Speaker’s preferred technique
  - One stage whenever possible
  - Single bundle “anatomic” reconstruction
  - Retention of hardware when possible
    - Stainless steel is harder than titanium.
  - Plug technique
    - Cloward Plugs
    - Allograft dowels used to fill in defects from removed hardware.
    - Battaglia T, Miller MD; *Arthroscopy* 2005; 21:767
• Complications in Revision ACL Reconstruction
  o Missed concurrent injuries
    ▪ Posterolateral corner injury
  o Graft migration
    ▪ Be prepared
    ▪ Don’t overstuff tunnels
    ▪ Don’t create oval tunnels
    ▪ Use fluoro liberally
    ▪ Back it up!
  o Non-anatomic placement
  o Graft Harvest issues
  o Rehab issues
  o Loss of Motion
  o Other

• Equipment for ACL Revision Surgery:
  • Have an extra Back Table
  • Helpful Additions:
    • Tunnel Dilators
    • Extra Fixation Systems
    • Hardware Removal Tools
    • Bone Graft Set
    • Screw and Soft Tissue Washers
  • Intra-op fluoroscopy unit
    • If you get stuck, take a picture!!

• Tunnel Placement
  • Radiographic Measurements
      –107/122 ACL Revisions referred were “nonanatomic”
      –Recommended 8mm offset guide for revisions
    • Sommer KSSTA 2000; 8:207-213
    • Bernard AJKS 1997; 10:14-22
      –Femoral tunnel should be in 4th Quadrant
    • Amis, Jacob KSSTA 2001; 9:104-109
      –Tibial tunnel should be 43% of A-P distance
Back it UP!

Revision with BPTB:
- Femoral Side
- Large Interference Screw
- Aperture Fixation (Endobutton)
- Tibial Side
- Large Interference Screw
- Aperture Fixation (Screw and Post/Button)

Non-Anatomic Placement:

**A vertical graft shouldn’t be replaced with a vertical graft**

Graft Harvest Issues

ACL Complications--Fractures
- Most Fractures occur 8-12 weeks post-op

• Reducing incidence:
  - Smaller Saw Blade*
  - Cutting Undersurface
  - Drill holes at corners
  - Less Rectangular graft
  - Bone graft defects

Viola et al, Arthroscopy 1999

ACL Complications

Hamstring Harvest
- Graft Amputation
- Saphenous Nerve Injury
  - Saphenous Nerve passes superficial to gracilis tendon (between gracilis and Sartorius) at the postero-medial joint line
- ? Loss of Terminal flexion strength

Revision ACL Complications

Rehab Issues
- Rehabilitation
  - 1989: Immobilization for 6 weeks in ankle-to-groin cast in 30° flexion
  - 1990’s: “Accelerated”/ “Aggressive” rehab
  - 21st Century: Moderation?

ACL Complications:

Loss of Motion (LOM)
- Pre-op
  - ROM, Effusion, Quad tone, Gait
  - MCL/MPFL Injury
- Intra-op
  - Tunnels & Tension
- Post-op
  - Hemarthrosis (Ice)
  - Early LOM (Extension!)

• LOA/MUA after 6-12 weeks if PT and serial splinting fails
  - RSD (CRPS)

Fighting LOM

Knee

Other Complications
ACL Reconstruction Complications:
- Hemarthrosis
  - Aspirate
- Tunnel Osteolysis
  - Observe
- Cyclops Lesion
  - Fibroproliferative tissue blocks extension
  - “Click” at terminal extension

Outcomes
- Not as good as Primary
- Studies Pending (MARS)
  - Apples and Oranges?

Thank You

Courtesy of Freddie Fu, MD
I. Introduction: ACL graft failure can be caused by recurrent instability, arthrofibrosis, extensor mechanism rupture, or the development of degenerative change or infection. This talk focuses on recurrent instability. Revision ACL reconstruction is increasingly common and is often technically challenging. The surgeon must address the following questions to provide optimal treatment:
   a. Why did the prior reconstruction fail?
   b. Is revision reconstruction indicated?
   c. What technique, graft and fixation will be utilized in the revision?
   d. Is a one-stage or two-stage reconstruction required?
   e. What will be done differently avoid repeat failure?

II. Analysis of the cause of failure
   a. Critical Data for planning
      i. History
      ii. Prior surgical notes, arthroscopic photos if available
      iii. Physical examination of the patient
      iv. Radiographic Evaluation
         1. Plain radiographs
            a. AP, Lateral, patellar, full leg if malalignment clinically suspected
         2. CT scan with 3-d reconstruction
   b. Technical Error – by far the most common problem
      i. Tunnel malposition
         1. Femoral
            a. Anterior placement – may lead to laxity in extension, poor control of Lachman
            b. Posterior placement – may lead to laxity in flexion, excessive tension in extension contributing to rupture
            c. Vertical in the notch – may lead to poor control of rotation
         2. Tibial
            a. Anterior placement – may lead to impingement in the notch in extension contributing to rupture
            b. Posterior placement – may lead to a vertical graft that poorly controls anterior translation
      ii. Poor fixation
         1. Technically malpositioned fixation device
2. Failure due to poor bone quality – especially interference screws
   iii. Poor graft quality – includes allografts sterilized inappropriately

c. Untreated associated instability
   i. Posteromedial or posterolateral corner injury – most common
   ii. PCL injury
   iii. Posterior horn medial meniscus – total or subtotal meniscectomy can contribute to anterior instability

d. Patient factors
   i. Excessive genu varum
      1. Greater than 6 degrees
      2. Can lead to increased graft stress and failure, especially in association with lateral ligament injury
   ii. Excessive posterior tibial slope
      1. Greater than 14 degrees
      2. Leads to increased graft stress and failure risk

e. Traumatic re-injury
   i. Rare cause of failure – for us, requires objective documentation of good stability following reconstruction and a history of a significant injury
   ii. Patients often attribute failure to trivial trauma – do not be fooled. Look for another cause

f. Biologic Failure: Failure of graft integration, rare. More common in allograft5

III. Is Revision Reconstruction indicated? Numerous factors affect this decision:
   a. The patient’s symptoms – instability is generally required
      i. Patients with physical exam and imaging findings consistent with graft rupture but without symptomatic instability are likely not candidates for reconstruction
      ii. An exception is the relatively common situation in which a patient presents with a meniscus tear and increased tibial translation on physical exam following ACL reconstruction, but without symptoms of instability. Instability may develop following meniscectomy in this patient population. ACL reconstruction should be considered.
   b. The patient’s desired activity level
   c. The anticipated outcome of surgery
      i. Easier reconstructions (without significant bone loss or concern with prior tunnel position) may yield improved results
      ii. Cases in which the reason for prior failure is a clear technical error that can be avoided on revision may have greater chance of success
   d. The patient’s willingness to undergo additional surgery and rehabilitation
      i. May be dependent on the need for a two-stage procedure

IV. Surgical Technique, Graft, and Fixation
   a. Technique
      i. Essentially the same as a primary ACL reconstruction
ii. Outside-in drilling technique for the femoral tunnel
   1. Often avoids prior the femoral tunnel, especially if it was performed via an all-inside technique

b. Graft
   i. Our preference is patellar tendon autograft
   ii. Repeat ipsilateral harvest is considered 18 months after prior harvest
   iii. Contralateral patellar tendon is second choice, quad tendon third
   iv. We prefer to avoid allografts

c. Fixation
   i. Femoral side – press fit fixation in the lateral femoral cortex – no hardware used
   ii. Tibial side
      1. Absorbable interference screw
      2. Backup tibial cortical fixation always used
      3. Can utilize a second tibial interference screw if there is bone loss or poor bone quality

V. One-stage versus two-stage reconstruction
   a. We prefer single stage revisions – more rapid recovery and fewer anesthetics
   b. Specific situations often requiring a two-stage revision
      i. Severe tunnel enlargement
         1. More frequently seen in the tibia
         2. Common after failed double-bundle reconstruction
      ii. Slightly too anterior femoral tunnel - very difficult situation
         1. Fixation may be compromised as drilling a new tunnel in the correct position may lead to one large tunnel
         2. The graft will tend to move to the anterior portion of the new large tunnel – the same position as the old graft
      iii. Slightly too posterior tibial tunnel – same problem as a too anterior tibial tunnel
      iv. Any concern about infection

VI. Avoiding failure in revision surgery
   a. Knees with associated instability
      i. Posterolateral corner instability
         1. Frequently missed
         2. These chronic lesions must be reconstructed – late repair will result in stretching and failure with subsequent ACL failure
      ii. Posteromedial laxity
         1. Rarely discussed
         2. Posteromedial capsular advancement may be indicated
   b. The varus knee
      i. We recommend an associated valgus-producing osteotomy in patients with failed ACL reconstruction and greater than 6 degrees of genu varum – medial opening wedge is our preference
ii. This is especially important to recognize in cases with lateral side injuries. The osteotomy then both protects the lateral repair and decreases graft stress.

c. The "very unstable" knee
i. Causes
   1. Posteromedial or posterolateral capsular injury
   2. General ligamentous laxity
   3. Medial meniscus injury
   4. Highly "ACL dependent" knee

ii. Recommendations
   1. Address associated lesions
   2. Consider the addition of a lateral extra-articular reconstruction (LEAR) for those with ligamentous laxity
   3. But... remember that a LEAR is not a magic bullet. It will not enhance stability in all cases – particularly a knee that is unstable due to posteromedial capsular injury or subtotal medial meniscectomy

d. Patients with traumatic re-injury
i. Consider the addition of a LEAR in patients who intend to return to contact sports
ii. Carefully consider the rehabilitation protocol and time to return to sport as it may have been inadequate following the initial reconstruction

e. Knees with excessive posterior tibial slope
i. Consider the addition of an anterior closing-wedge osteotomy to decrease tibial slope and reduce graft stresses

VII. Conclusion

VIII. References


Use of BPTB Graft via Anatomical Rectangular Tunnels for Failed ACLR

K. Shino, MD

Osaka, Japan

The anatomical rectangular tunnel ACL Reconstruction (ART ACLR) with the bone-patellar tendon-bone (B-PT-B) graft was developed to mimic fiber arrangement inside the natural ACL with a single B-PT-B graft. This technique has the following advantages: (1) to maximize the graft-tunnel contact area, (2) to completely keep the tunnel apertures of inside the ACL attachment areas, (3) to preserve the notch anatomy, and (4) to minimize the tunnel aperture area in the notch. Thus this technique is one of the most suitable techniques for revision surgery after failed ACLR using any types of grafts with or without bone plugs. This procedure could be applied to any patients requiring revision ACLR except for those who showed severe tunnel widening including the original ACL attachments. As the minimized tunnel aperture areas in this technique made it possible to create anatomical tunnels without overlapping tunnels in most cases. Thus no staged reconstructions were necessary. Postoperatively, few patients
were suffering from loss of motion or instability.
A good surgical technique is essential to avoid failure in the reconstruction but the surgeon must be aware of the complications of ACL reconstruction as well as to learn the techniques to avoid them and be prepared to treat them if they occur.

The pre-operative planning is very important and includes the selection of the best graft for each case, the placement of tibial and femoral tunnels, material removal, limb alignment and availability of surgical instruments if necessary.

In case of good positioning of tunnels the same can be used after material removal. In case of bad positioning new tunnels should be necessary.

The surgeon can find bone defects caused by removal of material synthesis that will need to be filled.

Large bone defects can be filled with bone graft in a first procedure. After consolidation, at the second time, the revision procedure is performed by positioning the new tunnels in an anatomic position.

The use of technology for orthopedic surgeries and navigation system assists the surgeon during the location of the best point for the tibial and femoral tunnels in ACL revisions.

Another challenge that might be found is the reconstruction of the posterolateral band alone in a situation where there is only injury of one of the graft bands.

If the graft is intact but insufficient and in a vertical position the revision concept of double bundle may be indicated.

Associated lesions not diagnosed and treated play an important role in the outcome of ACL reconstructions.
No one can say that the good results of revision ACL surgeries allow patients to return to previous levels of physical activity. Therefore do not sell illusions promising what you can not meet.
Failed ACL

James H. Lubowitz, MD  
Taos, New Mexico, USA

Arthroscopy journal: Assistant Editor  
isAKOS Newsletter: Editor  
US Ski Team

Disclosure

- Arthrex  
- Smith and Nephew  
- Breg

Practice profile

- Taos, New Mexico, USA  
- 17 years in practice  
- 120-150 primary ACLs/year  
  - Depends on the weather  
- 20 revision ACLs/year  
  - Mostly my own  
- Graft Preference  
  - Primary versus revision

ACL primary

- Graft choice  
  - Hamstring  
    - Younger patients  
  - Patellar tendon  
    - Non-compliant younger patients  
  - Allograft  
    - Older patients  
    - Quadriceps  
      - Little experience

ACL Revision

- Graft choice  
  - Achilles allograft  
    - Ideal  
    - Ample collagen  
    - Ample bone  
  - Autograft options  
    - Little experience

ACL Revision Technique

- Usually single-stage  
  - This may change  
- Two-stage for massive tunnel widening  
  - Rare indication in my experience
**Tunnel widening**
- Two-stage bone graft

**ACL Revision Technique**
- Anatomic single-bundle
  - Avoid “double-trouble”
  - Revision already challenging
  - This may change

**ACL Revision**
- Fixation
  - Prepare for anything

**Armamentarium of tools**
- Low profile reamer
  - AM portal technique

**Armamentarium of tools**
Guide pin —— RetroDrill

**Armamentarium of tools:**
Tibia retroscrew
#1 cause of failure

• Non-anatomic tunnel placement

• Transtibial drilling of femoral socket constrained
  – Too high femur
  – Too posterior tibia

Femoral

Stop transtibial: unstable rotation

Footprint anatomy: stable

What is my clinical approach?

• Improved stability creating femoral socket using
  – AM portal drilling
  or
  – Outside-in drilling

Surgical technique

• Primary transtibial
  – Revision AM portal or outside-in

• Primary Outside-in
  – Revision AM portal

• Primary AM portal
  – Revision outside-in
Femoral socket: Outside-in

Non-anatomic tunnel
- Easy revision
  - Ignore bad tunnel
  - Avoid (or remove) hardware

High femoral
- Non-anatomic
- Error of endoscopic transtibial technique
- Single stage revision
  - Single stage contraindication:
    • Concomitant error of posterior tibial tunnel

High femoral
Anatomic tunnel

• Easy revision
  – Use same tunnels

• Easy revision
  • However…
  – Must identify cause of failure
    • Trauma - not preventable
    • Rehab issues - must be addressed
    • Additional laxity/alignment/slope issue - combined surgery
    • Biological failure - ?

Clinical pearl of knowledge

• ACL tear is not a freak accident
  – Rehabilitation must address future prevention

Can ACL graft failures be prevented:
Rehabilitation issues

• Core
• Proprioception
  • Wobble or balance board
  • Single leg hop drills

Combined surgery

• Additional patholaxity
  – Posterolateral or posteromedial reconstruction
• Varus knee
  – HTO
• Excessive tibial slope
  – HTO plus correct slope

Dial test
Dial test

Can ACL graft failures be prevented: Ligamentous examination

• Posterolateral rotatory instability
  • Rare
  • Not subtle
  • Dial
  • Drive through

Can ACL graft failures be prevented?
Controversies

• Don’t know much biology
  • Lubowitz and Poehling, Arthroscopy 2008
• Incorporation and ligamentization
  • Poorly understood
• Biological failure
  • Diagnosis established by exclusion
    • Menetrey et al., KSSTA 2008

“In-between” tunnel

• Terrible tunnel
  – Ignore
• Anatomic tunnel
  – Reuse
• “In-between” tunnel
  – Challenge

“In-between” tunnel

• Two-stage option
• Single-stage
  – Personal preference

“In-between” tunnel

• Femur
  – Fill and redrill
    • Biocomposite screw
    • Autograft or allograft plug
  – Rotate achilles bone graft
“In-between” tunnel

- Tibia
  - Fill and redrill
    - Biocomposite Retroscrew
    - Autograft or allograft
  - “Push” graft with screw

My results

- ACL revision results
  - Not equal to ACL primary surgery

What is the evidence

- Best evidence for improving my results
- Revision ACL 2-Stage Technique with Bone Grafting of the tibial tunnel
  - Thomas, Kankate, Wandless, Pandit, AJSM 05

Thank you