Revision Anterior Cruciate Ligament Reconstruction

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Disclosures

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The following relationships with commercial interests existed during the past 12 months:

- Research Support: Arthrex Inc.  
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- Stock: Ostesys
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- Board/Committee: AOSSM STOP Sports Injuries  
  AOSSM Public Relations Committee
Incidence of Primary ACL Graft Failure

200,000 ACL Reconstructions per Year in U.S.

- Failure estimated in 5%-10% (16,000 cases!)

  - 32% +Lachman and 22% +pivot shift despite satisfactory subjective outcome

**Definition of failure?**
- Objective laxity
- Patient perception of instability
- Postoperative stiffness/pain
- Extensor mechanism dysfunction
- Infection

Cause(s) of Reconstruction Failure

- Technical error
  - Non-anatomic tunnel placement
  - Insufficient graft material
  - Insufficient graft fixation
  - Graft impingement

- Failure of biologic incorporation
  - Infection
  - Arthrofibrosis
  - Insufficient cellular re-population
  - Insufficient medial meniscal restraint

Poor-to-fair inter-observer agreement on graft failure etiology
Cause(s) of Reconstruction Failure

- Traumatic re-injury
  - Early: Fixation failure
    - Agressive rehabilitation
    - Premature return to sports
  - Late: Graft rupture

- Secondary instability patterns
  - Varus/valgus malalignment
  - Posterolateral corner insufficiency
  - Medial collateral ligament laxity
Mode of Failure – MARS Group (2010)

- Traumatic (32%)
- Technical Error (24%)
- Biologic (7%)

- 15%
- 12%
- 2%
- 6%
Relevance of Symptom Pattern

Timing of Symptom Onset

- If knee never felt stable:
  - Poor initial graft tension
  - Failure of initial fixation
  - Incorrect graft placement

- Late onset of instability:
  - New trauma
  - Biologic failure of incorporation
  - Insufficient secondary restraints
Relevance of Symptom Pattern

- Instability only
  - Optimum condition for revision surgery

- Pain only
  - Revision for pain only results in unsatisfactory outcome
  - Rule out infection, arthrosis, chondral damage, meniscal insufficiency, or arthrofibrosis

- Pain and instability
  - Pain from instability may be addressed by revision
  - Pain independent of instability: meniscal/chondral issues

MARS Cohort: 90% of patients have meniscal or cartilage damage
Comprehensive Physical Exam

- Standing alignment

- Gait
  - Varus thrust
  - Quadriceps avoidance

- Extensor mechanism
  - Patellar mobility

- Anterior laxity
  - Lachman
  - Pivot shift
  - Anterior drawer
  - KT-1000
Comprehensive Physical Exam

- Posterolateral stabilizers
  - Varus stress: 0° and 30°
  - External rotation recurvatum
  - Dial test: 0° and 90°
  - Reverse pivot shift

- Assessment of medial stabilizers
  - Valgus stress: 0° and 30°
  - Posteromedial drawer
Radiographic Evaluation

Assess x-rays for:
1) Hardware
2) Tunnel placement
3) Tunnel expansion

PA 45° Flexion-weight bearing

0° Lateral
30° Lateral
Merchant View
Full-length Upright
Radiographic Evaluation

- **Magnetic Resonance Imaging**
  - Evaluate menisci and cartilage
  - Multi-planar ligament evaluation

- **Computerized Tomography**
  - Determination of tunnel osteolysis
  - Hardware *not* an issue with CT

- **Technetium bone scan**
  - Helpful with discordant pain patterns
Influence of Limb Alignment

- Varus malalignment:
  - \( \uparrow \) adduction moment
  - ACL deficiency exacerbated
  - Medial compartment O.A.
  - Posterolateral corner insufficiency

- Combined HTO and ACL reconstruction:
  - Anterior laxity + medial O.A.
  - \( \downarrow \) strain on revision graft
  - \( \downarrow \) strain on posterolateral corner
Influence of Lateral Ligamentous Patholaxity

Influence of Medial Meniscal Deficiency

- Medial meniscal strain is increased in ACL deficiency
- Greater laxity after ACL-R in patients with previous medial meniscectomy compared to intact menisci

Technical Considerations: Co-morbidities

- Indications for two-stage procedure
  - >5° extension loss
  - >20° flexion loss

- Skin Incisions
  - Longitudinal incisions preferred
  - Use prior incision or last incision
  - Avoid:
    - Skin bridges <5 cm
    - “L-shaped” incisions
Anterior Femoral Tunnel

Problem
- Most common cause for failure
  - Tight in flexion
  - Graft attenuation or rupture

Management
- Far anterior:
  - Drill separate tunnel

- “Blended” tunnels:
  - Re-drill with 2-incision technique
  - Non-aperture fixation
  - Stacked interference screws
  - Two-stage revision with bone graft
Vertical Femoral Tunnel

The Problem
- Sagittal stability with rotational laxity
- Usually due to vertical tibial tunnel

Avoidance
- Drill femur from AM portal
  - Beware of MFC and posterior blowout
  - Hyper-flex knee to 105°
- Two-incision technique

Management
- Re-drill appropriate tunnel
- Use suspensory fixation
Tibial Tunnel Issues

- Graft too anterior:
  - Graft impingement
  - Loss of extension
  - Graft impingement

- Graft too medial:
  - Damage to medial plateau
  - Loss of extension

- Graft too posterior:
  - Vertical graft
  - Loss of extension
  - No rotational control
Tibial Tunnel Issues

Management

- Re-drill tunnel in optimal position
- Use divergent tunnels
- Compaction drilling
- Allograft dowel or bio-screw as “filler”
- “Stacked” interference screws
- Fix with suture over post
- Double-bundle augmentation
- Bone graft and staged reconstruction
Staged Bone Grafting

Indications
- Tunnel expansion >15 mm:
  - Rigid fixation is difficult
  - Precludes accurate graft placement
  - Prevents native bone incorporation

Technique
- Removal of all fibrous tissue
- Visualize tunnel interior
- Cancellous autograft/allograft chips
- Iliac crest dowel for structural defects

CT scan at 6 mo. to confirm incorporation
Determine Patient’s Definition of Success

- Primary goals of revision surgery:
  - Stabilize the knee
  - Prevent damage to menisci and cartilage
  - Maximize functional level

- Success of revision surgery is influenced by:
  - Etiology of primary failure
  - Preoperative knee laxity
  - Status of the menisci, articular cartilage, and 2° restraints

Realistic expectations **must** be discussed preoperatively
Outcome Based on Graft Choice

Autograft (Ipsilateral or Contralateral) *Failure* Rates

- Garafolo et al. *Arthroscopy* (2006): 6%
- Noyes and Barber-Westin, *AJSM* (2006): 19%
- Diamantopoulos et al. *AJSM* (2008): 7%
- Denti et al. *AJSM* (2008): 12%
- Shelbourne et al. *AJSM* (2014): 4%

Allograft *Failure* Rates

- Noyes et al. *AJSM* (1994): 33%
- Fox et al. *Arthroscopy* (2004): 25%
- Johnson et al. *CORR* (1996): 88%
Outcome Based on Time to Revision

Rate of O.A. at Follow-up: 37% to 80%

- Correlation between chondral lesions and O.A.

- Duration of instability symptoms correlated with O.A.
  - Battaglia and Miller, *Arthroscopy* (2005)

- Delayed revision associated with chondral lesions
    - Early revision (<6 months): 24% chondral damage
    - Late revision (>6 months): 52% chondral damage
Return to Play Following ACL Revision

- Reinhardt et al., *CORR* (2012)
  - 52% return to sport rate in athletes <18 years of age
  - >50% had allograft as primary graft source

- Wright et al., *JBJS* (2012)
  - Systematic review of 21 studies
  - 54% of 485 athletes returned to sports

- Shelbourne et al. *AJSM* (2014)
  - BTB autograft revision in 259 patients
  - Return-to-sport rates:
    - School age: 74%
    - Collegiate: 74%
    - Recreational: 62%
Summary of Key Points

1. Determine cause(s) of primary reconstruction failure: *Key to a successful revision*

2. Determine patient’s symptoms:
   *Knee instability should be the primary indication for a revision reconstruction*

3. Determine all relevant co-morbidities:
   *Careful physical examination and review of relevant imaging studies*
4. Determine patient’s goals for surgical outcome: *Not all failed reconstructions require revision*

5. Anatomic graft placement *must* be a priority

6. Address all co-morbidities:
   *A staged procedure is indicated if the morbidity of a combined reconstruction outweighs the chance for a safe surgery*

4. Set realistic expectations *preoperatively*
Thank You

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