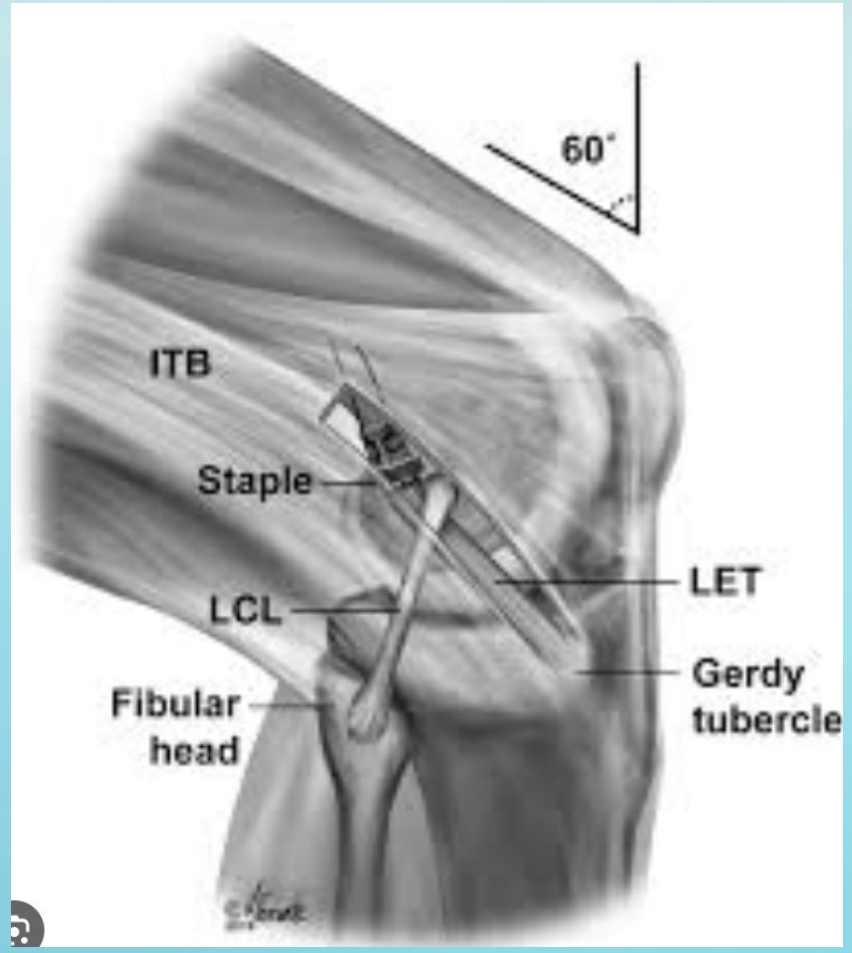
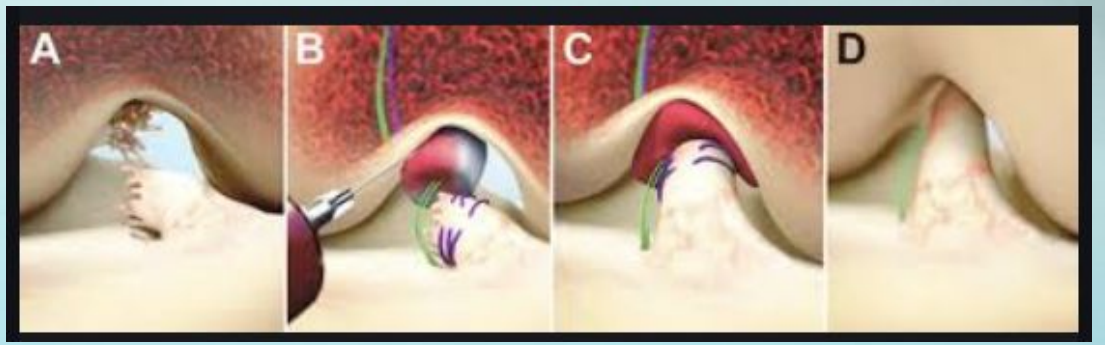
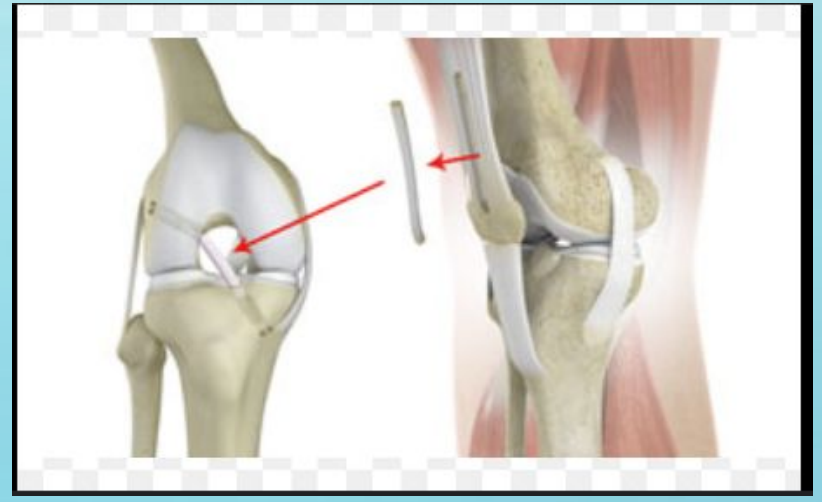
Current Knee Trends

Jessica Hart, MD
Ortho Montana Bozeman

Updates On ACL Reconstructions







Adolescent ACL ruptures

- Increased rates of injury
  - 17.6 in 1990 to 50.9 in 2009 per 100,000
- Increased engagement of adolescents in competitive sport activities
- Affects the sporting career of young athletes and may lead to early onset osteoarthritis
- Major issue is this population has increased susceptibility to graft re-rupture

Predictors of ACL Reconstruction Failure

- < 20 years old
- Small graft diameter
- Absence of lateral extra-articular procedures in adult studies
- Greater posterior tibial slope
- High-grade knee laxity
- Use of allograft instead of autograft
- Early return to high-level sport activities

So how are we doing?

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

Christopher C. Kaeding,*† MD, Angela D. Pedroza,‡ MPH, Emily K. Reinke,§ PhD, Laura J. Huston,§ MS, MOON Consortium,|| and Kurt P. Spindler,¶ MD
Investigation performed at the Ohio State University, Columbus, Ohio, USA, and Vanderbilt University Medical Center, Nashville, Tennessee, USA

- 4.4% over all ipsilateral graft tear

AJSM 2015

Comparative Study ➤ Am J Sports Med. 2019 Jul;47(9):2088-2092.
doi: 10.1177/0363546519854762. Epub 2019 Jun 24.

Anterior Cruciate Ligament Reconstruction in Young Female Athletes: Patellar Versus Hamstring Tendon Autografts

Hytham S Salem [1], Vaho Vardiabetyan [1], Nimit Patel [1], Christopher C Dodson [1], Fotios P Tjoumakaris [1], Kevin R Freedman [1]

Affiliations + expand

PMID: 31233335 DOI: 10.1177/0363546519854762

- 13.6% retear rate in high-risk patients with HA

AJSM 2019

Return to Sport Rates

Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: an updated systematic review and meta-analysis including aspects of physical functioning and contextual factors

Clare L Ardern,[1] Nicholas F Taylor,[1] Julian A Feller,[1,2] Kate E Webster[1]

- 81% return to any sport
- 65% return to preinjury level
- 55% return to competitive level

BJSM 2014

Return to Play and Performance After Primary ACL Reconstruction in American Football Players

A Systematic Review

Bailey J. Ross,* BA, Ian Savage-Elliott,† MD, Symone M. Brown,† MPH, and Mary K. Mulcahey,†‡ MD
Investigation performed at Tulane University School of Medicine, New Orleans, Louisiana, USA

- 67.2% RTP

OJSM 2020

Residual Rotational Instability

- Residual pivot shift present in 25-38% of patients undergoing ACLR

- So how are we doing?

So how can we improve these outcomes?

- One of the issues that has become very popular is the ALL complex

- Prevalence and Classification of Anterolateral Complex in Acute Anterior Cruciate Ligament Tears
  - Ferreti et al. Arthroscopy 2017

- 90% of ACLs had an associated ALL injury

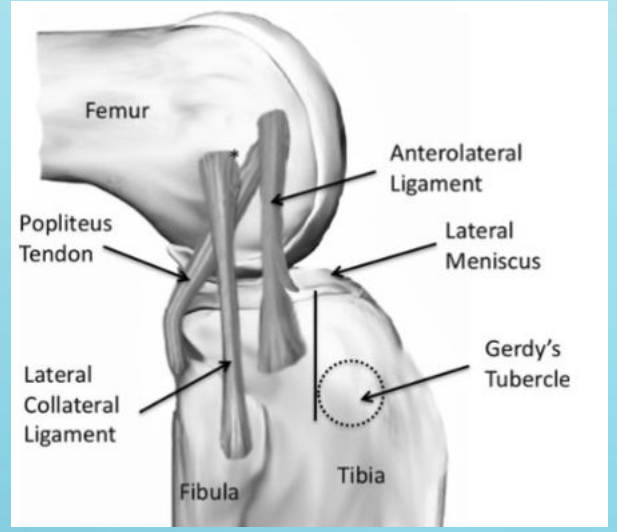
Anterolateral Ligament Complex – What is it?

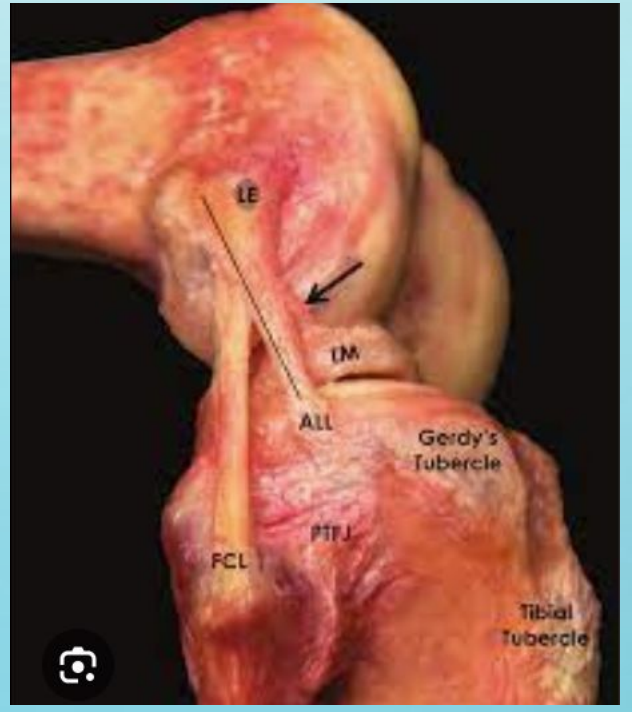
- Anterolateral ligament
- Iliotibial band
- Capsulo-osseous layer

- Complex works synergistically with the ACL to prevent internal tibial rotation
- Plays a crucial role in the pivot shift

Anterolateral ligament

- Origin from the lateral femoral epicondyle
  - Slightly anterior to the origin of the LCL
- Insertion on the anterolateral tibia
  - Midway between Gerdy's tubercle and the tip of the fibular head





Segond Fracture

ALL Avulsion Injury

So what?

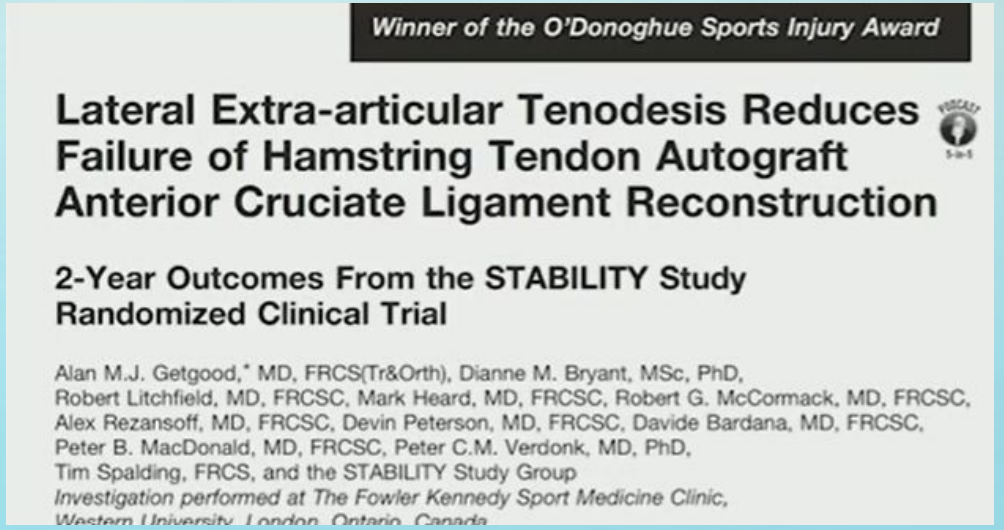
Use of Lateral Extra-Articular Procedures (LEAP)

- Madhan et al examined 87 surgeons in the Pediatric Research in Sports Medicine Society
- 56% sometimes performed LEAP with primary ACLR
- 79% with revision ACLR
- Some commented that deterrent was a lack of evidence to support these practices

Recent Studies Looking at LEAPs

- Added LEAP to high risk patients

- HA 40% clinical failure, 11% graft rupture
- HA + LET 25% clinical failure, 4% graft rupture
- Addition of LET led to 60% relative risk reduction in graft failure



Winner of the O'Donoghue Sports Injury Award

Lateral Extra-articular Tenodesis Reduces Failure of Hamstring Tendon Autograft Anterior Cruciate Ligament Reconstruction

2-Year Outcomes From the STABILITY Study Randomized Clinical Trial

Alan M.J. Getgood,* MD, FRCS(Tr&Orth), Dianne M. Bryant, MSc, PhD, Robert Litchfield, MD, FRCSC, Mark Heard, MD, FRCSC, Robert G. McCormack, MD, FRCSC, Alex Rezansoff, MD, FRCSC, Devin Peterson, MD, FRCSC, Davide Bardana, MD, FRCSC, Peter B. MacDonald, MD, FRCSC, Peter C.M. Verdonk, MD, PhD, Tim Spalding, FRCS, and the STABILITY Study Group

Investigation performed at The Fowler Kennedy Sport Medicine Clinic, Western University, London, Ontario, Canada

High Risk Patients

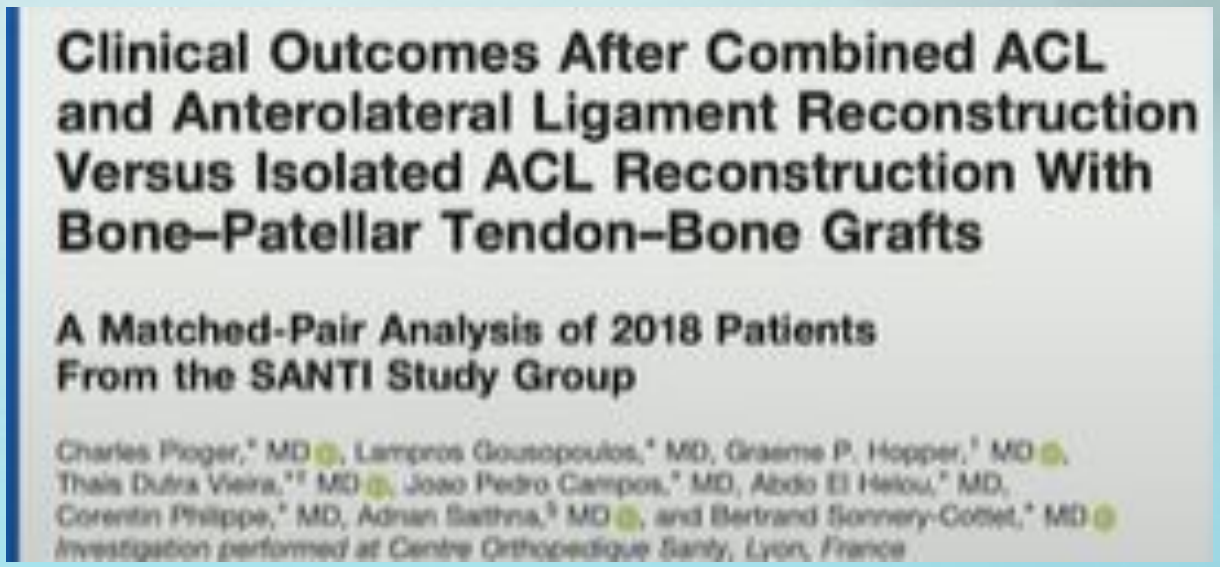
- Younger than 25 years old

- Needed to meet at least 2 criteria

- Grade 2 pivot shift or greater
- Desire to return to high risk/pivoting sports
- Generalized ligamentous laxity

Patellar Tendon Autografts and LEAPs

- Isolated BTB ACL group had > 3 fold increase risk of graft failure



Clinical Outcomes After Combined ACL and Anterolateral Ligament Reconstruction Versus Isolated ACL Reconstruction With Bone–Patellar Tendon–Bone Grafts

A Matched-Pair Analysis of 2018 Patients From the SANTI Study Group

Charles Ploger,* MD, Lampros Gousopoulos,* MD, Graeme P. Hopper,† MD, Thais Dutra Vieira,*‡ MD, Joao Pedro Campos,* MD, Abdo El Helou,* MD, Corentin Philippe,* MD, Adnan Saithna,§ MD, and Bertrand Sonnery-Cottet,* MD
Investigation performed at Centre Orthopedique Santy, Lyon, France

Is this worth another incision/procedure?

- Complications of LET (Marshall et al, Zhoa et al)

- Increased surgical time and blood loss
- Hematoma
- Painful hardware
- Increased infection risk
- Over constraint of lateral compartment -> early onset DJD

Does this apply to adolescent patients?

Impact of Lateral Extra-Articular Procedure Augmentation on Rerupture Risk and Tegner Activity Scale Outcomes in Adolescent Anterior Cruciate Ligament

A Matched Comparative Study With a Minimum 2-Year Follow-up

Mohamad K. Moussa,*† MD, MSc, Nicolas Lefèvre,† MD, Eugénie Valentin,† MSc, Adam Coughlan,‡ MD, Aymen Zgolli,§ MD, Antoine Gerometta,† MD, Alain Meyer,† MD, and Alexandre Hardy,† MD, MSc
Investigation performed at the Clinique du sport, Paris, France

- Retrospective analysis of patients <18 years old with minimal 2 year follow up
- Different grafts were used along with different techniques for LET versus ALL reconstruction (all autografts)

Results

- Graft rupture significantly less common in ACLR+LEAP
  - 2.5% versus 13.6%
  - Attributable risk reduction of 11.1%
  - Number needed to treat – 9
- Better rerupture-free survival at 5 years for ACLR+LEAP group
- 6-fold increase rereputure risk in ACLR alone

- At final follow up similar IKDC, KOOS, Lysholm values in both groups
- Higher Tegner score
- No significant differences were observed in RTS rates

Discussion

- Support growing evidence the use of LEAP in the pediatric and adolescent population
  - Results were derived from multiple types of LEAPs and different graft techniques
  - Demonstrates advantage of LEAPS across various techniques

- LEAPs could be a game changer in reducing re-rupture rates among young athletes

Limitations

- LEAP has not been shown in recent studies to be associated with long-term osteoarthritis
  - However, findings need to be validated in pediatric population
- Also need to explore risk of these procedures in patients with open physes
- Study was not randomized – selection bias

Radiographic Incidence of Knee Osteoarthritis After Isolated ACL Reconstruction Versus Combined ACL and ALL Reconstruction: A Prospective Matched Study From the SANTI Study Group

Jobe Shatrov, MD, Benjamin Freychet, MD, [...], and Bertrand Sonnery-Cottet, MD, PhD +5 View all authors and affiliations

- ACLR + ALL did not increase the risk of OA in the lateral tibiofemoral compartment compared with isolated ACLR
  - Medium term follow up
- Isolated ACLR with BPTB was associated with significantly increased risk of medial PF joint space narrowing
  - 66.7% compared with 11.9% in those with ACLR+ALL
- Lateral meniscus tear increased risk of lateral tibiofemoral narrowing by nearly 5 times

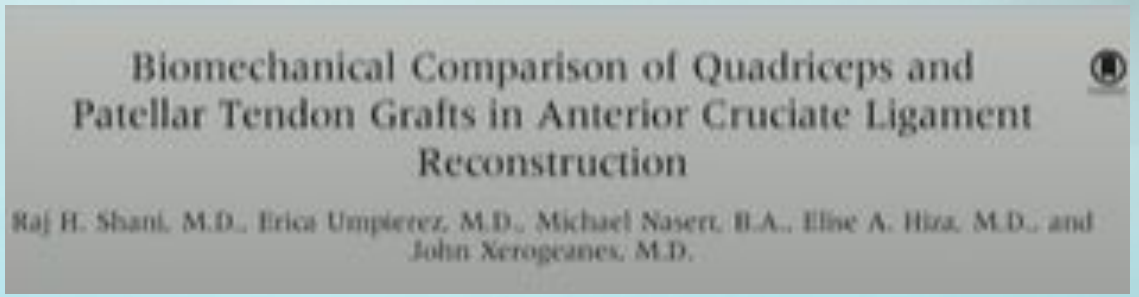
What else can we do to improve outcomes?

Quadriceps Tendon Autograft

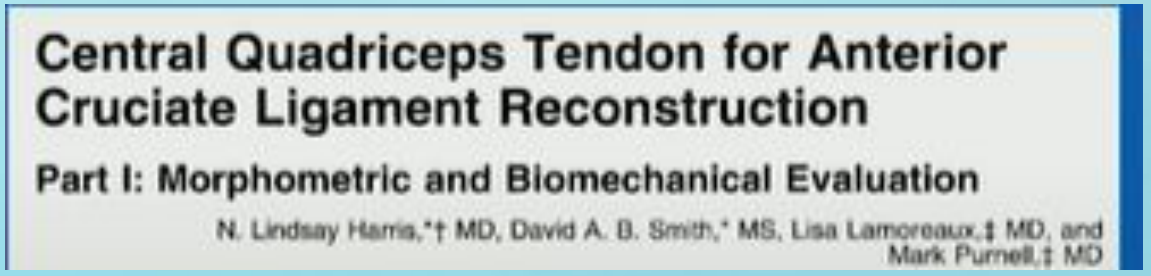
- Increasing recent interest in the orthopedic community in the use of quad tendon autografts
- Does it live up to all the expectations and deserve all this attention?

Quad tendon vs BTB Autograft

- 1.8x thicker than BTB autograft
- 20% more collagen
- Higher ultimate strength


Biomechanical Comparison of Quadriceps and Patellar Tendon Grafts in Anterior Cruciate Ligament Reconstruction

Raj H. Shani, M.D., Erica Umpierez, M.D., Michael Nasert, B.A., Elise A. Hiza, M.D., and John Xerogeanes, M.D.


Central Quadriceps Tendon for Anterior Cruciate Ligament Reconstruction

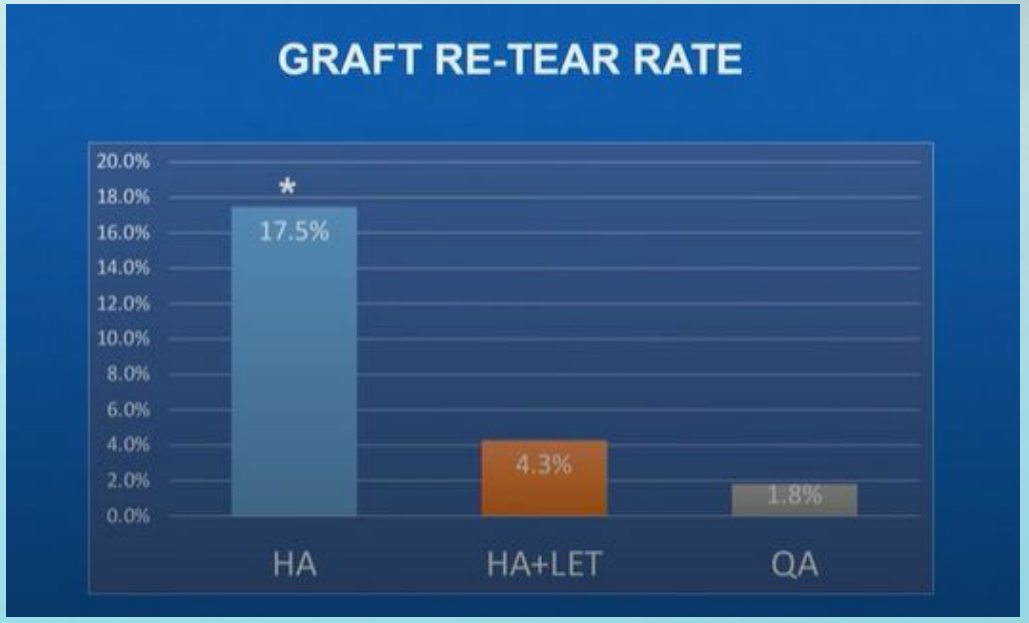
Part I: Morphometric and Biomechanical Evaluation

N. Lindsay Harris,*† MD, David A. B. Smith,* MS, Lisa Lamoreaux,‡ MD, and Mark Purnell,‡ MD

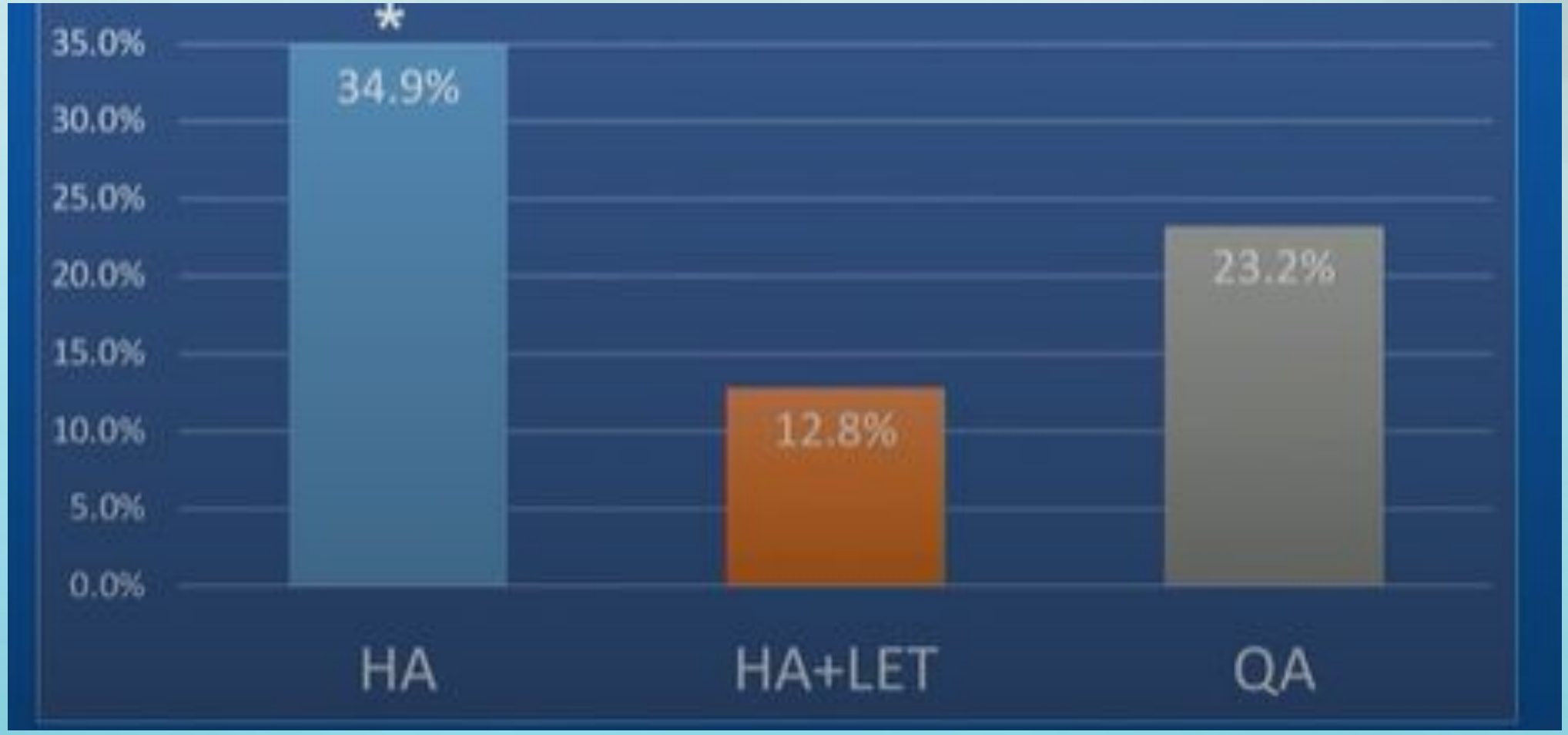
- Does the use of quad autograft without LET decrease the rate of graft failure as well as HA + LET in high-risk patients?

Paper 28: Both Hamstring Autograft Combined with Lateral Extra-Articular Tenodesis and Quadriceps Autograft Lead to Lower Graft Re-Tear Rates and Pivot Shift After ACL Reconstruction Compared to Hamstring Autograft Alone

Joseph Brinkman [1], Kade McQuivey [1], Justin Makovicka [1], Sailesh Tummala [1], Kostas Economopoulos [1]



Rate of residual pivot shift



Results continued…

- Similar return to sport rates (74-79%)
- Return to sport at same or higher level about the same (46-57%)

- QA returned slightly faster to sport at about 7.7 months
  - 9.4 for HA and HA +LET

- No difference in complications
  - LET had small incidence of hematomas

Quad autograft

- In this study equivalent to hamstring autograft + LET in high-risk patients in decreasing graft failure and residual pivot shift compared to HA

- May be another tool when deciding which graft to use in these high-risk patients

MRI Signal Intensity of Quadriceps Tendon Autograft and Hamstring Tendon Autograft 1 Year After Anterior Cruciate Ligament Reconstruction in Adolescent Athletes

Alexandra H. Aitchison, BS, David Alcoloumbre, MD, [...], and Daniel W. Green, MD, MS +4 View all authors and affiliations

- No study demonstrating a long term clinical benefit of QTA over HTA in more active, skeletally immature population

- This study looked at radiologic markers of graft strength and maturity
- No difference in SIR at 6 months
- SIR significantly less than in the HTA group on the 12 month MRI

- Findings suggest improved graft maturation, remodeling and structural integrity of the QTA compared with the HTA between 6 and 12 month post op
- At 1 year, QTA may have superior rate of incorporation and synovialization compared to HTA

Is there a role for ACL repair?

ACL Repair

- Primary repair was used until the mid-1980s – studies demonstrated failure rates as high as 50% at 2 years especially in younger, active patients
- ACL reconstruction became the standard of care
- Some success in previous studies in older patients with proximal tears where the ACL can be reattached to the femoral bone
  - Studies also showed in these patients that nonoperative treatment is equally effective
- Does not address the problem with the young and active patient population who are at greater risk for graft failure

ACL Repair

- Has been a resurgence in interest due to new technology – scaffolds, internal brace sutures

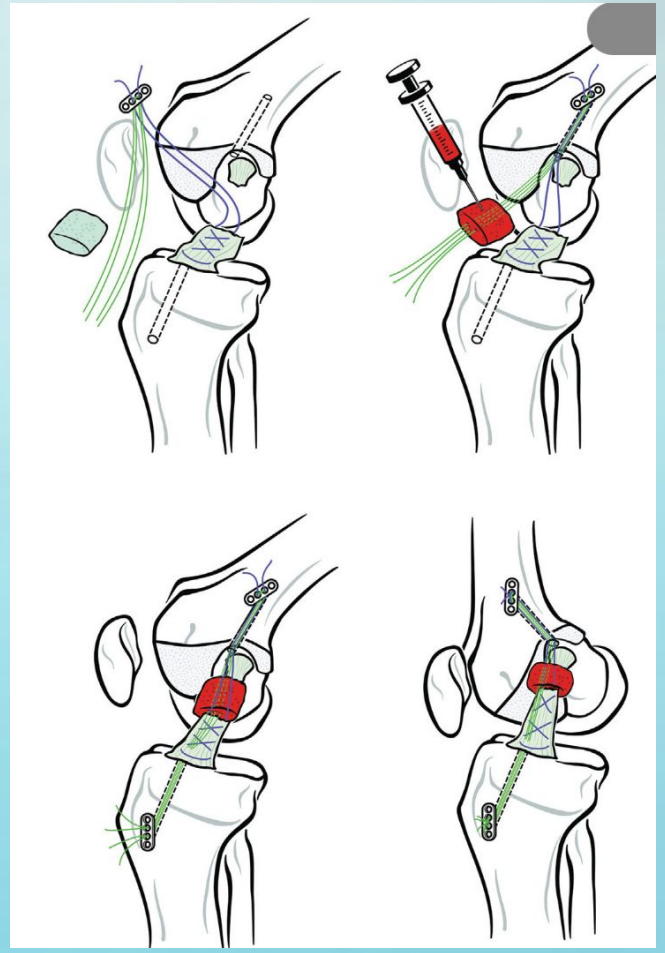
- For ligaments to heal, the gap is bridged by a fibrin clot
  - Provides scaffold into which the torn ligament ends grow and reunite

- Intra-articular location of ACL results in premature dissolution of the clot which inhibits healing
  - Development of a scaffold implant to bridge the gap

BEAR Implant (Bridge-Enhanced ACL Repair)

- Places a resorbable protein-based implant containing autologous blood in the gap between the 2 torn ends of a midsustance ACL tear

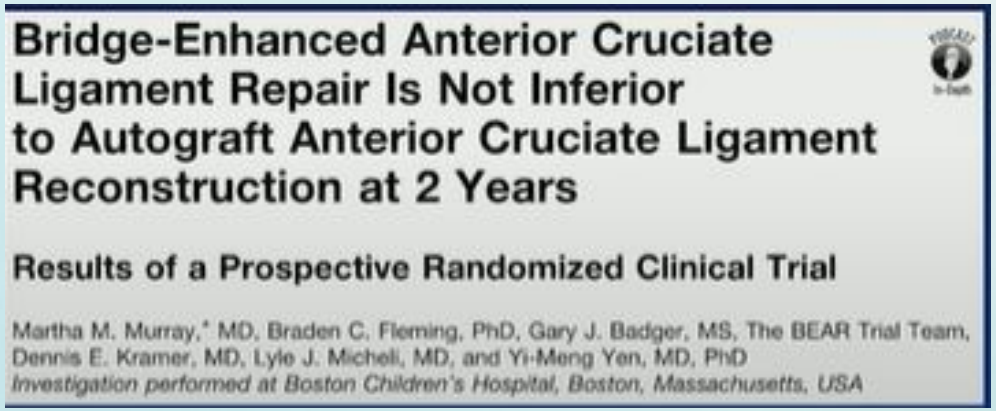
- In combination with suture repair of the ligament and suture sinch to reduce the tibiofemoral joint



Potential Advantages

- No need to harvest normal tissue to replace the ACL

- Decreased risk of post injury osteoarthritis
  - Suggested in preclinical study



Bridge-Enhanced Anterior Cruciate Ligament Repair Is Not Inferior to Autograft Anterior Cruciate Ligament Reconstruction at 2 Years

Results of a Prospective Randomized Clinical Trial

Martha M. Murray,* MD, Braden C. Fleming, PhD, Gary J. Badger, MS, The BEAR Trial Team, Dennis E. Kramer, MD, Lyle J. Micheli, MD, and Yi-Meng Yen, MD, PhD
Investigation performed at Boston Children's Hospital, Boston, Massachusetts, USA

- 100 patients with complete ACL tear
  - <45 days from injury
  - Closed physes
  - At least 50% of the length of the ACL attached to the tibia

- Evaluated IKDC scores, AP knee laxity, muscle strength at 2 years after surgery

Results at 2 Years

- No difference in IKDC Subjective Score
- No difference in AP knee laxity

- Hamstring index
  - ACLR group 63% hamstring strength vs nonop side
  - BEAR 98.2%

- 14% of BEAR patients were converted to ACLR
- 6% of patients in ACLR required revision

Discussion

- BEAR group was noninferior to ACLR at 2 years post op
- No statistically significant difference on failure rates
- Higher hamstring strength in BEAR group
  - Although lack of strength in ACLR did not affect hop testing results
- Suggest that ACL repair with BEAR implant is worthy of additional study

Rehabilitation

- It is assumed that with ACL repair there is faster recovery
- This is not true, and patient's expectations need to be addressed
- In the study, identical protocols were used for reconstruction and repair

Patients that may be good candidates

- As research evolves…
- This is meant to be a bridge – need ACL on both sides for BEAR technique versus just primary repair without scaffold

- MRI does not correlate well with what is seen intra-op
  - Difficult to determine preop who is a candidate for repair procedure
  - Always need a back up plan going in if not amenable to repair

- A lot not known yet in terms of what patients would benefit most from repair
  - Need to consider other injuries, hyperlaxity, pivot shift, patient demands

Meniscus Tears

Meniscal Anatomy

Meniscal vascular supply

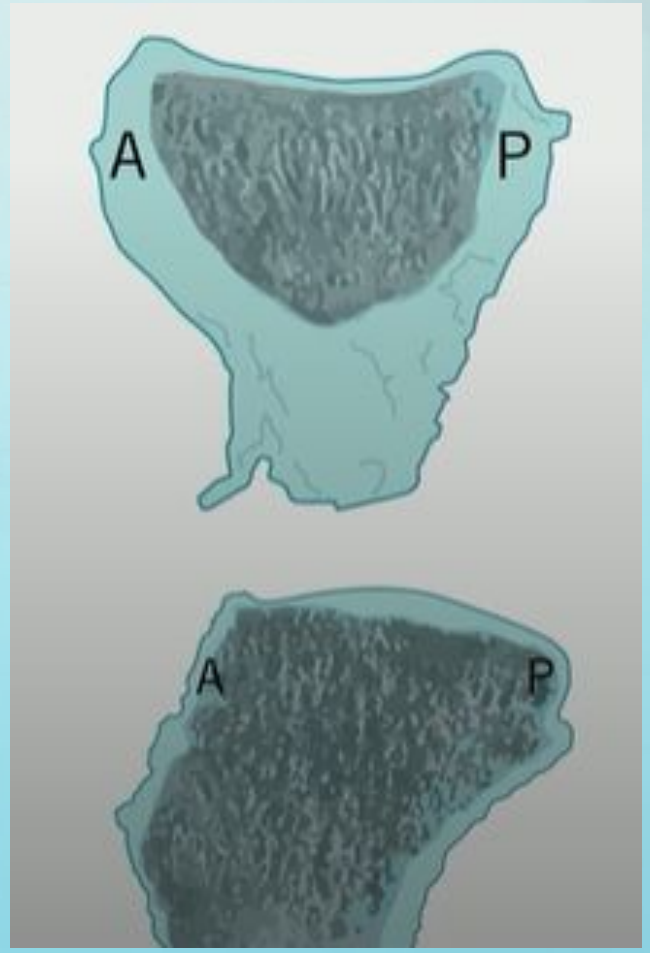
- **Age dependent**

- Zones
  - Red
  - Red-White
  - White

Red Red-

Plateau Anatomy

- Medial plateau
  - Concave, larger
- Lateral plateau
  - Convex, smaller
  - Higher contact forces
  - Need to be aggressive with repair



Meniscus Tears

- Ideal Meniscus Tears
  - Small vertical tears
  - Vascular (peripheral)
  - Acute tear
  - Young patient
  - Stable knee
  - No malalignment

- Most times this is not what we are seeing in the OR…

Meniscus Repair Outcomes

- Meniscal repair failure about 20%
- Failure rate was similar for the medial and lateral meniscus as well as for patients with an intact and reconstructed ACL

Meniscal Repair Outcomes at Greater Than Five Years

A Systematic Literature Review and Meta-Analysis

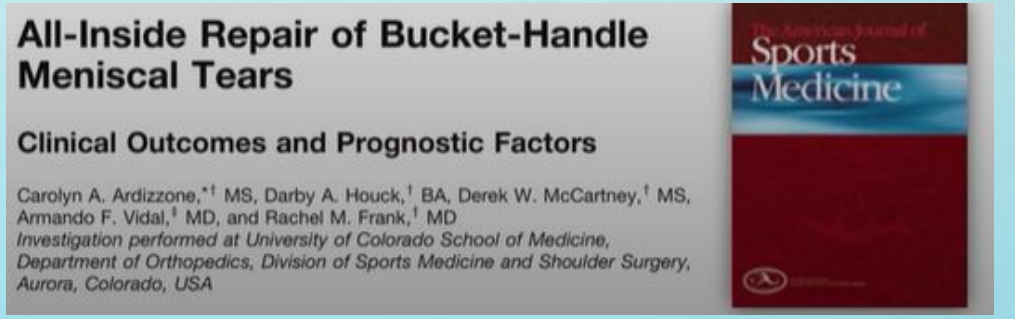
Jeffrey J. Nepple, MD, Warren R. Dunn, MD, MPH, and Rick W. Wright, MD

Investigation performed at the Sports Division, Department of Orthopaedic Surgery, Washington University School of Medicine, St. Louis, Missouri

Bucket Handle Meniscus Repair Outcomes

- Overall failure rate of 29% at 13 months

- Longer follow up duration -> higher failure rates



All-Inside Repair of Bucket-Handle Meniscal Tears

Clinical Outcomes and Prognostic Factors

Carolyn A. Ardizzone,*† MS, Darby A. Houck,† BA, Derek W. McCartney,† MS, Armando F. Vidal,‡ MD, and Rachel M. Frank,† MD

Investigation performed at University of Colorado School of Medicine, Department of Orthopedics, Division of Sports Medicine and Shoulder Surgery, Aurora, Colorado, USA

More Outcomes

- MOON Cohort -> ACLR + meniscus repair
- 16% meniscus failure rate

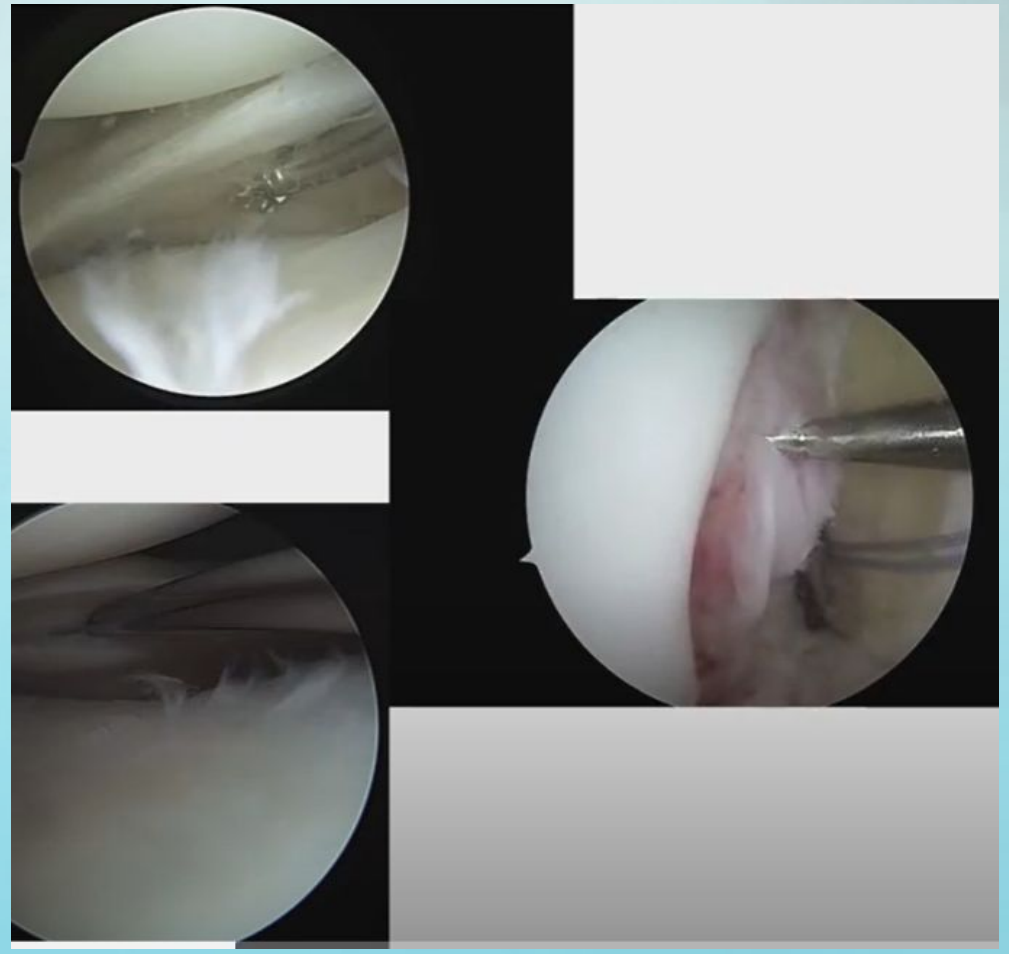
- Risk factors for meniscus repair failure
  - Medial (versus lateral)
  - Baseline Marx activity (very low or very high)
  - Allograft ACLR (versus autograft)

Outcomes

- So with a 10-30% failure rate what can be done to try and improve this?
- How can we conquer this healing challenge?

Additions to Meniscal Repairs

- Standard Additions
  - Rasping – induces synovial ingrowth, repair and cytokine expression
  - Notch Microfracture
  - Trephination



Biologic Additions

- Fibrin clot
  - Decreased failure rates in some studies
  - Difficult to maintain clot localization
- PRP/BMC/Adipose
  - Some initial studies encouraging
  - But again, what happens to it when you take the camera out?
- PRP -> 2x platelets above baseline level
  - Multiple different systems/preparations

PRP

- No Difference with PRP

Augmentation of Meniscal Repair With Platelet-Rich Plasma

A Systematic Review of Comparative Studies

John W. Belk,*† BA, Matthew J. Kraeutler,‡ MD, Stephen G. Thon,† MD, Connor P. Littlefield,† BA, John H. Smith,† BA, and Eric C. McCarty,† MD

Investigation performed at Department of Orthopedics, University of Colorado School of Medicine, Aurora, Colorado, USA

- Lower Failure Rates with PRP

Platelet-Rich Plasma Augmentation for Isolated Arthroscopic Meniscal Repairs Leads to Significantly Lower Failure Rates

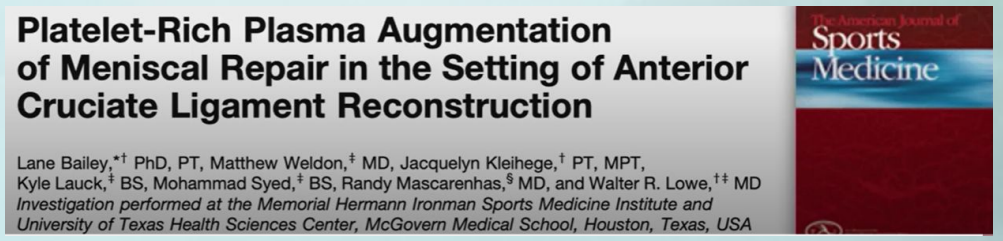
A Systematic Review of Comparative Studies

Kyle R. Sochacki,*† MD, Marc R. Safran,† MD, Geoffrey D. Abrams,† MD, Joseph Donahue,† MD, Constance Chu,† MD, and Seth L. Sherman,† MD

Investigation performed at Stanford University Medical Center, Palo Alto, California, USA

PRP Addition

- ACLR with Meniscus repair + PRP
- Intra-op PRP did not improve any outcomes following ACLR with meniscus repair
- PRP group with higher rate of post op stiffness

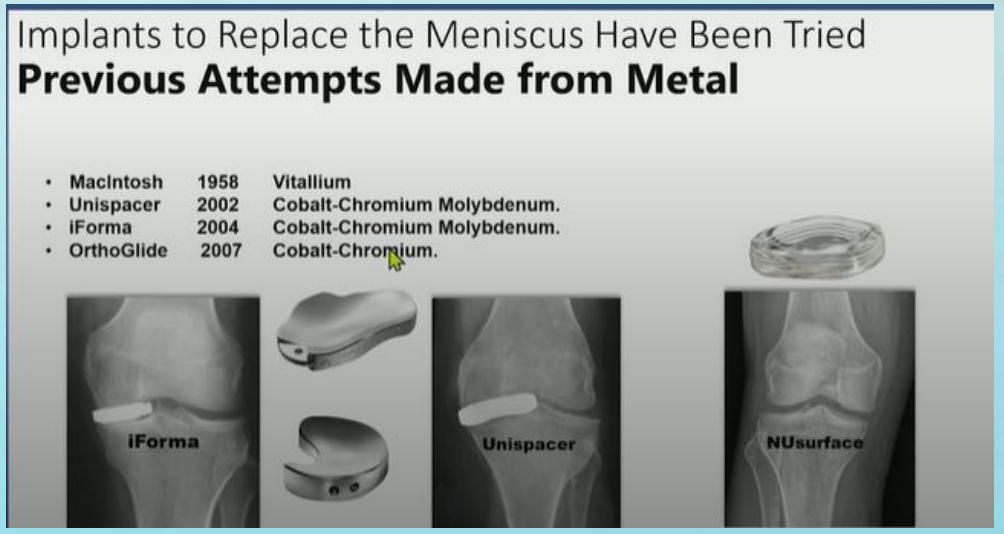


Not exciting conclusion to meniscus repair

- Majority of techniques of meniscus repair yield favorable outcomes
- Intra-op strategies such as rasping, marrow venting and biologics may enhance healing process
- We need more evidence along with better delivery systems

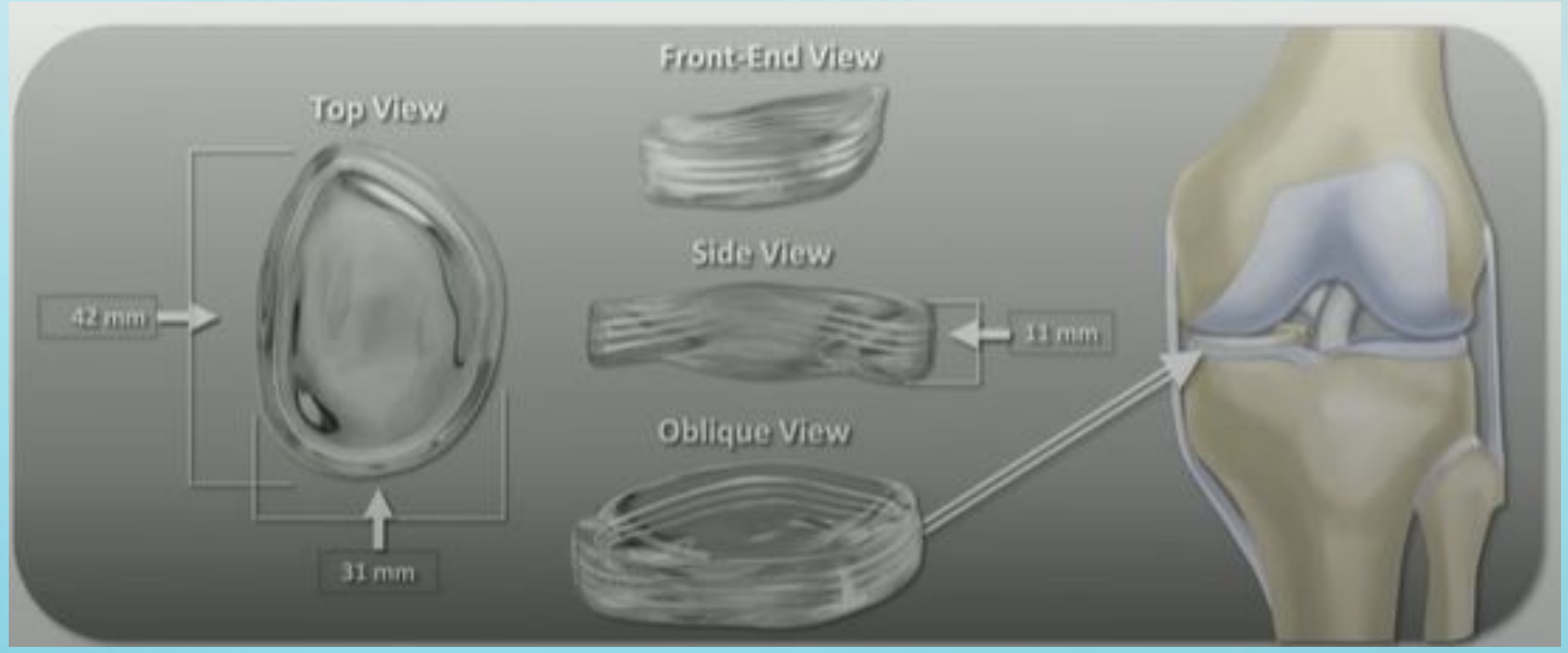
Meniscus Implants

- Partial menisecectomies numbers continue to rise
- There is a clear treatment gap for younger patients that are not candidates for repair or transplant yet are too young for arthroplasty

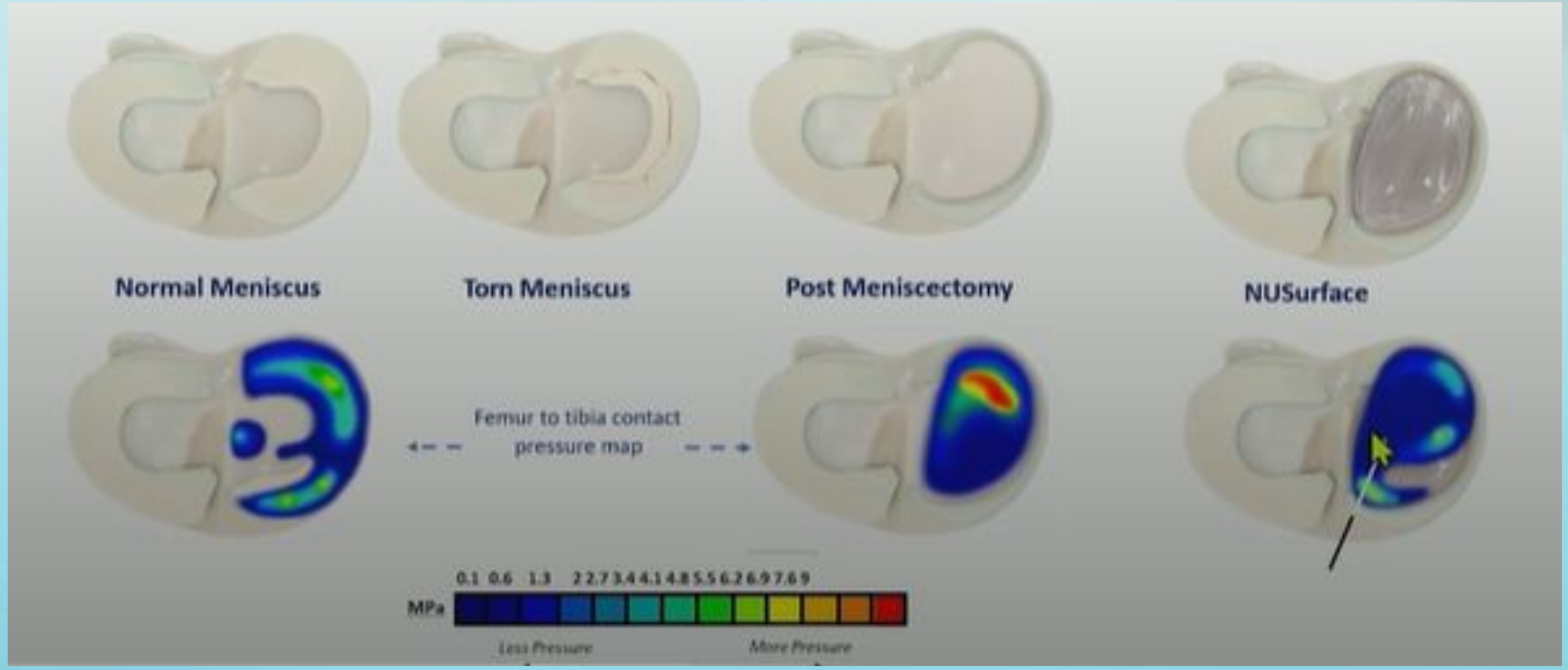


Possible New Implant

- NUsurface – new polymer

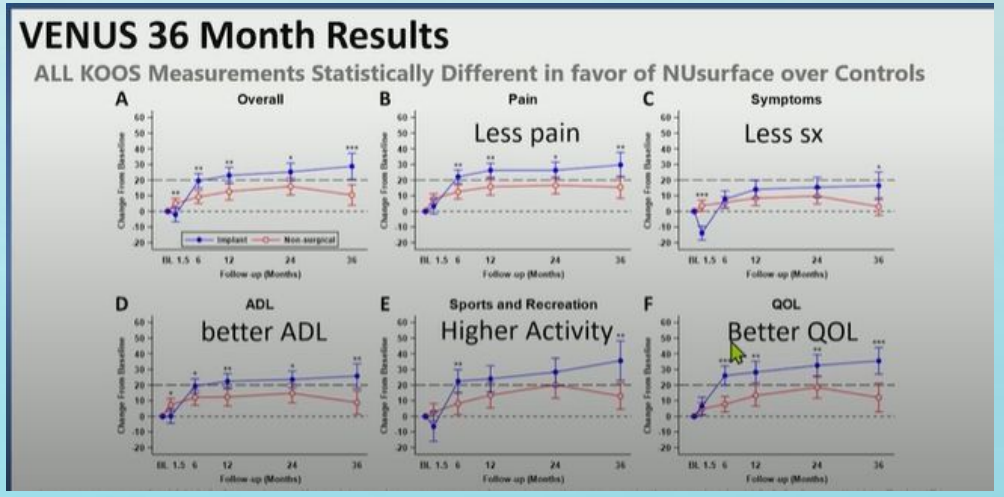


Load Distribution – Biomechanical study



VENUS Study

- Arthroscopically assisted surgery and inserted through mini-arthrotomy
- Need 1-2 mm rim on meniscus
- Movable implant that acts as meniscus spacer



Outcomes

- Nusurface maintained similar KOOS improvements at 3 years
- Controls experienced a 35% decline in KOOS overall improvement between year 2 and 3
- Some promising initial results
- Although still has a 16% failure rate at 2 years that needs to be addressed
  - Although meniscus transplant has a higher rate of revision surgery and a much more extensive surgery to recover from
- But an exciting new technology that could fill a major treatment gap

Thank you