

ACL Surgery: Avoiding Revisions

**Oregon Association of Orthopedics
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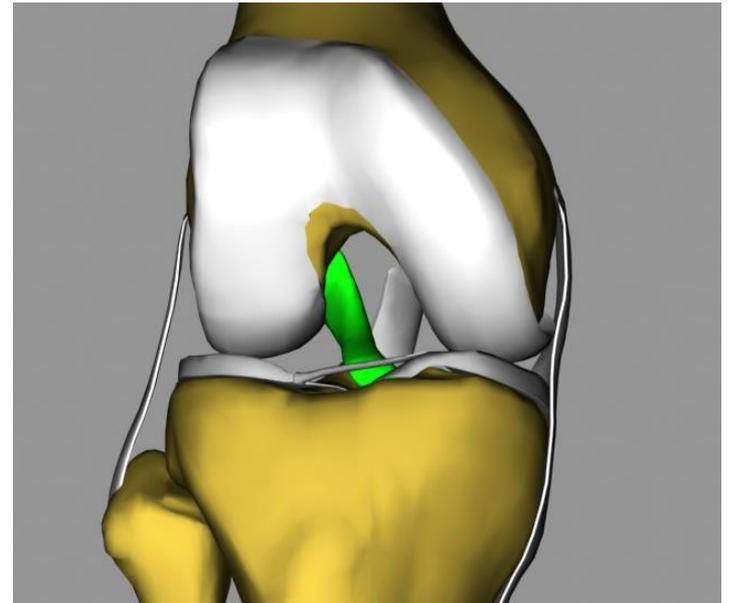
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Employment

Oregon Health & Science University

Volunteerism

Mount Hood Meadows Emergency Mountain Services
Portland State University Athletics

Independent consultant/publication committees

Joint Restoration Foundation (Colorado)
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Histogenics (Massachusetts)
Zimmer (Texas)
Medinet (Japan)

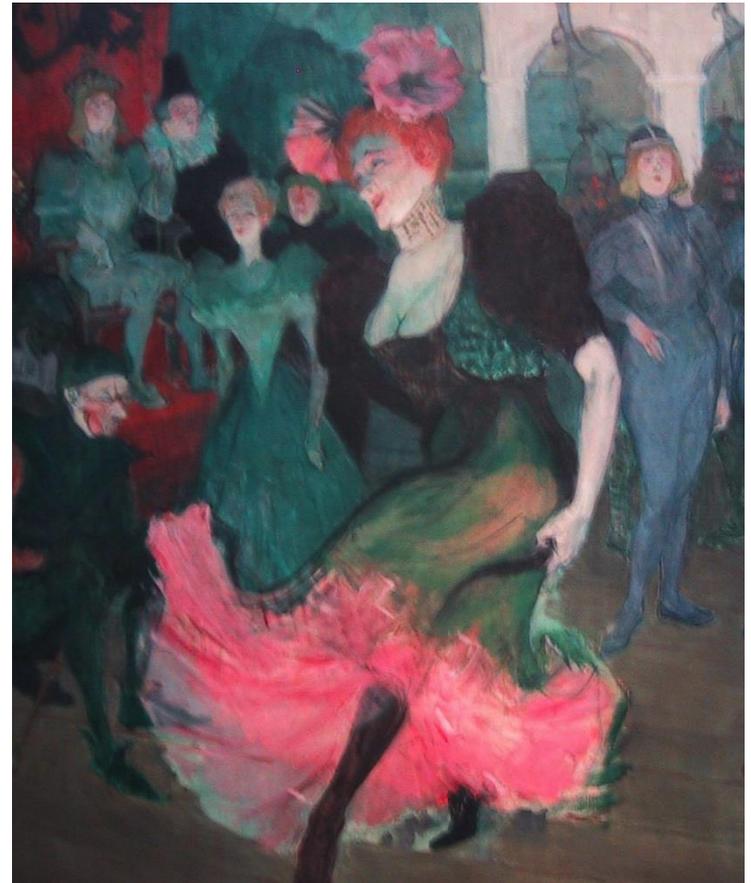
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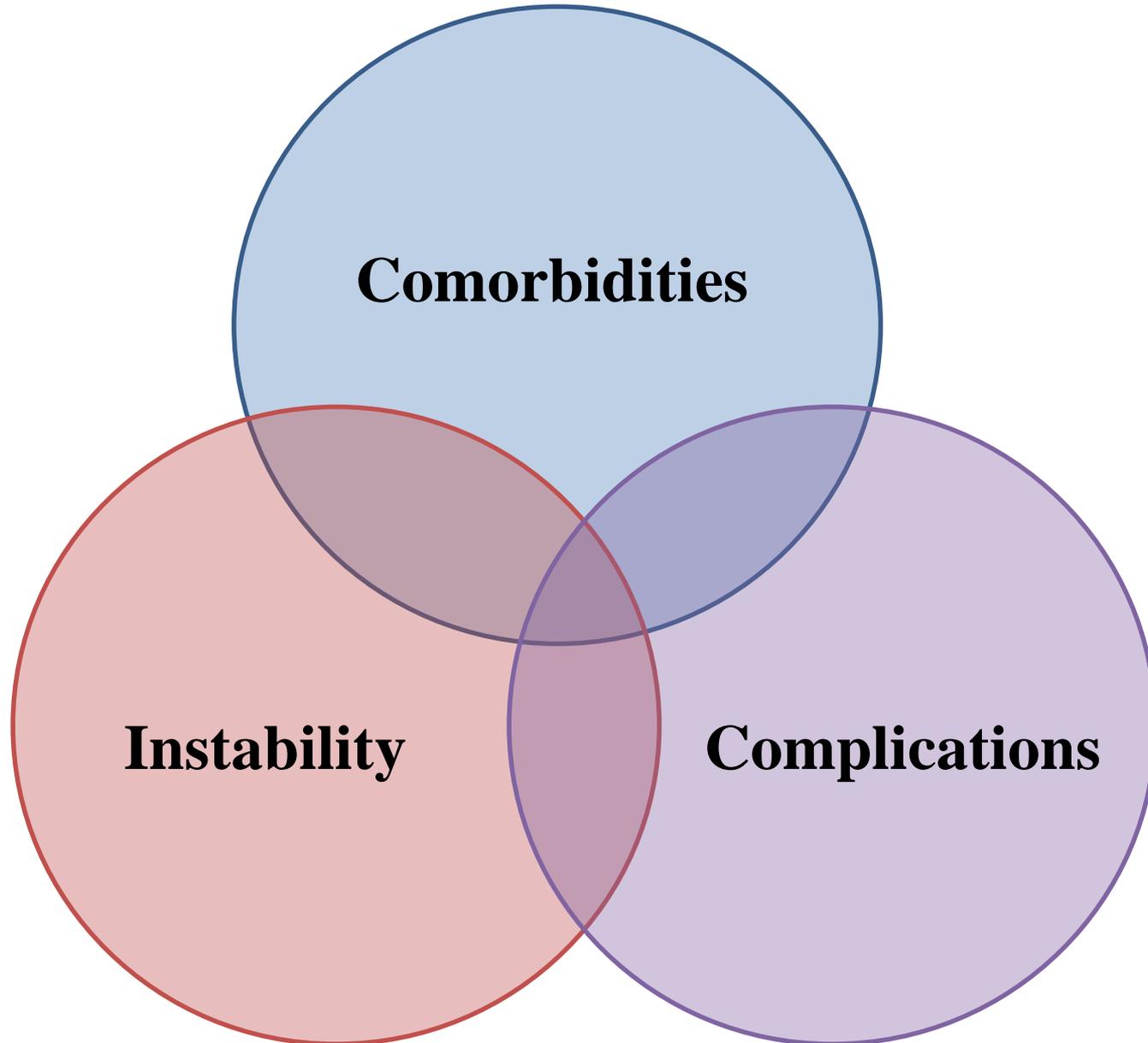


Introduction to Revision ACL

- **Incidence:** 30 primary ACL reconstruction per 100,000
 - “Success” rates: ~75 – 95 %
 - Thus 5-25% ACL surgery “fail”
- **~100k revACLs** in US/year
 - Increasingly common
 - Significant # of pts undergoing ACL reconstruction are at risk of unsatisfactory outcome



Patient “Dissatisfaction” Factors



Categories of Failure

- No singular definition of “failure”
- **Recurrent instability**
 - Graft failure
 - Re-rupture
 - Under/imbalanced constraints
- **Postoperative complications**
 - Infection, loss of motion, fracture, hardware related (pain/hydrolysis)
- **Comorbidities related to concomitant abnormalities**
 - Malalignment (Coronal, Sagittal)
 - Extensor dysfunction (e.g., arthrofibrosis, patella compression/baja)
 - Donor site pain (BTB > HT)
 - Cartilage damage
 - Osteoarthritis spectrum
 - Meniscus tears



Non-graft related causes of ACL failure

- **Loss of motion**
 - Non-anatomic graft placement
 - Impingement
 - Infection, Capsulitis
 - Cyclops lesion
 - Concomitant ligament surgery
 - Immobilization
- **Extensor mechanism dysfunction**
 - Anterior knee pain
 - Donor site pain
 - Quadriceps muscle weakness
 - Patellar tendonitis
 - Patellar fracture
 - Patellar tendon rupture
- **Degenerative Arthritis**
 - Initial traumatic event (bone bruise)
 - Meniscectomy
 - Damage secondary to recurrent giving way
- **Hardware Related**
 - Impingement/mass effect
 - Aseptic hydrolysis v. Infection
 - Crawford et al. OJSM 2015

Differentiating Occult *Propionibacterium acnes*
Infection From Aseptic “Biologic” Interference Screw
Hydrolysis After ACL Reconstruction. OJSM 2015

**Introducing a Novel Culture Protocol
for Detecting Low-Virulence Organisms**

Kathryn Metcalf,* BA, Jia-Wei Kevin Ko,* MD, Samantha Quilici,* PA,
Penelope Barnes,* MBBS, PhD, and Dennis C. Crawford,*[†] MD, PhD

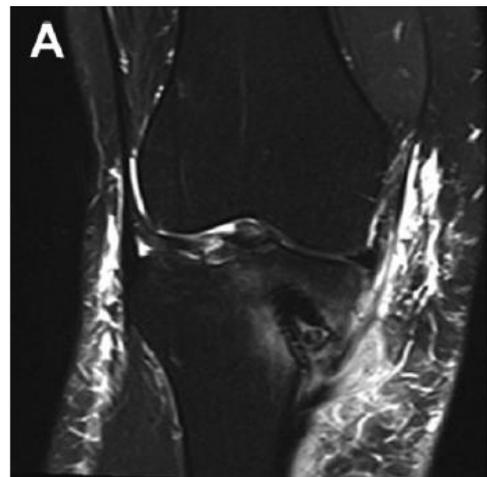
*Investigation performed at the Department of Orthopaedics and Rehabilitation,
Oregon Health and Science University, Portland, Oregon, USA*

- Present 2 cases of insidious proximal tibial pain > 2 years post ACL recon with “BioAbsorbable Tibial Fixation”
 - Infection v. “Bio-Absorbable” screw hydrolysis & fragmentation
- Describe a specific culture procedure developed to identify occult device related infection from aseptic “biologic” interference
 - Institutional Standard of Care OHSU (Barnes et al.)

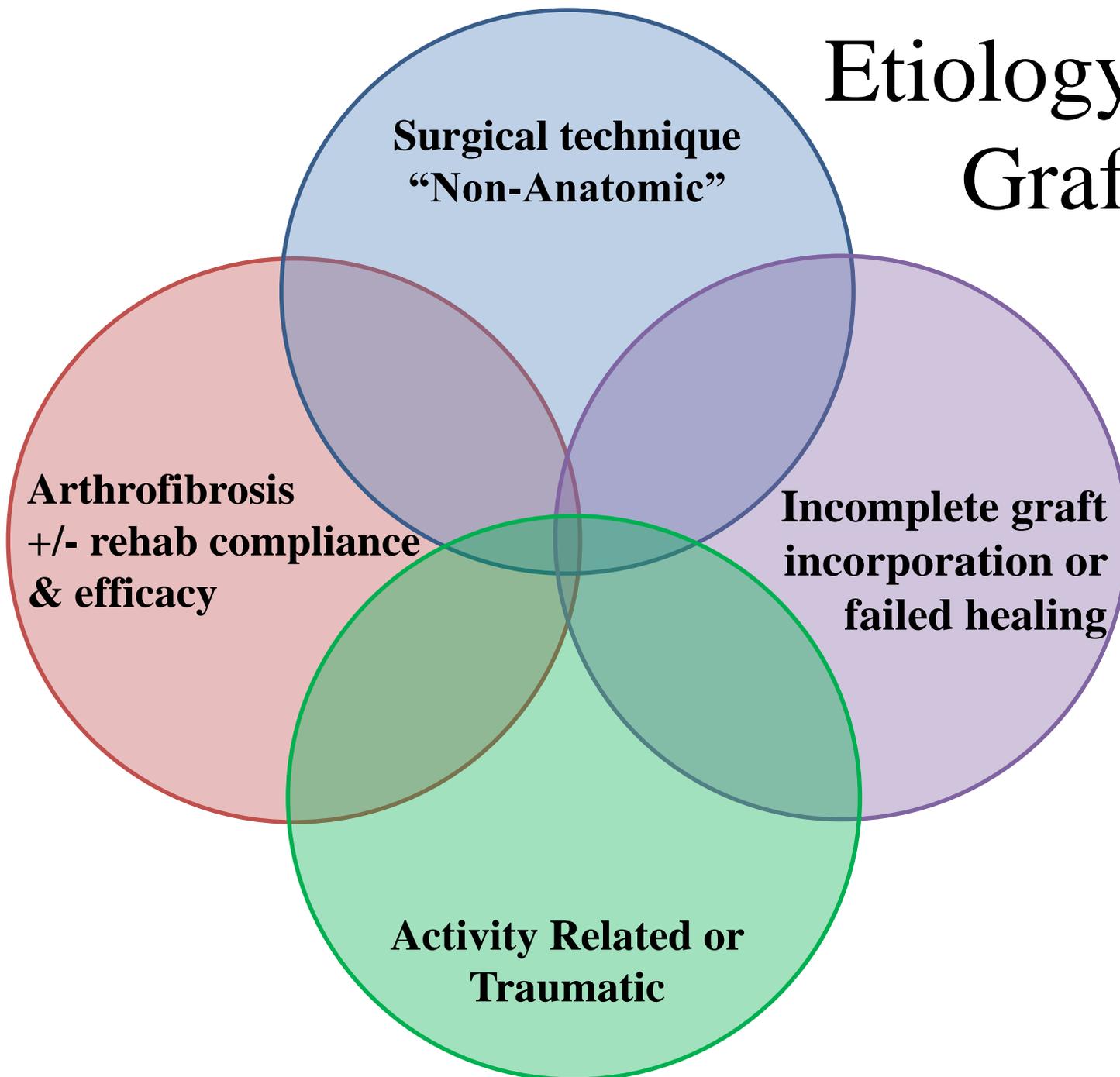
Differentiating Occult *Propionibacterium acnes* Infection From Aseptic “Biologic” Interference Screw Hydrolysis After ACL Reconstruction. OJSM 2015

Culture Procedure

- 6 samples from “region of greatest suspicion”
 - 5 → microbiology
 - 1 → surg. pathology
- Each specimen taken with separate clean instrument
- Samples incubated on **blood agar** and **chocolate media** plates aerobically & anaerobically for **5 days (Kaiser Lab, Portland)**
- Samples incubated in **thioglycolate broth** anaerobically for **10 days.**
- Allows for growth of fastidious organisms (e.g. *Propionibacterium*)

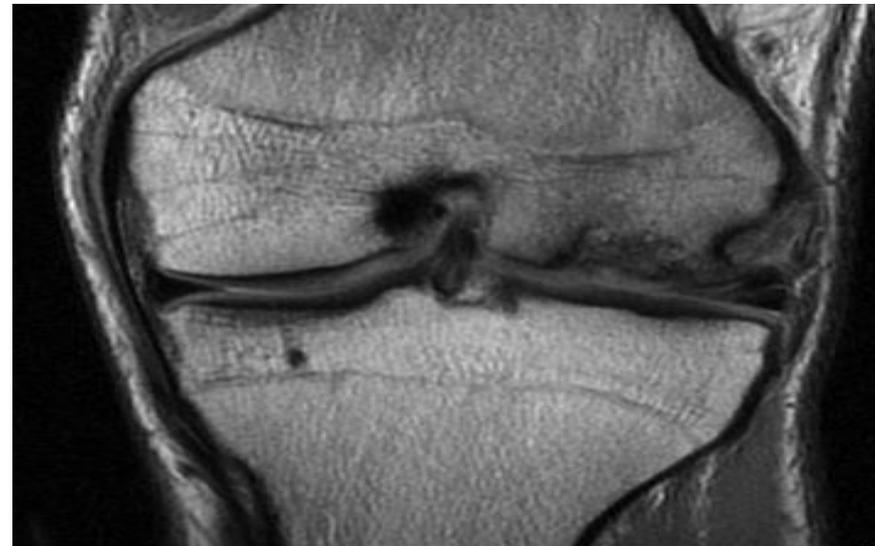


Etiology of ACL Graft Failure



Etiology of ACL Graft Failure

- Early Failure (<3 months)
 - Incomplete incorporation or healing
 - Biologic vs. Mechanical
 - Irradiated Grafts, Failed fixation, infection
 - Arthro-fibrosis
 - Rehab/restriction compliance
 - Mechanical blocks
 - Poor tunnels
- Mid-term Failure (3-6 months)
 - Surgical Technique
 - Failure to restore stability
 - Secondary pathology manifests
 - Unable to return to activity
- Late failure (> 6 months)
 - Return to Sports & re-injury
 - Consider activity modifications
 - Progressive degeneration
 - Missed or occult cartilage injury?



Technical Issues: US MARS study group

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J Knee Surg. 2012 November ; 25(5): 361–368. doi:10.1055/s-0031-1299662.

Femoral Tunnel Malposition in ACL Revision Reconstruction

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¹Department of Orthopaedic Surgery, Mayo Clinic, Rochester, Minnesota

MARS Multicenter Anterior cruciate ligament (ACL) Revision Study

460 revisions performed by 87 surgeons

- 276 (60%) “technical cause of failure”
- 219 (48%) femoral tunnel malposition
- 117 (25%) **femoral tunnel primary cause of failure**
 - 42 (36%) too vertical
 - 35 (30%) too anterior
 - 31 (27%) too vertical & anterior

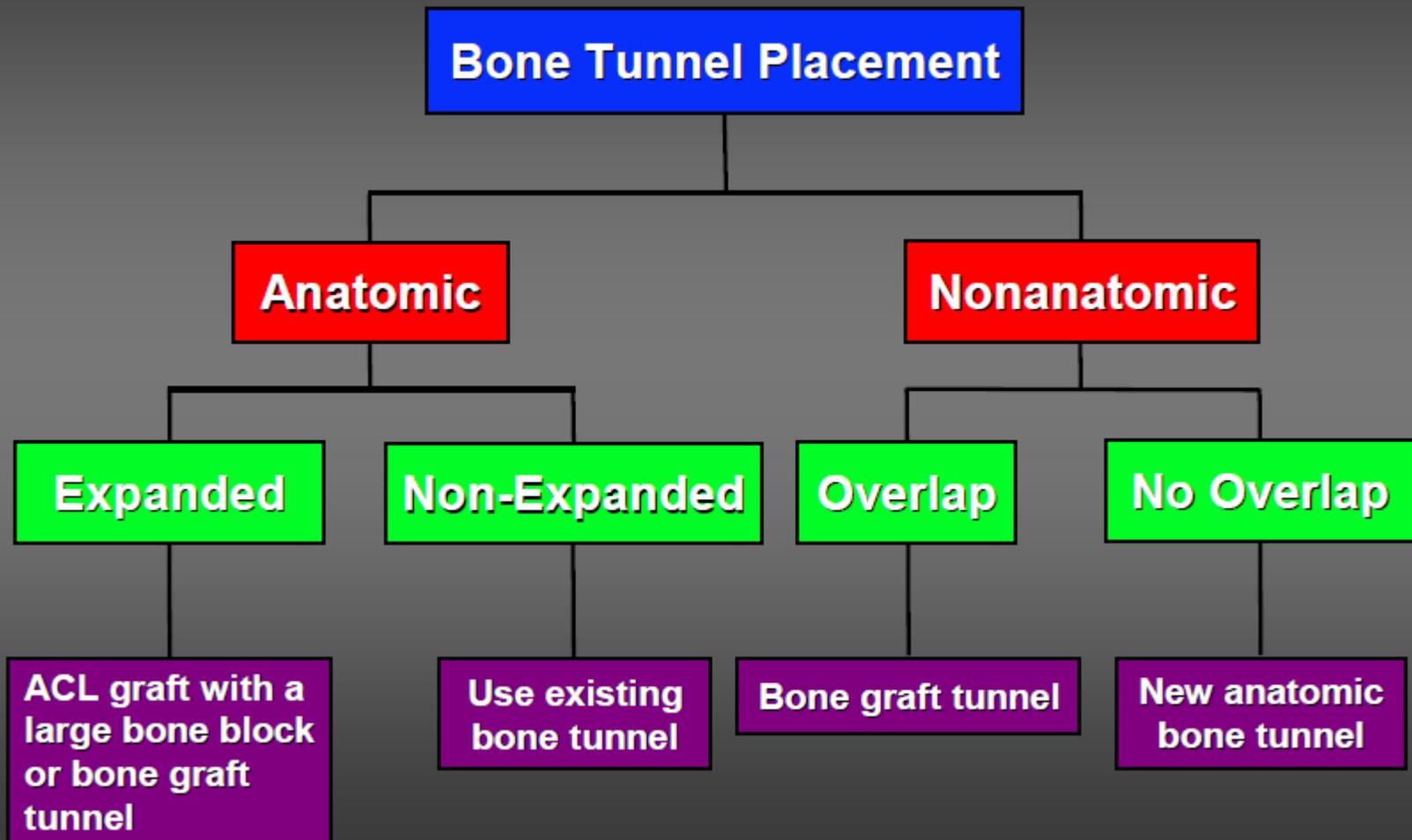


“Tunnels” Considerations

- Tunnel Malposition
 - Femoral tunnel
 - Tibial tunnel
- Tunnel preparation
 - Avoid over drilling
 - NO tourniquet
 - Use AM portal if Transtibial constrains
- Tunnel “widening”
 - Radiographs
 - Not necessarily quantitatively accurate > CT



Preoperative Bone Tunnel Assessment



Preoperative Evaluation

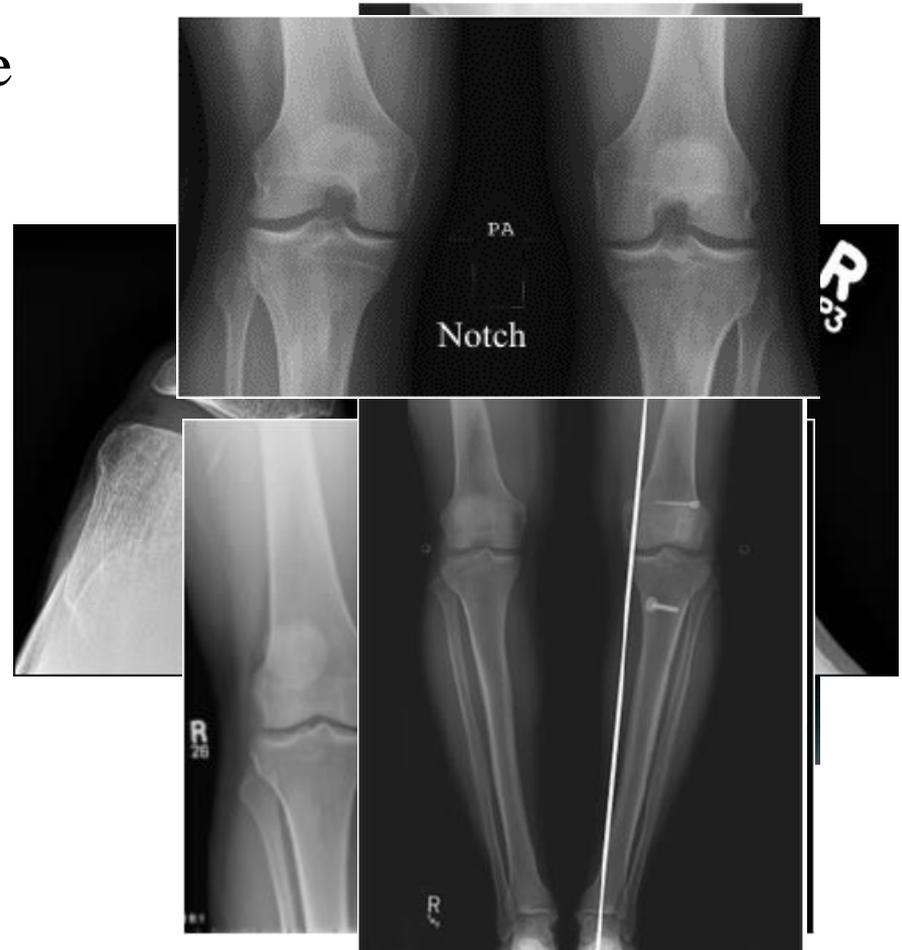
- **Determining patient dissatisfaction origin**
 - Recurrent instability
 - Postoperative complications (Arthrofibrosis, pain, mechanical)
 - Pre-existing comorbidities (Alignment, BMI, cartilage/meniscus injury)
- **Indications for revision ACL**
 - “Reconstruct a ruptured or incompetent ACL graft after ACL reconstruction with goal of stabilizing the knee...maximizing function and activity level. Be cautious of ability to effect complete pain relief”
- **History**
 - Cause of injury, history of re-injury, symptoms (pain v. instability), original graft type, operative technique, graft fixation, rehab timeline & compliance, return to activity (level & timing)
- **Physical examination**
 - Alignment, gait (varus thrust, hyperextension), p/a ROM, Extensor mechanism, ligament exam, incisions, quad atrophy?

Preoperative Evaluation

Radiographic examination:

Preoperative imaging should be assessed for:

- Presence of interfering hardware
- Tunnel position
- Tunnel expansion
- **X-rays**
 - True lateral (tib. Tunnel)
 - AP view (fem. Tunnel)
 - Merchant's view (both knee)
 - Standing AP and PA @ 45 flexion views AP view both knees (joint space narrowing)
 - Standing long films of lower extremities (align.)



Preoperative Evaluation

Imaging:

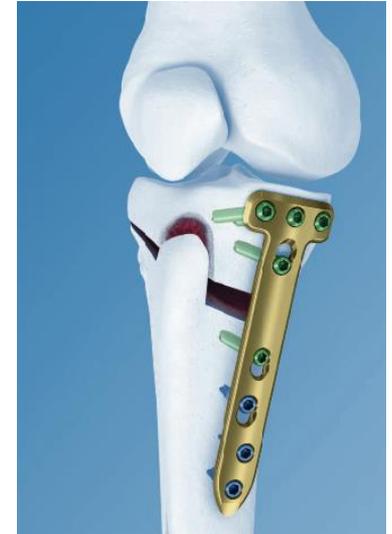
- CT scan
 - Tunnel trajectory/size
 - Bony avulsion/cortex integrity
- MRI Scan
 - ACL graft
 - Articular cartilage
 - Collateral ligaments
- Bone Scan (+/-)
 - Osteoarthritis
 - Infection



Preoperative Planning: Expectations

Essential for patients to understand the **realistic outcomes** after revision ACL

- Restores stability (possibly 100%)
- Unpredictable “return to activity”
 - Lose ~1 level Tegner activity scale
- May not relieve pain from...
 - Extensor mechanism dysfunction (TTO)
 - Compartment overload
 - Patella femoral dysfunction (TTO)
 - Varus/Valgus overload/thrust (HTO/DFO)
 - Articular cartilage injury
 - repair v. transplants



Preoperative Planning

“Success” of revision ACL influences:

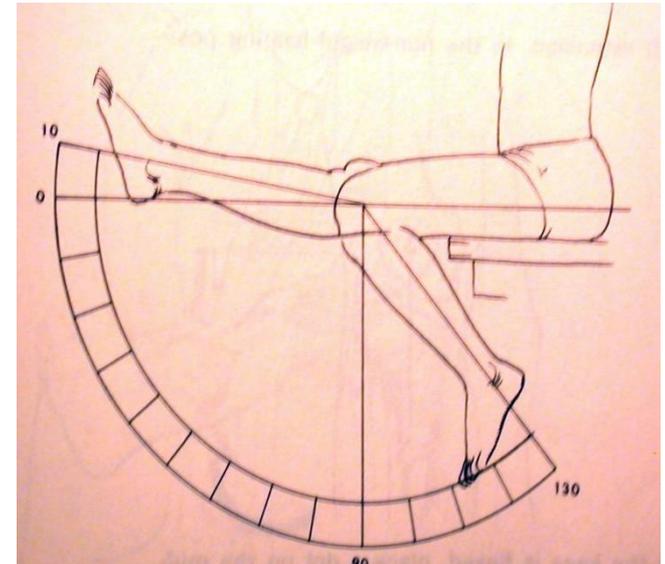
- Patient expectations
- Etiology of primary failure
 - Graft, surgical technique, trauma
- Pre-operative laxity of the knee
 - secondary restraints
- Status of cartilage
 - Lateral Meniscus!, Hyaline, OA
- Patient demographic: Risks
 - Gender, age, general health & activity, employment status, Weight gain, education



Preoperative Planning

Important **preoperative factors**:

- Range of motion
- Placement of previous incisions
- Type of graft previously used
 - Which autografts maybe available?
- Type & location
 - Fixation hardware
 - Bone tunnels
- Presence of associated
 - Ligamentous injury
 - Cartilage injury
 - Bone integrity/density



Preoperative Planning

Staged procedure may be required when there is:

- Loss of motion
 - Release/Debride > MUA prior
 - PT; restore A&P ROM
 - 1-6 months
- Massive bone tunnel enlargement
 - Bone grafting & healing
 - ~ 6 months, consider CT
- Overlapping bone tunnels fixation
 - Associated Medial MAT



Graft selection: Autograft



Advantages

- Faster and more complete biological incorporation
- No added costs
- No risks of disease transmission
- Better objective stability results and lower failure rate compared to allografts

Disadvantages

- Autograft tissue may not be available
- Donor site morbidity
- Greater surgical exposure required
- Limited soft tissue and bone block size

Graft selection: Allograft



Advantages

- Wide variety of tissue Possible cost
- No limitation of soft tissue or bone block size
- No donor site morbidity
- Decreased operative time (no autograft harvest required)

Disadvantages

- Cost
- Slower graft incorporation
- Risk of disease transmission
- Inferior objective results and higher failure rate compared to autografts

Technical considerations in ACL revision surgery

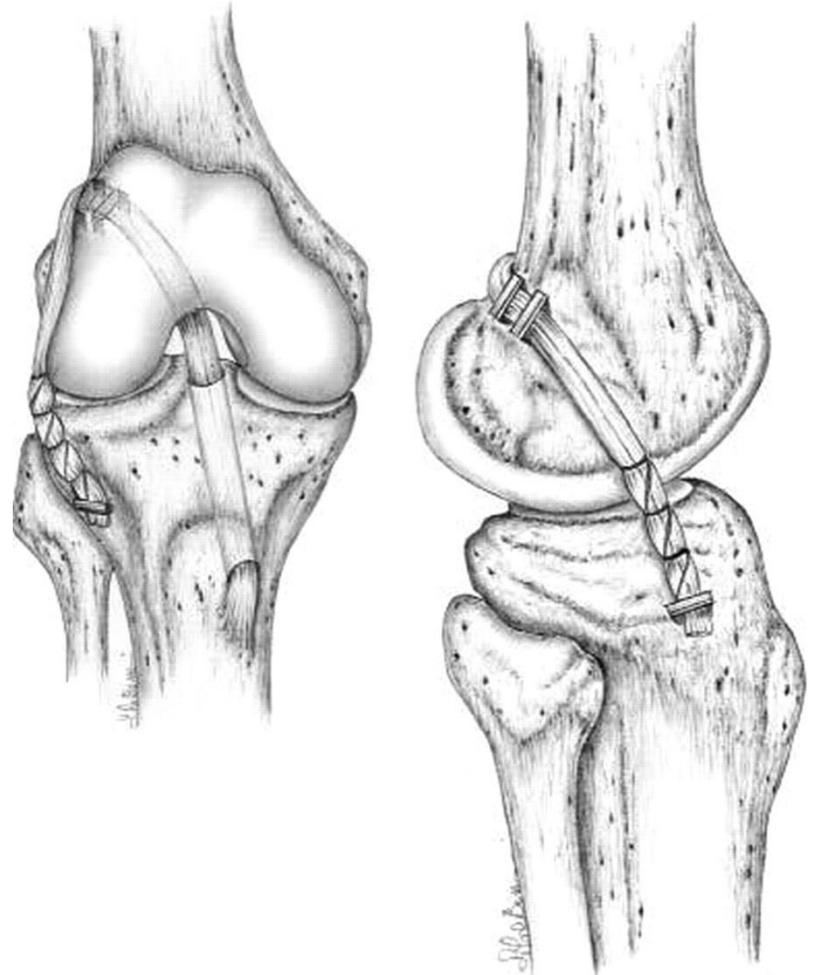
- Skin incision; placement may allow simultaneous:
 - Graft harvest
 - Drilling of the Tib. Tunnel
 - Tibial graft fixation
 - But do not constrain approach
- Hardware removal:
 - Don't underestimate; -"no one looks good taking out"
- Leave secure hardware if it does not interfere
- Bone tunnel placement most technically challenging
 - Best: recapitulate ACL origin & insertion footprint
- Graft fixation (all fixation options for bone & soft tissue)
 - Need to be facile with numerous options & techniques



Role of extra-articular reconstruction

OTT & ALL

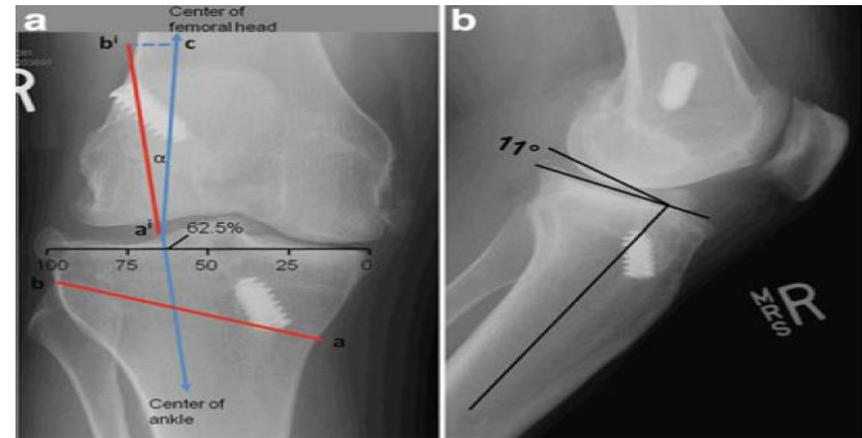
- Over the top & Ant Lat Ligament
- Extra-articular recon has **longer lever arm**.
 - Better controls **tibial rotation**
- Extra-articular recon may **reduce forces** on ACL graft
 - Over constrains knee (AJSM 2016)
- Useful in complex revision ACL
 - Multiple failed revisions
 - Lack of Intra-articular options
 - Gross instability (Marfans, Multi-Lig)



Technical considerations in ACL revision surgery

Associated surgical procedures

- Osteotomy (malalignment)
 - Slope & Coronal Plane
- Posterolateral reconstruction
 - Double & Triple varus...
- MCL/POL reconstruction
 - Over constraint with early repair
- Meniscal repair/transplant
 - MAT assist with AP translation
- Articular cartilage surgery
 - Osteochondral v. cell based



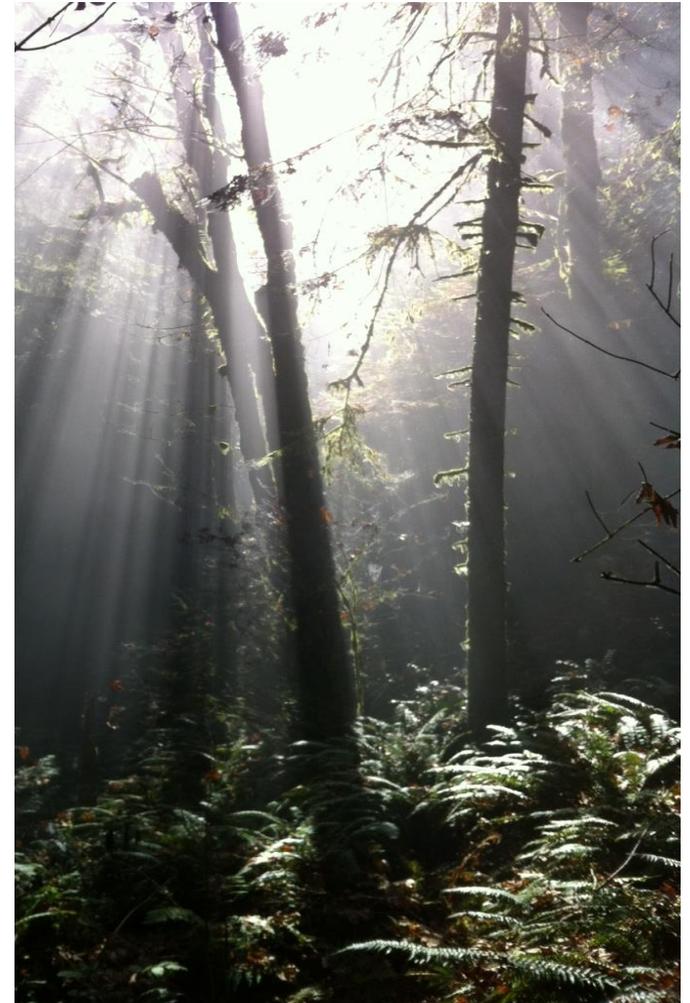
Rehabilitation

- Avoid pressure to RTS
- Rehab program dictated by:
 - Graft type (Allo v. Auto)
 - Bone quality
 - Type of fixation
 - Assoc. surgery
- Soft tissue grafts w/ suspensory fixation may require **more & longer** postop protection
- Min. **9 months** Ret. To Competitive Sports



Summary

- Etiology of ACL “failure” is multifactorial
- Failure etiology dictates ACL Revision recon strategy
- Technical failure is primary culprit
- Surgical planning is crucial for ACL Revision
- Consider failure potential when planning primary ACL recon
 - It’s not simply: Auto v. Allograft

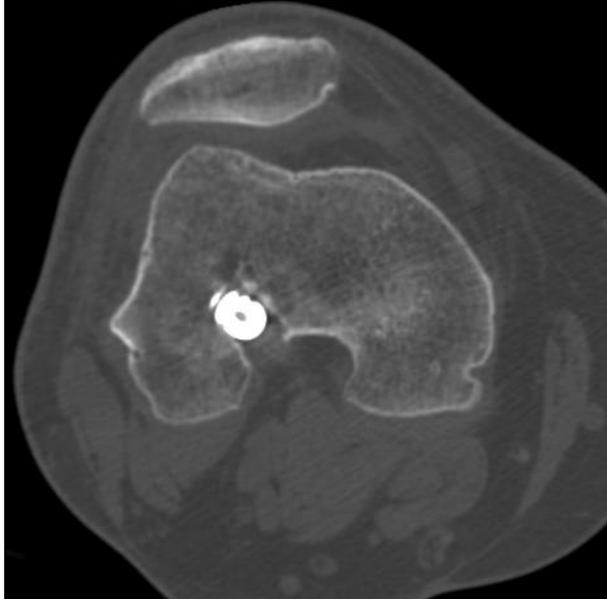


Hardware Issues

- Avoid hardware
 - Preferable if;
 - Allows anatomic recon
 - Not possible
 - Consider necessity of staged procedure?
- Remove
 - Single stage ?
 - Extraction equipment
 - Be prepared
 - Bone graft option
 - ALLO, Auto, Proprietary



Hardware Interference & ACL Revision

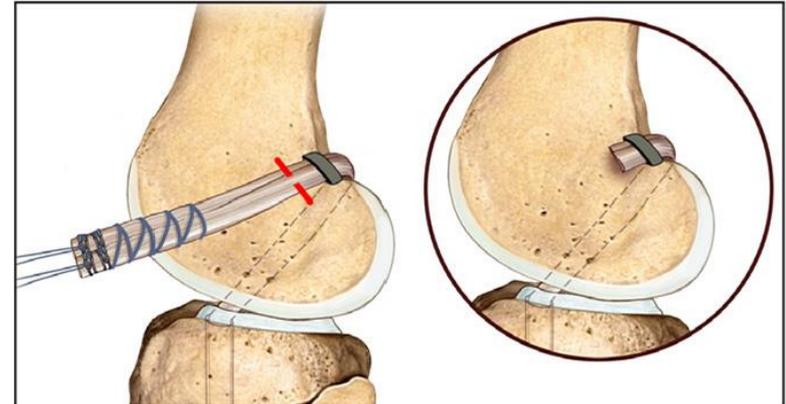


- CT scan
- Low strength MRI less responsive to metal artifacts
- Historic methods
 - Open surgery is OK
 - Remember cortical fixation is strongest
 - Endobuttons
 - Interference screws
 - “over the top”
 - Post and washer



Open “Over the top” Technique

- Secondary anatomic real estate challenges
 - Morbid Obesity
 - Peri-articular hardware
- Open lateral incision
 - Peroneal n- posterior
 - Poplitear a - medial
 - “over the top” wrasp
 - Fix with
 - Staples v. Bi-cortical post



Complex Revision Scenario



- 26 y f med student
- ACL BptB recon, MMx 9 y ago
- Instability & standing pain limiting ADL's
- Anterior tibial tunnel, tibial tunnel widening, absent MMx



Staged ACL Recon (Ach ALLO) after MAT



Achilles Allograft with Bone

8-14 mm bone block depending on tunnel aperture and Femoral or Tibial defect



Allograft Achilles with Calcaneal Bone

Single stage Revision, Tib Tunnel



Recurrent ACL Instability

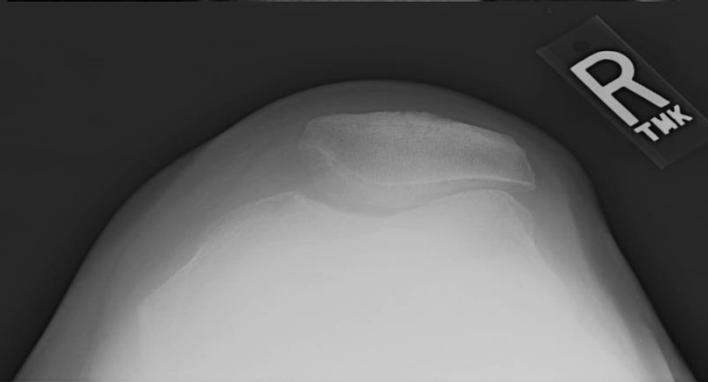
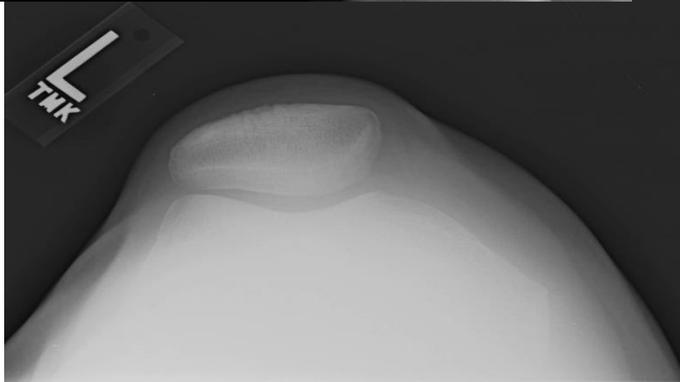
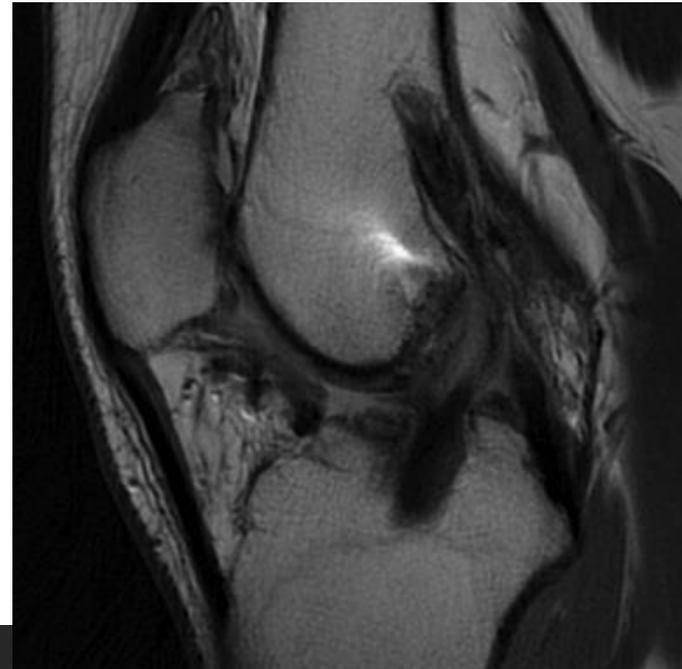
- 18 y male
 - Soccer athlete
 - Non-contact ACL injury
 - 2 prior ACL reconstruction
 - Autograft ACL (14 y)
 - Allograft revision ACL (16 y)
 - Intact medial meniscus
- Complaint of instability
 - 1+ Lachman
 - MRI intact graft
 - Lateral Xray
 - 15 degree slope



Neutralize Tibial Slope



Anterior Femoral Tunnel? Post Autograft Bone Patella Tendon



Anterior femoral tunnel > PF OA



Questions

A scenic view of a mountain peak above a sea of clouds, with several hikers visible on the slope. The sky is a clear, deep blue, and the clouds are a thick, white layer that fills the middle ground. The mountain slope in the foreground is covered in snow and has several hikers walking up it. The hikers are small figures against the vast landscape. The overall atmosphere is serene and majestic.

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“Simple” Primary ACL Recon Approach

Trans-tibial Reconstruction
of the ACL using Tibialis
Anterior Allograft

Michael Rose, MD and
Dennis Crawford, MD, PhD

The authors have nothing to disclose