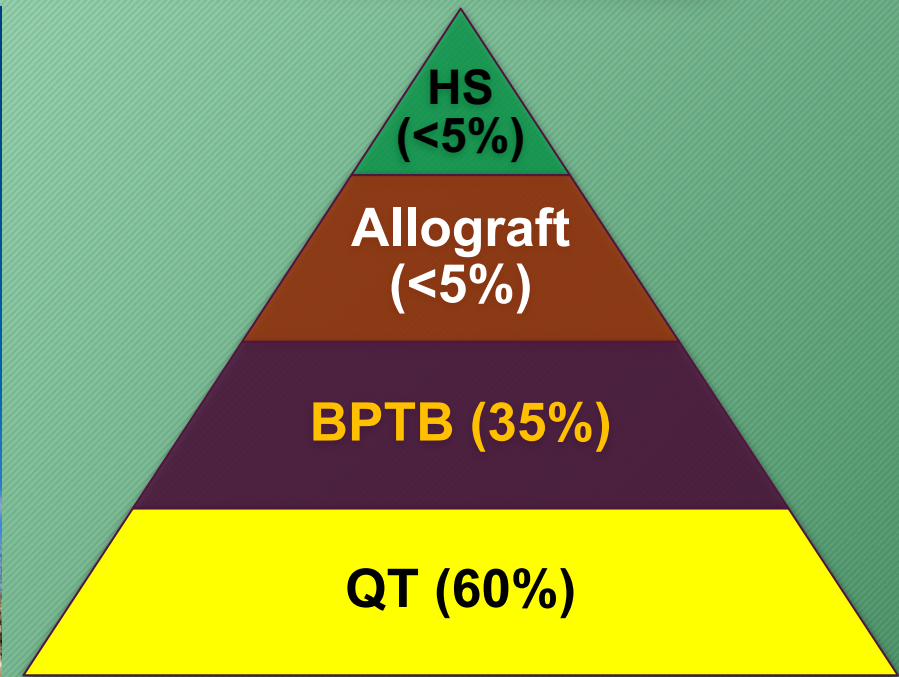
Tanaka, Musahl KSSTA 2012
Dadoo, Musahl KSSTA 2023

4. The right graft for the right patient



Panther Meeting 2011

Middleton, Fu, *KSSTA*, 2014



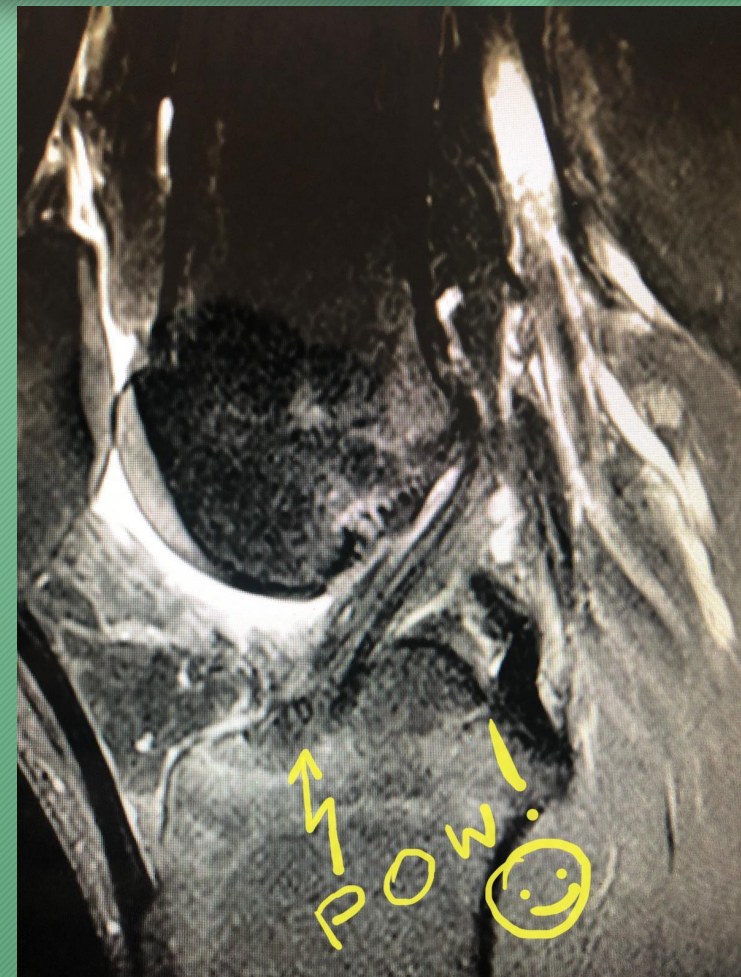
Pitt Graft Choices 2024

Winkler, Musahl, *KSSTA*, 2021

4. Why I like quads



8 weeks looking great!



5. Timing: Early!



UNIVERSITY OF
GOTHENBURG



Superior Outcome of Early ACL Reconstruction versus Initial Non-reconstructive Treatment With Late Crossover to Surgery

A Study From the Swedish National Knee Ligament Registry

Emma Bergerson,^{*†} MD, Kajsa Persson,^{*†} MD, Eleonor Svantesson,^{*†} MD , Alexandra Horvath,^{*§} MD, Jonas Olsson Wållgren,^{*†||} MD, Jon Karlsson,^{*†‡} MD, PhD, Volker Musahl,[†] MD, Kristian Samuelsson,^{*†‡} MD, PhD, and Eric Hamrin Senorski,^{*‡***} PT, PhD 
Investigation performed at University of Gothenburg, Gothenburg, Sweden

- PASS applied to all KOOS subscales
- 1-, 2-, 5- and 10-year follow-up
- Early ACL-R (n=20,352) vs. Non-op. crossover (n=1,074) to late ACL-R
- Early ACL-R results in higher rate of acceptable knee function

Bergesson, Musahl, Hamrin-Senorski AJSM 2022



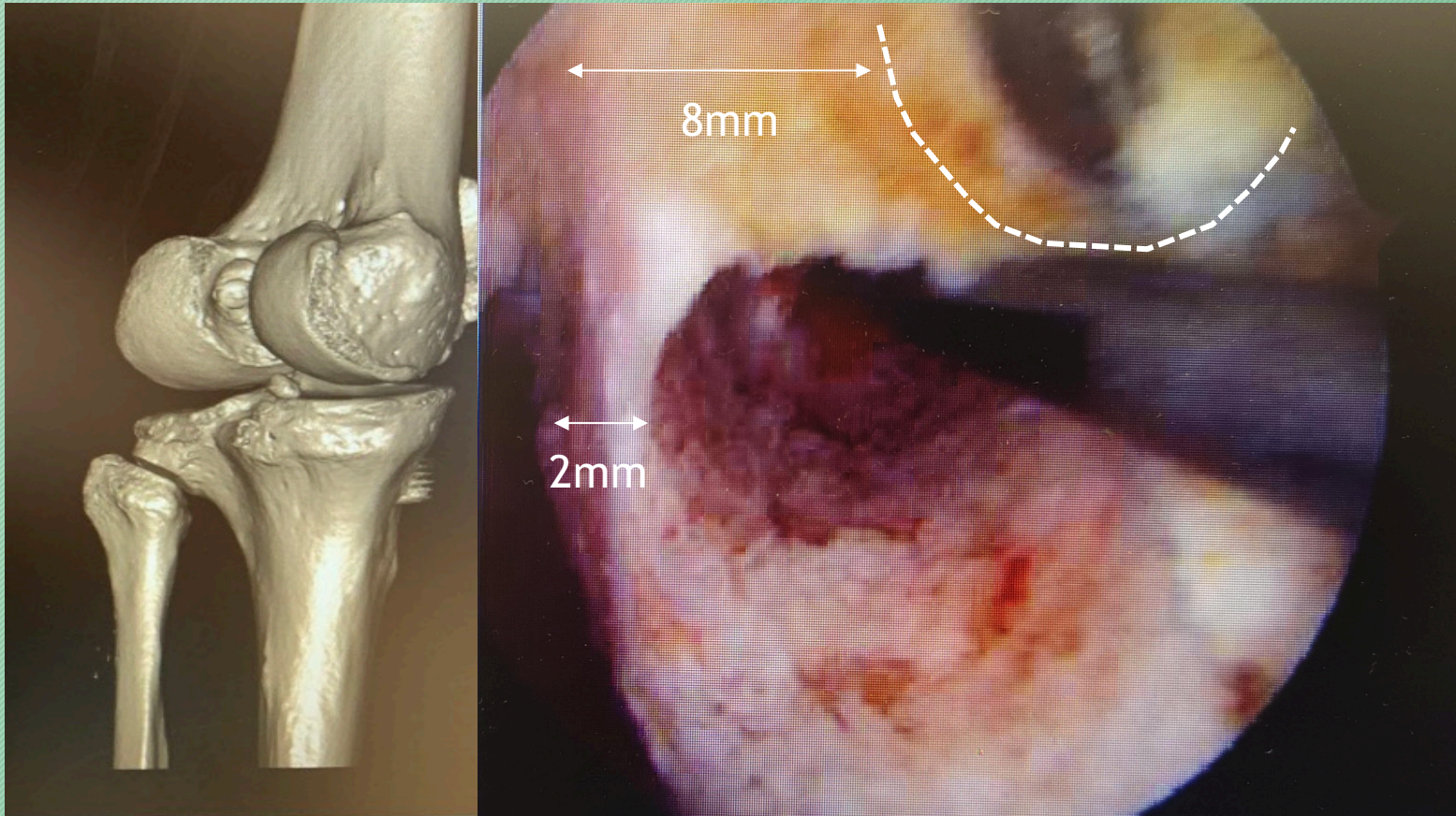
EARLY:

Herbst, Musahl, Fink KSSTA 2016

Von Essen, Eriksson, Barenius KSSTA 2019

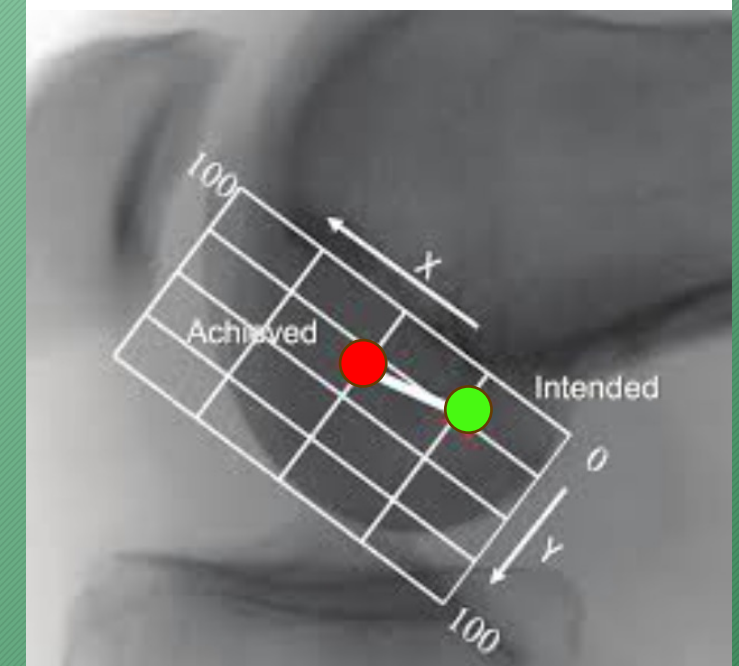
6. Location (of tunnels)

Hughes, Musahl KSSTA 2024, Clin Sports Med 2024, JEO 2023 (x2), KSSTA 2022 (x2), OJSM 2022

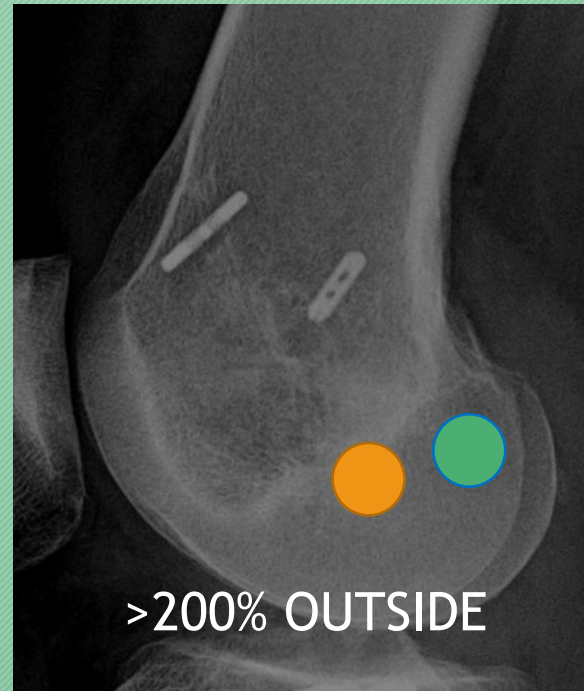
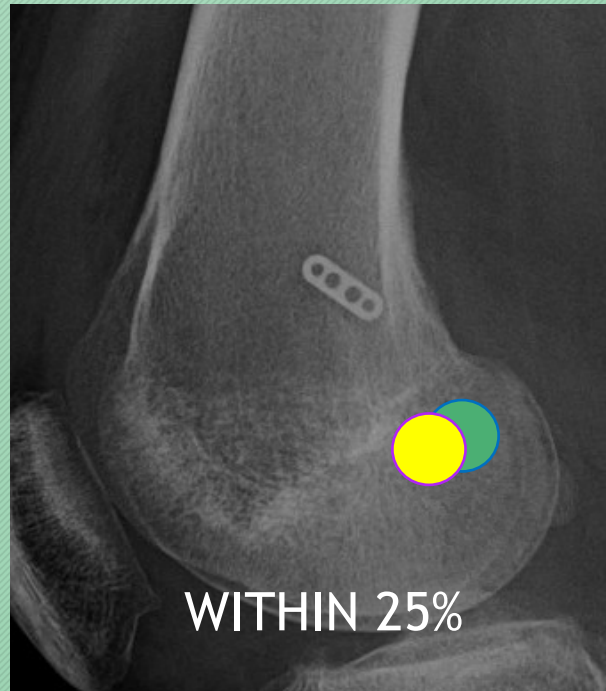


Anterior Cruciate Ligament Femoral Tunnel Placement: An Analysis of the Intended Versus Achieved Position for 221 International High-Volume ACL Surgeons.

Robinson J, Inderhaug E, Harlem T, Spalding T, Brown CH Jr. **AJSM 2020**



6. Avoid low volume



-  Anatomy
-  Intact ACL-R (N=58)
-  Failed ACL-R (N=59)

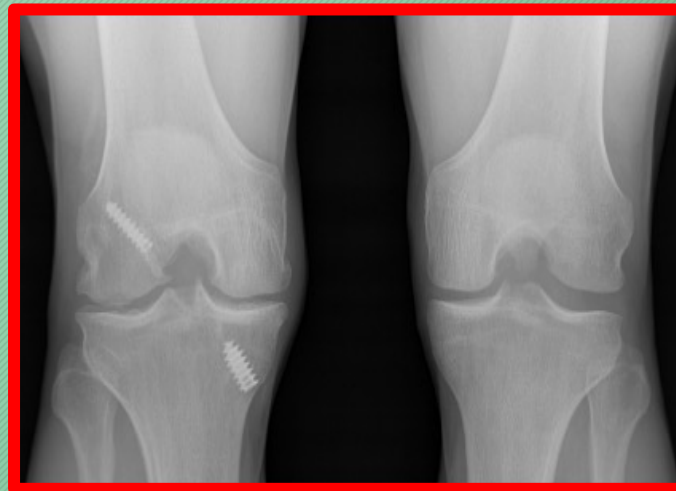
Byrne, Hughes, Musahl (KSSTA 2021)

6. So, do all Athletes get Arthritis?



SR (2069 patients) min. follow up 10 years

Group	Arthritis Prevalence
Non-Anatomic	44%
Anatomic	23%



44%



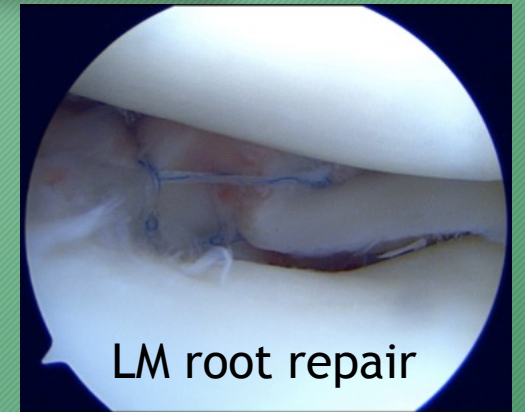
23%

Rothrauff, Musahl KSSTA 2019

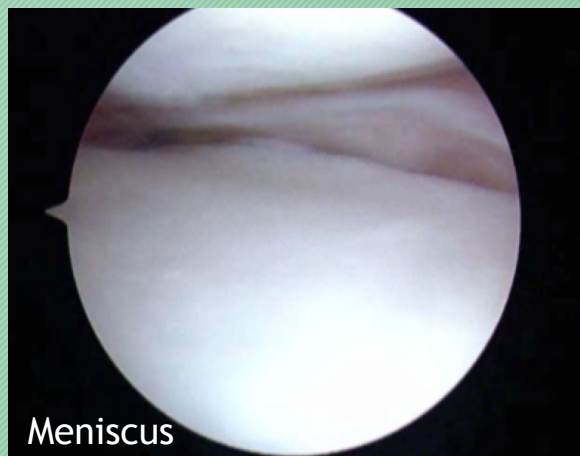
7. Avoid Removing LM during Primary ACLR



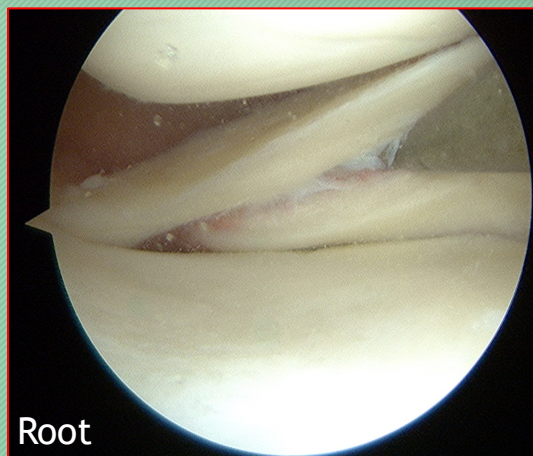
- SNKLR 29,270 pts (719 (2.5%) with revision)
- Lowest odds of meniscus injuries at the time of revision when initially isolated ACL
- Higher odds of cartilage injuries at the time of revision when initially LM partial resection during ACLR (OR 1.8)



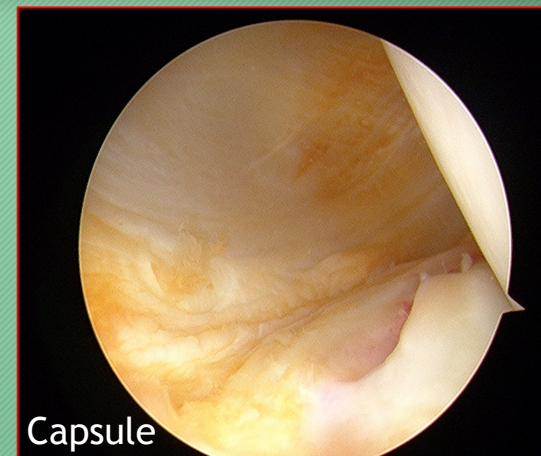
7. Fix the meniscus



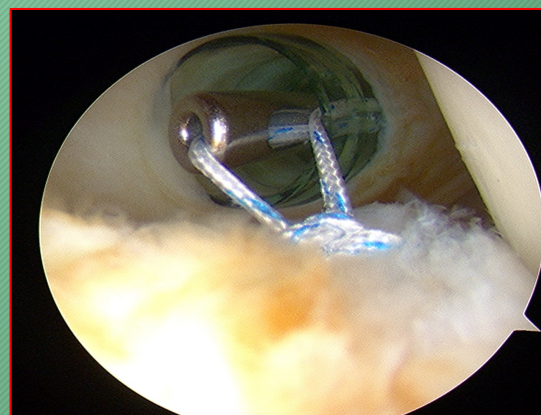
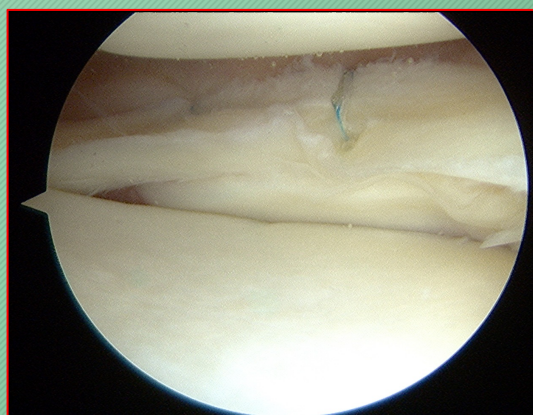
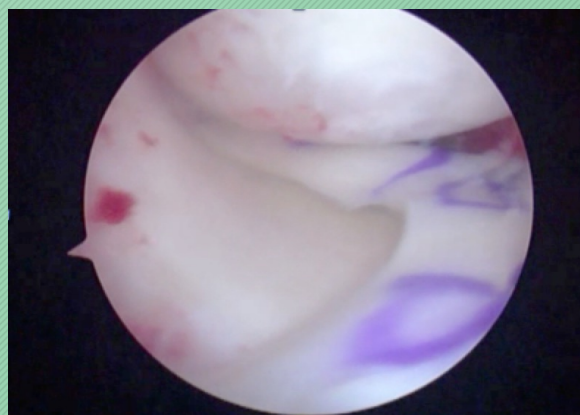
Meniscus



Root



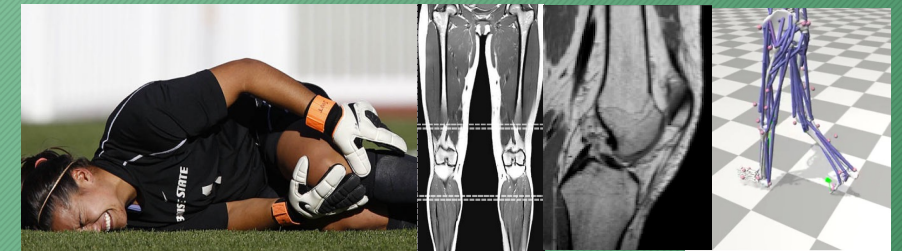
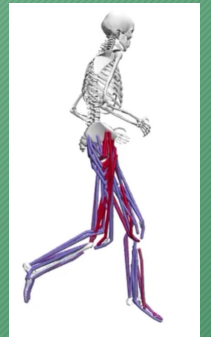
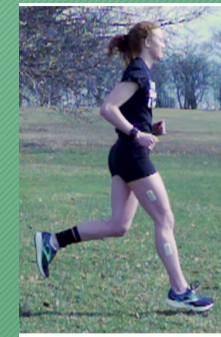
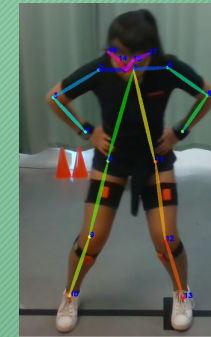
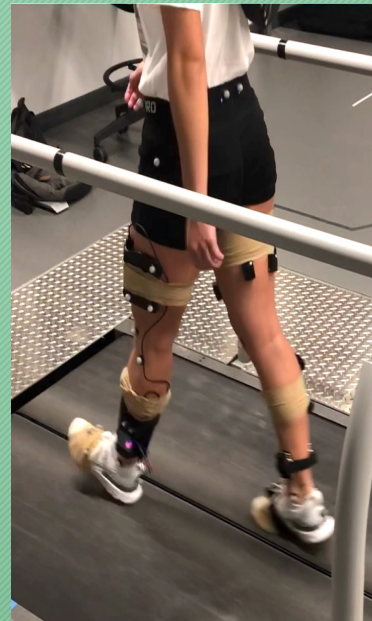
Capsule



8. Precision Rehabilitation



- Digital wearable tech to detect PTOA risk after ACLR
- 90 patients
- MRI, biomechanics, PROs
- CMU, Pitt, and Stanford
- NIH R01-AR080310-01



8. Quads for everyone?



- Predictors of lower knee extension LSI:
 1. Female sex
 2. Increased age
 3. Large QT graft



9. RTS - Panther ACL Consensus Meeting Pittsburgh



1. Criteria-based
2. Abandon purely time-based
3. Progression along RTS continuum
4. Decision making by multi-disciplinary group
5. Objective exam and validated RTS tests for function and...
6. Psychological readiness
7. Consideration for biol. healing



Meredith, Irrgang, Musahl JISAKOS 2021

10. Complications... there are never any ;-)



1. Infection: QT-0.1% vs. HS 0.7% (6652 patients) Özbek, Musahl AJSM 2023
2. Arthrogenic muscle inhibition 50% Sonnery Cottet OTSR 2024
3. Donor site morbidity 20-60% (QT>>HS>>BTB) Kunze, Williams KSSTA 2023
4. Patella fractures <3% Fu OJSM 2019
5. Cyclops lesion <10% Xerogeanes Arthroscopy 2023; Cong, Musahl ACLsg 2024
6. Arthrofibrosis <10% Ekhitari, Ayeni KSSTA 2017
7. Re-rupture 3-25% (allo>>HS>QT/BTB) Musahl KSSTA 2021
8. Contralateral rupture ~7-15% Wiggins, Webster, Myer AJSM 2016
9. PTOA (20-60 %) Rothrauff, Musahl KSSTA 2019; Castoldi, Servien AJSM 2020

11. Bonus Tip: ChatGPT - It has Potential



- We asked 20 questions from perspective of patient and doctor
- Correct responses in 65% of the cases related to ACL surgery
- Fair accuracy, average correctness scores of 1.7
- 3 (15%) responses incorrect



Kaarre, Musahl, KSSTA 2023

What do we need? BIG DATA!



STABILITY I STABILITY II

STABILITY I (2014-2018, ISAKOS)

Multicenter RCT comparing hamstring ACL-R with/without LET

600 Patients at high risk of graft failure

- Age < 25
- Pivot shift grade 2 or higher
- High risk/ pivoting sport

Getgood, ISAKOS 2019



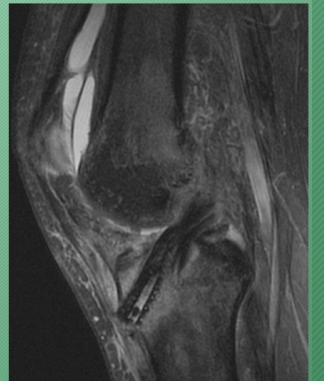
STABILITY II (NIH U01AR076144-01)



- Multicenter RCT comparing Patella tendon vs. Quadriceps tendon ACL-R with/without tenodesis (LET)

- 1200 Patients
- 20 Centers
- Same inclusion/exclusion criteria as STABILITY I

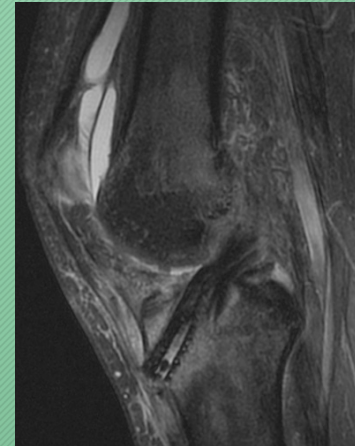
- **Co-PI**
Getgood/Bryant/Irrgang/Musahl



STABILITY II (NIH U01AR076144-01)



- Multicenter RCT comparing Patella tendon vs. Quadriceps tendon ACL-R with/without tenodesis (LET)
- 1200 Patients
- 30 Centers
- Same inclusion/exclusion criteria as STABILITY I
- **Co-PI**
Getgood/Bryant/Irrgang/Musahl



Total Screened	2873
Total Consented	969
Randomized	856

STABILITY 2: Anterior Cruciate Ligament Reconstruction +/- Lateral Tenodesis With Patellar vs Quad Tendon (STABILITY 2)

ClinicalTrials.gov Identifier: NCT03935750

The safety and scientific validity of this study is the responsibility of the study sponsor and investigators. Listing a study does not mean it has been evaluated by the U.S. Federal Government. [Know the risks and potential benefits](#) of clinical studies and talk to your health care provider before participating. Read our [disclaimer](#) for details.

Sponsor:
University of Pittsburgh

Recruitment Status : Recruiting
First Posted : May 2, 2019
Last Update Posted : June 18, 2023
[See Contacts and Locations](#)

[View this study on the modernized ClinicalTrials.gov](#)

YES



Thank You!

