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Avoiding Complications with the Transtibial Technique

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Member of Biomedical Graduate Group
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Sacramento, CA

8 min

Conflict of Interest

- Consultant and receive royalties from Biomet Sports Medicine
- Co-founder of OtisMed and designer of kinematically aligned TKA
- Consultant for Stryker

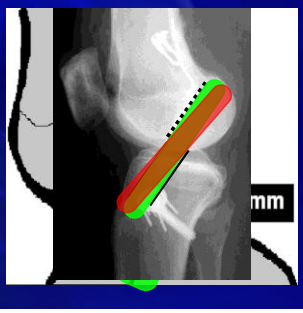
Objective

- Share guidelines for placing the tibial and femoral tunnels in the sagittal and coronal plane that avoids complications with the transtibial technique

Placement of Tibial Tunnel in the Sagittal Plane

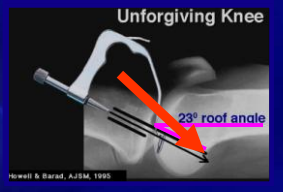
Place Tibial Tunnel 'Just' Posterior to Intercondylar Roof in Extended Knee

- Applies to both the transtibial and AM portal techniques
  - Tibial tunnel must be just posterior to intercondylar roof
  - Anterior placement causes loss of extension and instability from roof impingement



Customize the AP Location of the Tibial Tunnel

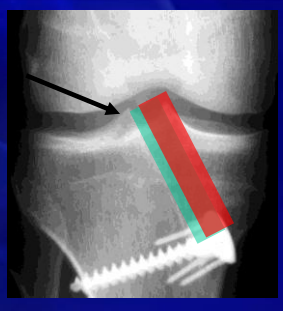
- Applies to both the transtibial and AM portal techniques
  - An 'average placement' results in 'average results' and a higher failure rate
    - Howell, AJSM, 1995



Placement of Tibial Tunnel in the Coronal Plane

Place Tibial Tunnel Between Tibial Spines and Through Tip of Lateral Spine

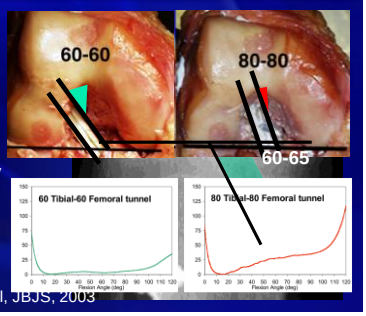
- Applies to both the transtibial and AM portal techniques
  - Tunnel should be between tibial spines
  - Medial placement causes PCL impingement and loss of flexion and instability



Romano, AJSM, 1993

For Transtibial Technique, Set the Tibial Tunnel at an Angle of 60-65^0

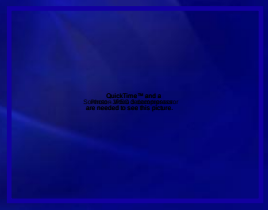
- Places femoral tunnel HALF-WAY down side-wall minimizing loss of flexion and instability from PCL impingement



- Simmons, Howell, Hull, JBJS, 2003

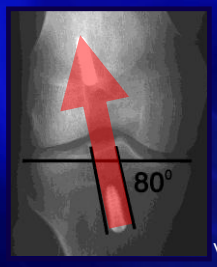
Consider Using a Tibial Guide That References the Intercondylar Roof

- Insert guide
- Extend knee
- Align rod parallel to joint line and perpendicular to tibia, which sets tunnel at 65 degrees



Placement of Femoral Tunnel in the Coronal Plane

Place the Femoral Tunnel Without PCL Impingement



View from Transpatellar Tendon Portal

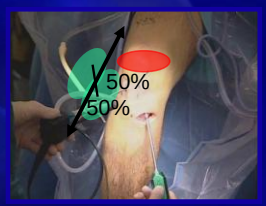
Perform a Wallplasty in Most Knees

- Assess width of notch with a probe that matches width of the ACL graft
- Remove portion of lateral femoral condyle from apex of notch to bottom

View from Transpatellar Tendon Portal

Place Femoral Tunnel NO MORE than Half-Way Down Side-Wall

- Widen notch & avoid placement close to the PCL
- Insert, hook, & rotate aimer away from PCL
  - Moves femoral tunnel down side wall



View from Transpatellar Tendon Portal

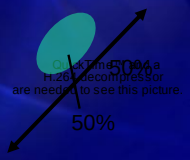
Photograph the 'Triangle' Documenting there is No PCL Impingement

View from Transpatellar Tendon Portal

Placement of Femoral Tunnel in the Sagittal Plane

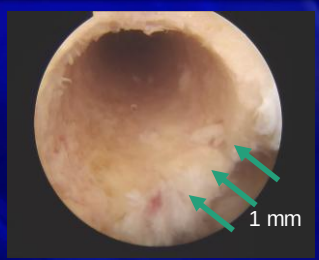
Place the Femoral Tunnel with No More Than a 1 mm Back-Wall

- Applies to both the transtibial and AM portal techniques
  - Consider an over-the-top femoral aimer with an offset no more than 1 mm



View from Transpatellar Tendon Portal

Photograph the 1mm Backwall Documenting the Femoral Tunnel is Posterior



View from Transpatellar Tendon Portal

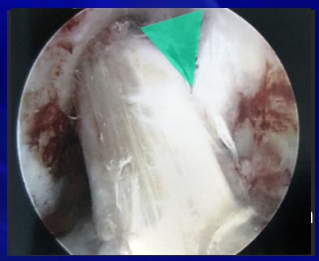
Summary

Findings of Danish ACL Registry

- Anteromedial technique has a 2 times greater risk of revision compared to transtibial technique
- KSSTA, Star Paper, 2012

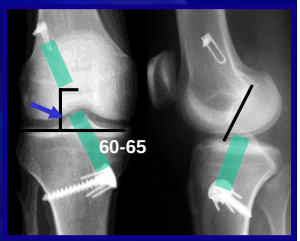
Arthroscopically Document Femoral Tunnel is Well-Positioned

- Photograph 'triangle' showing no PCL impingement
- Photograph 1mm back-wall showing posterior femoral tunnel



Radiographically Document Tibial and Femoral Tunnels are Well-Positioned

- Coronal plane
  - Widen notch
  - Place tibial tunnel through tip of lateral spine
  - Angle 60-65^0 (TT technique)
- Sagittal plane
  - Posterior to intercondylar roof
  - Parallel to intercondylar roof (TT technique)



Thank You!

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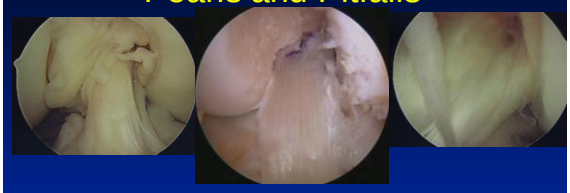
ACL Surgery: Medial Portal Pearls and Pitfalls



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Professor and Chairman
Department of Orthopedic Surgery
Medical Director of Sports Medicine
University of Kentucky School of Medicine

Disclosure

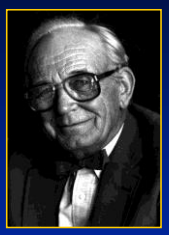
- Consultant: Smith-Nephew Endoscopy
  - Royalties: Instrument development
- Institution: Research/Education
  - Smith-Nephew Endoscopy
  - DJO Orthopaedics

Clinical experience

- 19 years: Academic
- 100% sports practice
- KNEE/SHOULDER
- 450 cases/yr
- 175-200 ACL/YR
- 25-30+ REVISION ACL
- 20 COMBINED PCL/MCL/FCL
- Acute/Chronic
- Fellowship:3 fellows

Reproducing Anatomy

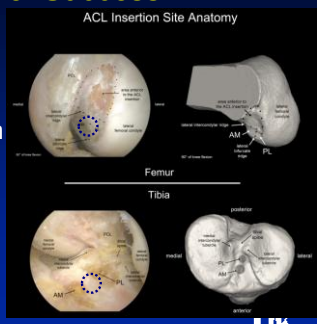
"Whenever you are having your anatomy sessions, pay particular attention, because orthopaedics is all anatomy, plus a little bit of common sense."



J. Hughston

ACL Technique Secret of Success

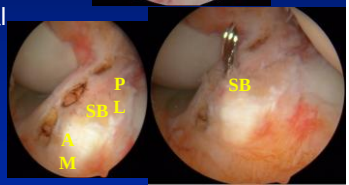
- Perhaps the most important factor for ACL Reconstruction in 2012 is surgical technique!
  - ***Anatomic*** *ACL Reconstruction!*



Forsythe B, Kopf S, Wong A, Martins C, Anderst W, Tashman S, Fu F. *J Bone Joint Surg Am.* 2010;92:1418-1426.

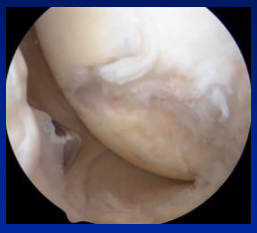
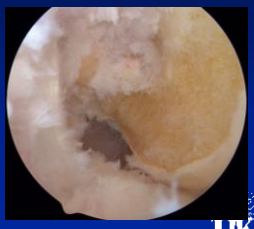
Why Medial Portal drilling??

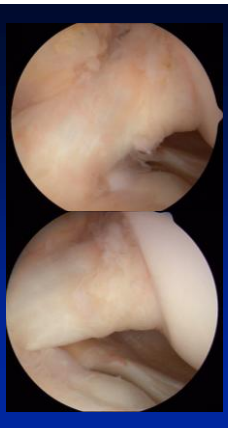
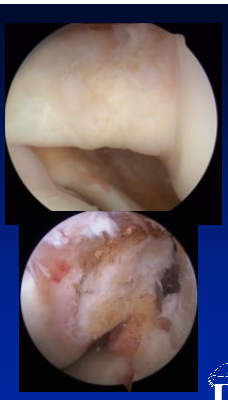
- Anatomy:100% fill of tunnel within native footprint
- Independent tibial tunnel placement
- Size of opening is accurate: not oval



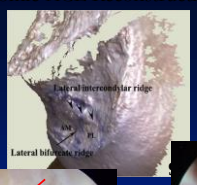
Pitfalls of MP drilling

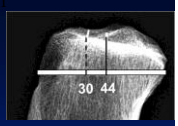
- Damage to MFC
- Short femoral tunnel
- Posterior blow-out

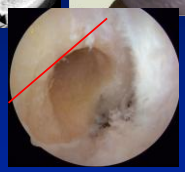
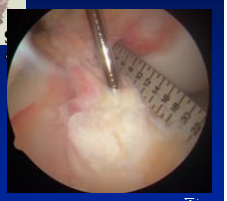



Anatomic ACL Reconstruction



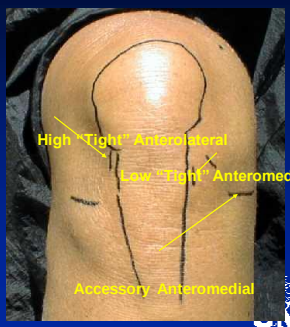
Zantop T, Wellman M, Fu FH, Petersen W. Tunnel Positioning of Anteromedial and Posterolateral Bundles in Anatomic Anterior Cruciate Ligament Reconstruction: Anatomic and Radiographic Findings. *Am J Sports Med.* 2008; 36:65-72.

Patient Setup is Critical

- Patient Set up for Hyperflexion in Arthroscopic Leg Holder
- Note Flexion of Hip Which Allows Knee Hyperflexion

Portal Placement is Critical

- MUST Include Accessory Anteromedial Portal For Drilling and Fixation of Femoral Tunnels



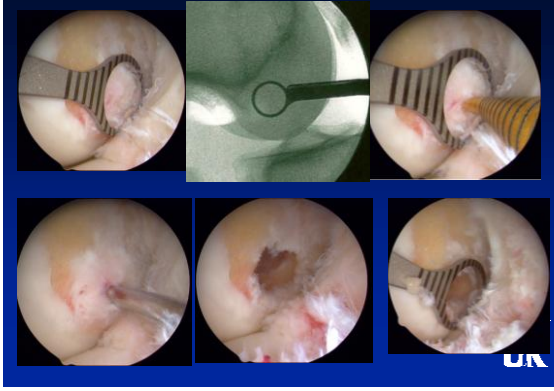
Accessory Far Medial Portal

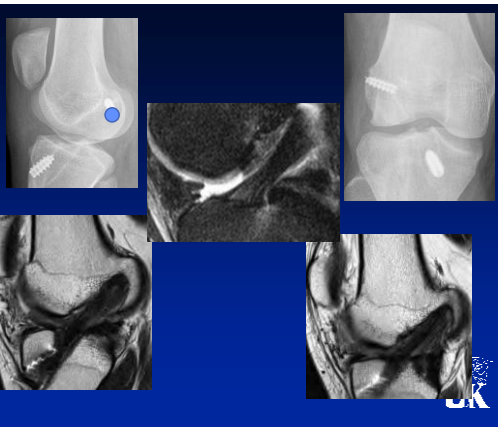
- Create Under Direct Visualization of Spinal Needle
- Just Over Medial Meniscus
- Horizontal Allows Side-to-Side Movement for Drilling and Pins
- Drill is perpendicular to wall: round tunnel not oval!

Drilling femoral tunnel

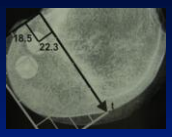
- 130º Flexion
- Guide Pin and Drilling From Accessory Medial Portal
- View From mid portal
- Direction determines tunnel length: 32-40mm
- Aim proximal to FCL

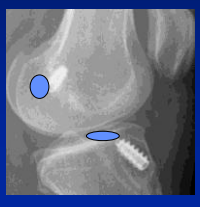
Femoral Tunnel





X-ray Anatomic SB



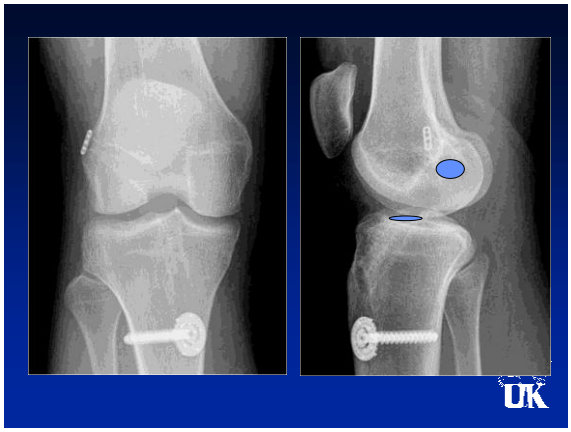


Video Clip

Future of ACL Surgery

We will individualized the surgery/rehab/RTP to the athlete, injury pattern, unique patients anatomy/pathologic kinematics. Not all athletes with an ACL injury will have the same operation/rehabilitation timeline/RTP


THANK YOU
UK


UK

Central Quadriceps Free Tendon Reconstruction of the ACL

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Orthopedic Associates of Hartford
Clinical Professor of Orthopedic Surgery
University of Connecticut School of Medicine
Farmington, Connecticut

- The author is president of the Patellofemoral Foundation that receives undirected grant support from Smith and Nephew and DJO

Why use quadriceps free tendon for ACL reconstruction?

- Easy Access, low morbidity harvest
- Less pain and quicker rehab than other autografts (Joseph et al)
- Preserve hamstrings-no loss of power in flexion
- No added risk of patella fracture
- Strong graft
- Possible simultaneous harvest
- No evidence of anterior knee pain at long term follow up (DeAngelis, Cote and Fulkerson)

Original Descriptions-Quad tendon with bone
Marshall, Blauth, Staubli

- Quad tendon in continuity with patellar tendon: **Clin Orthop 143: 97-106, 1979**.
- Quad tendon with bone: Unfallheilkunde 87: 45-51, 1984

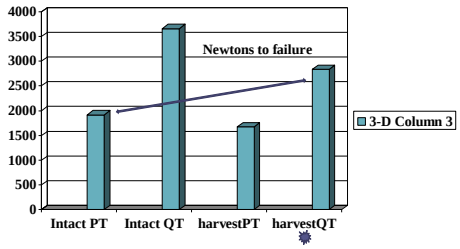
First published description of quad tendon without bone for ACLR 1998

- Isolated Quad tendon without bone**: Techniques in Orthopedics 13(4): 367-374, 1998.**
- Op Tech Sports Med 7:195-200, 1999.

Quad tendon strength

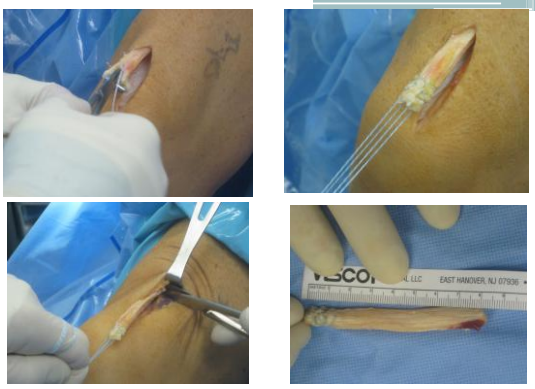
- The Central Quad Tendon is thicker than the patellar tendon
- 9 vs 4.8 mm thick
- Staubli has shown comparable strength
- Partial thickness (7mm) harvest is preferable
- No rupture or problem with quad tendon in 17 year experience using CQT for ACLR

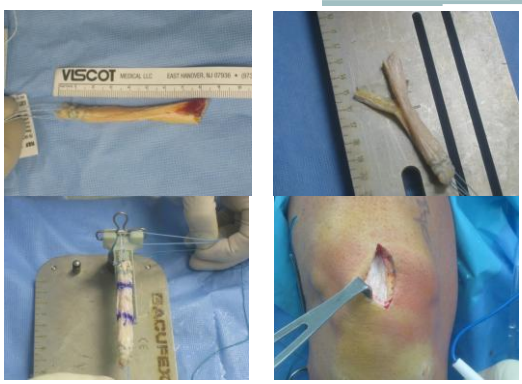
Quad tendon is stronger after CQFT harvest than PT before harvest(Mazzocca)



Release under direct vision

- Pull tendon distally and release
- At least 7 cm from distal end
- Then whip stitch the second end



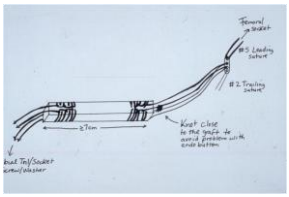


CQFT GRAFT

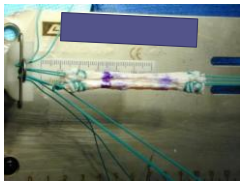
- 2-2.5 cm in each tunnel
- Bone disk option on femoral end to meet screw tip
- #5 nonabsorbable suture whip stitches
- 7 cm long graft or longer

The endobutton works well with CQFT

- Our experience with endobutton fixation has been very successful.
- With four strands of ultrabraid or fiberwire, fixation is extremely secure.
- Short tunnel with anatomic femoral fixation and "bungee cord" effect has not been noted



Preparation

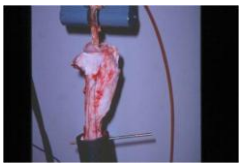


- # 5 whip stitches (4 strands) each end. Currently use Ultrabraid
- Endo button

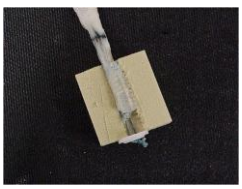
- Play Video

MTS Testing of CQFT Fixation using biointerference screw

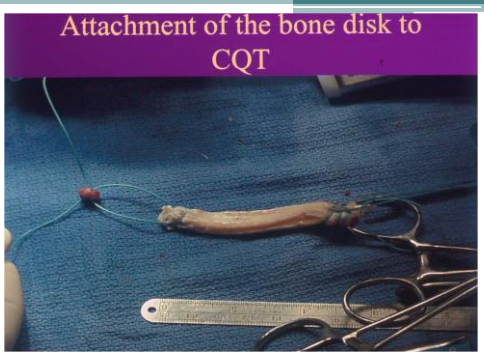
- With ***Compression and Anchor fixation***, using bioabsorbable screw in a"stuffed"tunnel one size smaller than the screw, there is <1mm of slippage after 2500 cyclical loads of 150 Newtons (**Nagarkatti, Jan/Feb 2001 AJSM**)



Load to failure-soft tissue screw with button anchor



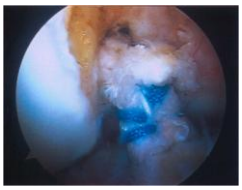
- Note graft tearing beyond screw (density matched foam bone)
- Button reduces slippage to very low level
- Illustration courtesy of Patrick Kwok, M.D.



This is an option, but **I do not currently use this technique**

CQFT advanced into femoral socket

- Graft should be snug in the socket such that passage will require a firm pull and probe assistance
- Ultrabraid, #5 ethibond or fiberwire sutures



My preference

- Endobutton with Ultrabraid (4 strands) whip stitched on femoral end
- With or without biointerference screw femoral side
- Recessed biointerference screw or button on the tibial side

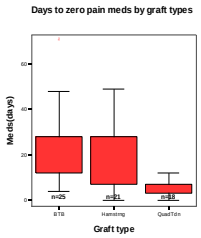
We can say with confidence that you do not need to take a bone block from the patella any more than you need to take bone with a hamstring graft

Double bundle options with quad free tendon

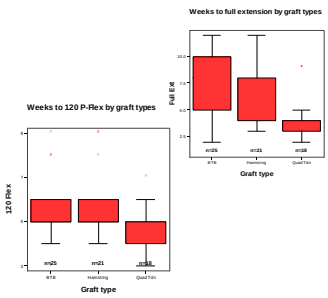
Quad tendon has intermedius and rectus components

Post operative pain medication after ACLR comparing BTB, hamstrings, and CQFT

- Perhaps most striking of all is the consistently diminished pain medication requirements of CQFT reconstructed patients (Joseph, 2000)



Restoration of ROM after CQFT ACLR compared to BTB and hamstring



- Mick Joseph (independent PT) studied BTB, hamstring, and CQFT ACLR prospectively and found more rapid return of ROM in CQFT patients

CQFT data >2 years

- DeAngelis et al. Clinics in Sports Med 26(4), October 2007. 66 month mean f/u (24-105). Five patients with known graft failure out of 154 patients >2 years. Using Noyes' criteria of arthrometric success up to 5 mm side-side, 94% success at > 1 year (86% <3mm). Single leg hop quotient 0.96
- >90% return to pre-injury athletic activity
- Two NCAA national champions after CQFT ACLR- lacrosse (Univ of Virginia) and gymnastics (Univ of Michigan)
- No anterior knee pain or motion loss >2 yrs (Cote)
- Walter Shelton is reporting similar results with quad free tendon ACL reconstruction (Arthroscopy, 2010).

No anterior knee pain or loss of motion at follow up >2 years!

\

Conclusions regarding CQFT

- Very favorable results at average f/u>5 years (DeAngelis, 2007)
- **No ROM loss or anterior knee pain in our f/u.**
- Residual strength of quad tendon after harvest is greater than patella tendon **before** harvest.
- Well suited for double bundle ACLR
- Less post op pain and risk than other autografts
- Least morbid of the autograft alternatives with comparable long term results. Therefore, quad tendon without bone is our first choice autograft for all ACLR patients

VuMedi Webinar
Avoiding Complications and Revision ACL Reconstruction

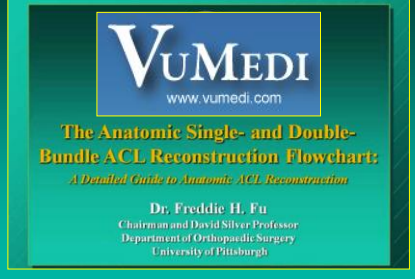
Revision ACL Reconstruction -Causes-

Dr. Freddie H. Fu
Distinguished Service Professor
David Silver Professor and Chairman
Department of Orthopaedic Surgery
University of Pittsburgh
Head Team Physician
University of Pittsburgh Athletic Department

Individualized Anatomic ACL Reconstruction

Anatomic ACL Reconstruction is the functional restoration of the ACL to its native dimensions, collagen orientation, and insertion sites.

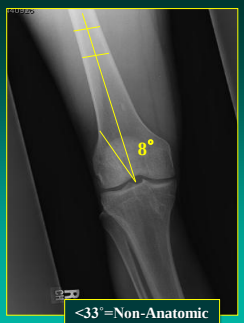
http://www.vumedi.com



van Eck, Fu et al. Arthroscopy, 2010

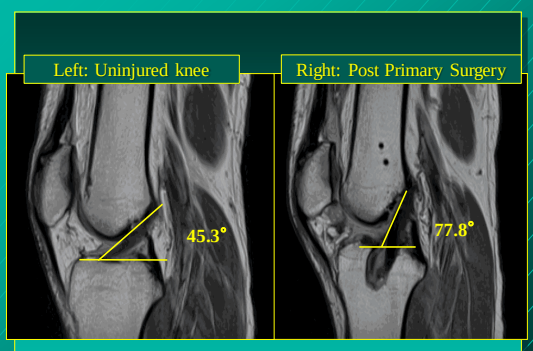
Instability

- 33 y/o male
- Rotational Instability

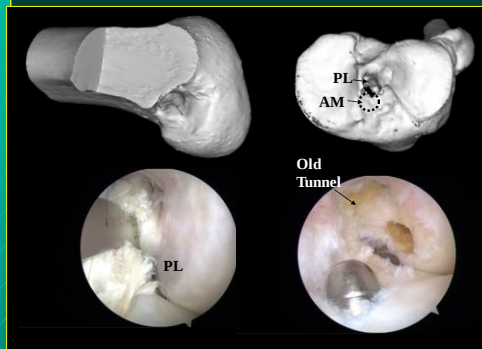


<33°=Non-Anatomic

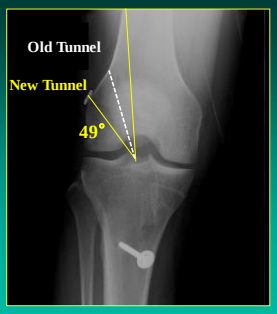
Illingworth, Fu et al. AJSM 2011



Non-Anatomic



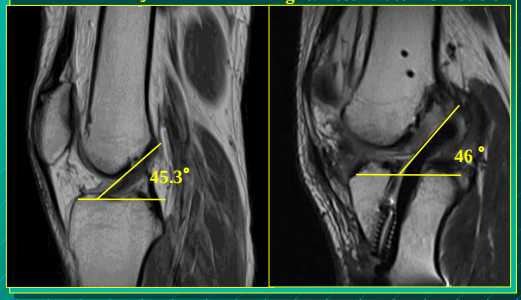
Post Anatomic Revision



Evaluation with MRI

Left: Uninjured knee

Right: Post Anatomic Revision



The American Journal of Sports Medicine

Prevalence of Nonanatomical Graft Placement in a Series of Failed Anterior Cruciate Ligament Reconstructions

Marchant, Noyes et al. AJSM Oct. 2010

122 patients: failed ACL → revision surgery

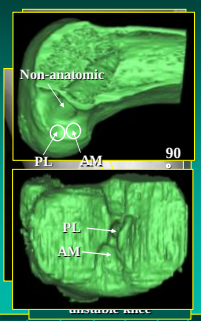
88% of operated knees: non-anatomic tunnels

However; Many Non-Anatomic Grafts Survive

Non-Anatomic

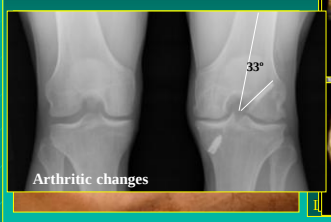
- Single bundle ACL-R >15 yrs
- Stable Knee

Office visit after rescope, stable knee



Non-Anatomic

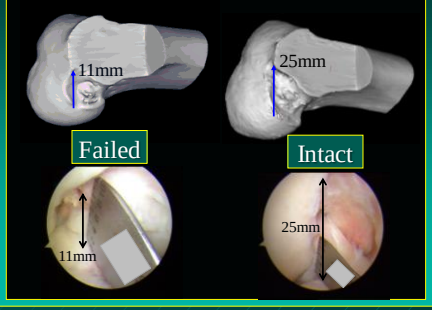
- Transtibial BPTB allograft, 1989
- 20 yrs follow-up
- 11 yrs of professional NFL career
- Stable knee, occasional discomfort



Arthritic changes

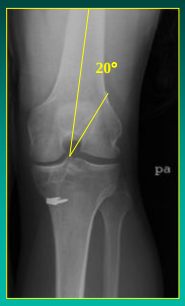
Why Do Non-Anatomic Grafts Survive?

Notch Height Variation

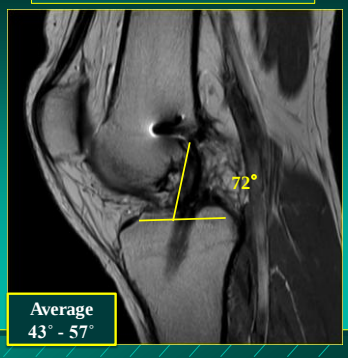


Captured Knee

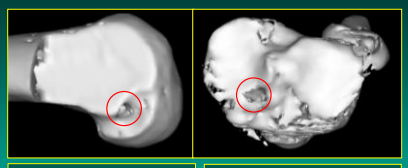
- 27 y/o, male
- 2008: ACL-R
- Pain
- 10° extension lag
- Miserable
- **No instability**



Intact Graft



Non-Anatomic

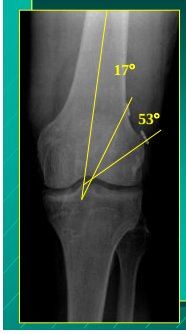


Intact Graft

Non-Anatomic

5 Days Post Op

- Relieved Patient
- Increased Extension



We Have To Eliminate Non-Anatomic ACL Reconstruction as a Risk Factor For Osteoarthritis

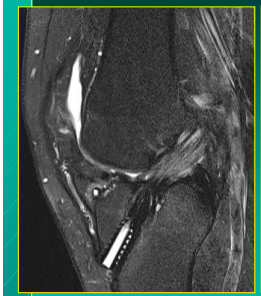
What Did We Tell Our Patients?

- 95% Success Rate
- Back to Activity in 6 Months

Criteria to Return to Sports

- Full Range of Motion
- Quadriceps-Strength
- Graft-Healing?

Return to Sports



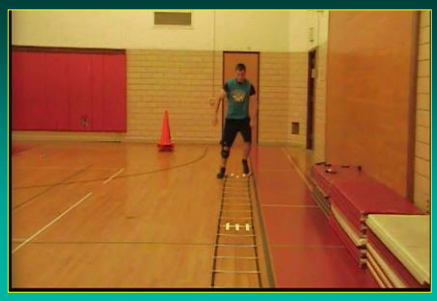
6 Months Post-op:

- Went Back to Practice

→ MRI:

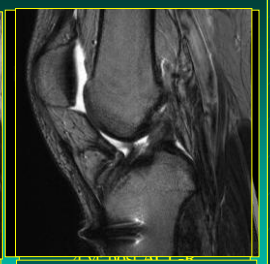
- Immature Graft

Early Return to Activity



Graft Re-Rupture

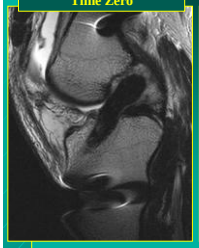
4 months post ACL reconstruction
Unhealed Graft



Re-rupture

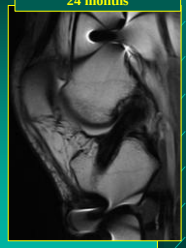
Graft Healing

Time Zero



6 months

24 months



Miyawaki, Fu et al. Ongoing Study

Return to Sports

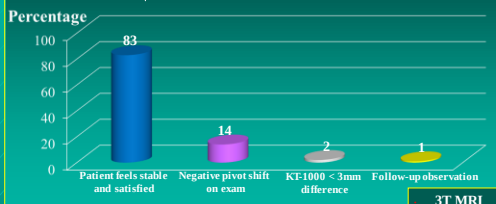
- 6 Months: MRI
- 9 Months Autograft
- 12 Months Allograft

van Eck, Fu et al. AJSM 2012

How Do We Measure Success?

Survey amongst 215 surgeons

Return to Sports ← Subjective



Objective →

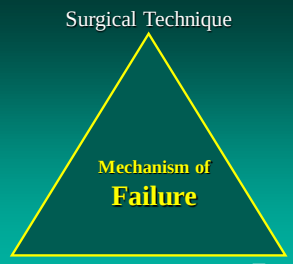
- 3T MRI
- 3D CT
- Biomarkers
- RSA

Orthopaedics Today, 2011

Definition of Failure?

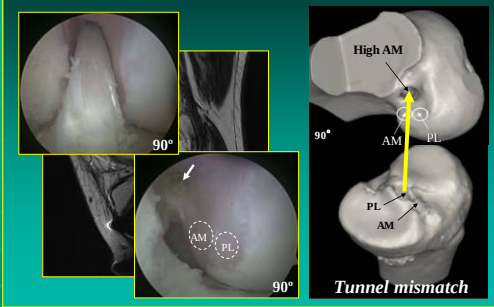
- Re-rupture
- ROM
- Subjective/ Objective Instability
- Pain, Miserable

Revision ACL Surgery



Harner, Fu et al. AAOS 1994

Failure of Graft Incorporation after Non-Anatomic Tunnel Placement



Tunnel mismatch

Conclusions

- Anatomical
- Individualize
- Understand Healing
- Be Critical on Outcome Measurements

Thank You!

Revision ACL Reconstruction

David R. McAllister, MD
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UCLA Athletic Department

Chief, Sports Medicine Service
Professor
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David Geffen School of Medicine at UCLA
Los Angeles, CA
USA

Disclosure

- Member of Medical Board of Trustees and Consultant to MTF

Outline

- Epidemiology
- Causes of Failure
- Pre-operative evaluation
- Surgical considerations
- Clinical Results

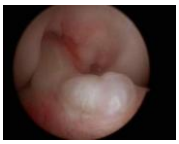
Demographics

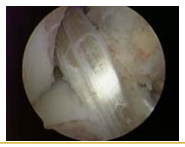
- 250,000 ACL reconstructions per year performed in United States
- Annual incidence of ACL tears in the US is 1 in 3000 Americans
- Average age: 26
- 70% occur as result of indirect contact
- Annual Cost is > 2 Billion dollars
- Graft failure rate is ~8%

4

Goals of Revision ACL Surgery

- Provide stable joint
- Preserve Meniscus
- Maintain full ROM
- Return to sport, work, daily activities
- ? Chondroprotective
  ? Prevent osteoarthritis





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Success

- Functional stability
- Relief of Symptoms
- Return to pre-injury level of activity
- Objective outcomes:
  - Lachman, anterior drawer, pivot shift tests, KT 1000
  - Kocher et al. AJSM 2004
    - Pivot shift is the only test shown to correlate with subjective satisfaction

6

Recurrent Instability

- Early failure (<6months)
  - Surgical technical error
  - Failure of graft incorporation
  - Diagnostic error
  - Incorrect or aggressive rehab
  - Premature return to sport
- Late failure (> 1 year)
  - Significant re-injury
  - Delayed return to sport

7

MARS Study

- 460 patients (57% men; median age, 26 years).
- Mode of failure as deemed by the revising surgeon:
  - traumatic (32%)
  - technical (24%-majority femoral tunnel malposition)
  - biologic (7%)
  - combination (37%)
  - infection (<1%)
- Graft choice for revision ACL reconstruction was 45% autograft, 54% allograft, and more than 1% both allograft and autograft.
- Meniscus and/or chondral damage was found in 90% of patients.

Wright et al, AJSM 2010

8

Surgical Technique

- Most avoidable cause of graft failure
- Technical Errors:
  - Non-anatomic tunnel placement
  - Inadequate notchplasty
  - Inadequate graft fixation
  - Improper graft tensioning
  - Improper graft selection
  - Failure to address secondary stabilizers

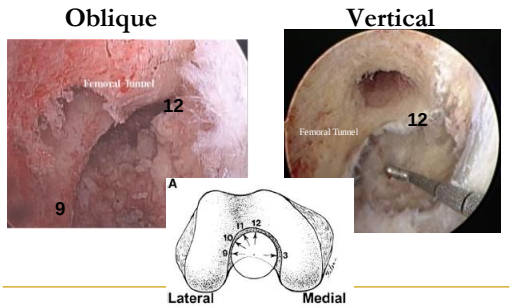
9

Anatomic Tunnel Placement

- Many ACL graft failures are caused by tunnel mal-position
- Aberrant tunnel placement can lead to:
  - **Loss of knee ROM**
  - **Graft impingement**
  - **Stretch-out and Laxity**

10

Femoral Tunnel Placement



11

Femoral Tunnel Placement

- Too Anterior
  - A common error
  - Tight in flexion
  - Lax in extension
  - Loss of flexion or stetch-out of graft
- Too Vertical
  - May not provide enough rotational stability

12

Aberrent Tibial Tunnel Placement

- Too Anterior
  - Notch impingement
- Too Posterior
  - PCL impingement

13

Inadequate Notchplasty

- ACL graft often larger than native ACL
- Need clearance between graft and roof of notch
- Notch large enough to accommodate full ROM
- Inadequate notchplasty
  - Impingement in extension
  - loss of extension
  - Can lead to graft attrition
  - Formation of “cyclops” lesion

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Graft Fixation

- Tibial fixation is weak point
  - Less bone density
    - Dual Photon Absorptometry (DEXA) of the tibial metaphysis less bone density than femoral metaphysis.
  - Angle of force
    - Line of force on graft directly in line with tibial tunnel
    - Line of force on graft oblique to femoral tunnel in WB

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Graft Incorporation

- Biologic failure may occur from:
  - Loosening within tunnel before bony ingrowth
  - Delayed remodeling of allografts
  - Avascularity caused by over tensioning of graft
  - Avascularity from allografts
  - Allograft immunologic response
  - Infection

16

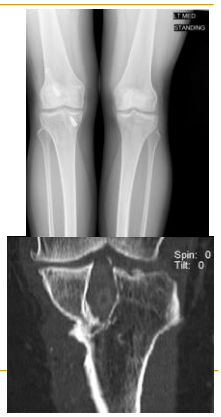
Pre-operative Evaluation

- Etiology of failure
- Is there symptomatic instability?
- Whether or not a patient is a candidate for revision

17

Radiographs

- X-rays: AP, lateral, 45° PA weight bearing view
  - Arthritis
  - Size and position of previous tunnels
  - Previous hardware
  - Notch architecture
  - Alignment
- CT
  - Bone tunnel enlargement
- MRI
  - Bone tunnel enlargement
  - Graft integrity
  - Associated injuries



Surgical Considerations

- Staging
- Graft selection
- Hardware removal
- Notchplasty
- Bone tunnel placement
- Graft fixation
- Rehabilitation

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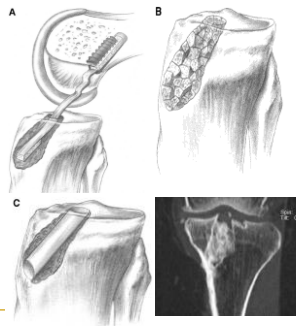
Staging

- Tunnel expansion
  - Bone grafting as a separate procedure required less than 10% of cases in MARS series
  - Wright et al, AJSM 2010
- Loss of motion
- Limb mal-alignment



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Graft Selection

- Auto vs Allograft
  - Allograft
    - Advantages
      - Shorter operative time
      - Smaller incisions
      - Avoid donor site morbidity
      - No size limitation (for large tunnel diameters can use a large bone plug)
    - Disadvantages
      - May play role in failure
      - Longer incorporation times
      - Immunologic reaction
      - Higher cost
      - Disease transmission
        - Radiation kills viruses but required dosage alters graft integrity

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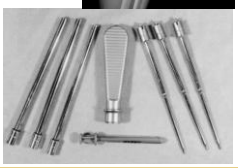
Surgical Considerations

- Hardware removal
  - Remove only when necessary
  - Commercially available revision set may be helpful
  - Use fluoroscopy, if necessary
  - Avoid stripping screw head
  - Knee flexion angle should be the same as when screw was inserted
- Notchplasty
  - As necessary



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Tunnel Placement

- The most important and challenging hurdle
- Anatomic vs non-anatomic
- Tunnel widening or no tunnel widening

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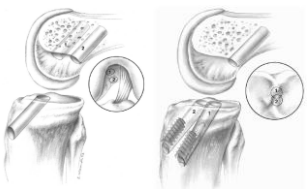
Tunnel Placement

- Non anatomic tunnels
  - Drill new anatomic tunnels
  - Leave old hardware in place



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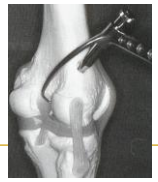
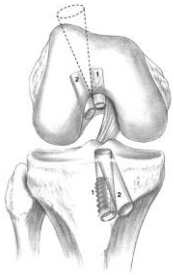
Tunnel Placement

- Anatomic or near anatomic
  - Remove old hardware
  - Redirect anatomic tunnel
  - Two incision technique, AM portal, etc.





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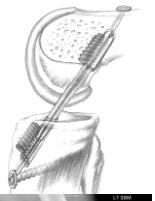
Tunnel Placement

- Tunnel widening
  - Staged bone grafting
  - Stacked interference screws
  - Larger bone plugs
  - Bone Dowels

26

Graft Fixation

- Secure graft fixation is critical
- May re-enforce primary fixation
  - Post and washer
  - Staple
  - Endobutton
  - Stacked interference screws



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Revision ACL results

- Diamantopoulos et al. AJSM 2008
  - 107 pt with 73 month f/u
  - Avg Lysholm score was 88.5
  - 62/107 had normal or near normal results on IKDC
- Battaglia et al. AJSM 2007
  - 63 pt with 72 month f/u
  - 71% good to excellent results
  - 59% returned to sports
  - 25% required additional surgery

Cartilage Status at the Time of Revision

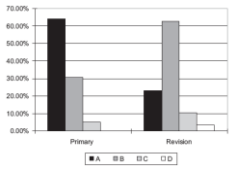
No cartilage defects:	39 (36.5%)
Grade I	2 (1.8%)
Grade II	37 (34.6%)
Grade III	21 (19.6%)
Grade IV	8 (7.5%)

- O'Neil et al. AJSM 2004
  - 48 revision ACL with f/u of 90 months
    - 73% had normal or near normal scores on IKDC
    - 6% failure rate
  - 225 primary ACL
    - 92% had normal or near normal scores on IKDC
    - 7% failure rate

28

Comparative Studies

- Ahn et al. AJSM 2008
  - 56 revision vs 117 primary reconstructions
  - Variety of grafts used (hamstring autografts, BTB allograft, Achilles allograft)
  - No difference in laxity
  - Lysholm score 63 vs 93
  - IKDC score 85% A/B vs 95% A/B
  - No differences between grafts used



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Summary

- Revision ACL reconstruction will continue to be a growing problem
- Identify the cause of failure
- Identify the appropriate candidate for reconstructions
- Need meticulous pre-operative planning
- Inform patients on appropriate expectations

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Thank You