Two-stage Revision Anterior Cruciate Ligament Reconstruction: Indications, Review, and Technique Demonstration

Aaron C. Coats, MD; Darren L. Johnson, MD

Abstract: Revision anterior cruciate ligament reconstruction has inherent technical challenges not encountered during primary reconstruction. Prior tunnel placement and tunnel lysis can significantly alter graft fixation, compromising patient outcome. Preoperative recognition of patients with existing tunnel overlap and severe tunnel lysis will allow appropriate surgical planning and patient counseling, optimizing patient outcome. When single-stage revision is not possible in the presence of significant tunnel overlap and lysis, performing a 2-stage revision is recommended.

Revision anterior cruciate ligament (ACL) reconstruction is increasing in frequency. This is directly related to an overall increase in athletic participation and a desire to return to competition following primary reconstruction. When compared with primary ACL reconstruction, multiple studies have shown that revision surgery is associated with a higher incidence of meniscus and cartilage injury, lower return to play percentage, and lower knee outcome scores.1-3

Due to the unique challenges associated with revision ACL surgery, certain cases are best addressed with staged surgery to optimize patient outcome. Previous hardware, inaccurate tunnel placement, and tunnel expansion can diminish outcomes by impairing anatomic graft placement and biological fixation, both of which are important for immediate rehabilitation. In addition, motion restoration surgery should not be concomitantly performed with revision ACL reconstruction.4 Therefore, when loss of motion is encountered, a motion-restoring procedure should be performed first, followed by revision surgery once motion has returned.

The exact etiology of tunnel lysis is unknown, but mechanical and biologic factors are believed to contribute. Although graft motion (associated with suspensory fixation) is the predominant mechanical theory, other factors include tunnel expansion at surgery (ie, screw fixation of a soft tissue graft compresses softer cancellous bone), non-anatomic tunnel placement (resulting in nonphysiologic forces on graft during knee motion), accelerated postoperative rehabilitation, and stress shielding.5-7 Biologic causes include synovial fluid bathing of the tunnel, graft swelling, and inflammatory cytokines.8-9

Tunnel Lysis, Widening, and Expansion

Figure 1: Notch view radiograph displaying tunnel expansion (A). Sagittal magnetic resonance imaging revealing expansion (B).

1A 1B
However, most authors support a multifactorial etiology of tunnel expansion, including biological and mechanical contributions. The occurrence of various forms of tunnel lysis (conical, cavitory, cystic, and linear) further supports a multifactorial theory.

Tunnel widening may adversely affect graft placement and fixation in the revision setting. Placing a revision graft into a widened tunnel may compromise its stability. Preoperative assessment of tunnel width can be achieved using radiographs, magnetic resonance imaging, and computed tomography. These imaging modalities can detect the extent of tunnel widening and allow for proper surgical planning. Lesser degrees of tunnel widening may be addressed with the use of a larger graft or additional interference screw fixation in a stacked technique. Although no evidence-based guidelines exist for the degree of tunnel lysis requiring a 2-stage revision, authors have suggested that a tunnel diameter greater than 16 to 17 mm is the threshold for necessitating bone grafting.

**TUNNEL PLACEMENT**

Previous tunnel position may also affect revision graft integrity and, therefore, the ability to perform a single-stage revision. Preoperative evaluation of the tibial and femoral tunnel positions on radiographs, magnetic resonance images, and computed tomography scans is critical. In addition, previous surgical technique may predict tunnel placement. For example, a transtibial primary ACL reconstruction commonly results in a posteriorly placed tibial tunnel and an anterior and superiorly placed femoral tunnel. In this scenario, drilling an anatomic femoral tunnel in native bone is often possible; however, it is more common that the tibial tunnel necessitates bone grafting and staged surgery.

Prior tunnel position can be described as anatomically placed (entire tunnel opening is 100% in the native ACL footprint), nonanatomically placed (commonly seen in transtibial femoral tunnel drilling), or partially anatomic (overlapping).

The greatest variation in tunnel placement is seen on the femur. When the femoral tunnel is non-anatomically placed, it rarely interferes with the revision tunnel placement and can be ignored, leaving the previous fixation hardware in place. Partially overlapping tunnel placement creates the most difficult scenario because the existing and revision tunnels will create a figure-of-eight tunnel. Often, redirection of the tunnel (diverging from the existing tunnel) can address this on the femur, allowing for adequate fixation of the new graft. In the authors’ experience, outside-in femoral tunnel drilling has proven successful in this situation. A revision ACL surgeon must be comfortable with multiple techniques to reproduce anatomic tibial and femoral tunnels.

To the authors’ knowledge, no studies have evaluated the outcomes of single- vs 2-stage revision in patients with tunnel overlap. However, Thomas et al reported on whether graft integrity following a 2-stage revision was comparable with primary ACL reconstruction. The focus of this study was not to define when tunnel overlap necessitated bone grafting but rather to show objective laxity following a 2-stage revision was comparable to that of a primary ACL reconstruction. Although this study showed comparable knee stability for 2-stage revisions, this approach should be used judiciously to minimize unnecessary risk to the patient. One obvious risk is the patient’s exposure to 2 surgeries. Also, knee instability continues until definitive fixation after bone graft incorporation, which is typically 4 to 6 months. This can result in progressive cartilage and meniscus damage, potentially affecting long-term outcome.

**CASE REPORT**

A 30-year-old woman presented with knee instability following a noncontact pivot injury. She had undergone 2 previous ACL reconstructions. Her primary ACL reconstruction (hamstring autograft) was performed 13 years previously, followed by a revision ACL reconstruction (Achilles allograft) 6 years prior to presentation.

Significant findings on physical examination included a positive pivot shift and no...
endpoint with Lachman examination. Radiographs (Figure 1A) revealed tunnel widening, and magnetic resonance imaging confirmed a retear of the ACL graft and tunnel lysis involving the tibia and femur. Tibial tunnel lysis measured 20 mm in diameter (Figure 1B). Due to significant tunnel widening, a staged revision involving bone grafting of the femoral and tibial tunnels with femoral head allograft was recommended.

Intraoperatively, the femoral tunnel was prepared with reamers, curettes, and a shaver. Bleeding bone was visualized, and the tunnel was also filled with femoral head allograft (Figure 2D). After radiographs confirmed incorporation at 5 months (Figure 3), definitive fixation was performed. An anatomic ACL reconstruction using hamstring allograft (Figure 4) was achieved using the accessory anteromedial portal technique.

**CONCLUSION**

For all candidates of revision ACL reconstruction, a comprehensive preoperative evaluation must be performed, including a thorough history, physical examination, and appropriate imaging. As part of the history, special attention should be given to previous surgeries, surgical technique, grafts and implants used, and associated injuries. Physical examination must include evaluation for associated ligamentous injuries. Preoperative radiographs should include weight-bearing anteroposterior, 45° posteroanterior, standing alignment, lateral, and sunrise views. Special attention must be given to the placement of previous tunnels and tunnel lysis. Magnetic resonance imaging can identify associated cartilage damage and confirm tunnel lysis and placement.

Revision surgeons should be knowledgeable in advanced tunnel drilling techniques (ie, accessory medial portal and outside-in) when presented with previous tunnels. Often, these techniques will adequately address tunnel overlap scenarios in the femur. However, when these techniques are insufficient in achieving anatomic ACL placement and stable fixation in the setting of significant tunnel lysis or overlap, a 2-stage revision is critical to achieving a successful outcome.

**REFERENCES**