Why ACL reconstruction fails?

Kim A Jansson

Jorvi Hospital, Helsinki University Central Hospital, Espoo

Anterior cruciate ligament (ACL) tear is a common sports injury of the knee. Between 100,000 and 150,000 ACL surgeries are performed every year in the United States. In Finland, 2861 ACL reconstructions (NGE 30 and 35) were performed in 2010. These comprised 65% male and 35% female patients, mean age 32 years (1).

Arthroscopic reconstruction using autogenous graft material is widely used for patients with ACL instability. Advances in reconstructive techniques and rehabilitation have led to substantially improved results. Nevertheless, there exists a substantial group of patients with unsatisfactory results following ACL reconstruction. The estimated graft failure rate after ACL reconstruction has been reported as between 3% and 52% of cases, depending on the criteria used to define failure (2).

Recurrent pathologic instability with graft failure represents the most common symptom of failed ACL reconstruction. Causes of failure include new trauma, improper surgical technique, biologic failure, postoperative infection, arthrofibrosis, and deficiency related to accompanying injuries.

Magnetic resonance imaging (MRI) is the preferred advanced imaging modality for the evaluation of ACL reconstruction failure. In follow-up, MRI permits direct evaluation of the ACL graft, the bone tunnels, and additional disorders of the knee (3). Proposed indications for MRI after ACL reconstruction include persistent knee instability, knee stiffness or pain, a new injury of the knee, infection, and preoperative evaluation for revision ACL surgery (4).

Technical errors

Technical error appears to be the most common cause of ACL reconstruction failure, accounting for 77% to 95% of all cases (5). Nonanatomic tunnel placement with an improperly placed femoral tunnel being the major cause in most cases (6). Other types of technical error include improper graft tensioning, insufficient graft material, and inadequate graft fixation.

The femoral tunnel is often placed in a position that is too anterior, resulting in graft constraint in flexion and laxity in extension. The femoral tunnel may also be placed too posteriorly, resulting in loss of fixation due to posterior wall blowout and constraint in extension, but this is less common. In addition, placement of the femoral tunnel in a position that is too central (at the 12 o'clock position) results in a nonanatomic graft that may not restore the rotational component of stability provided by the ACL, leading to a persistently positive pivot shift, despite objective anteroposterior stability (7). Tibial tunnel placement is a less common cause for ACL failure, but improper positioning may still lead to persistent instability. A tibial tunnel placed too anteriorly may lead to impingement and graft rupture or constraint in flexion, and a posteriorly placed tunnel may lead to laxity in flexion.

A graft that is undertensioned will result in excess laxity and persistent instability, and an overtensioned graft can result in a constrained knee with delayed graft incorporation. The exact amount of tension required remains poorly defined, and determining the appropriate tension intraoperatively remains a clinical challenge.

The use of synthetic grafts, poorly harvested autografts, or poorly selected allografts may result in insufficient graft material, which can lead to ACL reconstruction failure. Synthetic grafts are rarely used, but appropriate attention to harvesting technique may avoid autograft problems, and allograft donors should be screened for donor age and sterilized by nondamaging techniques to ensure adequate graft material.

Inadequate graft fixation may lead to persistent instability, and the surgeon must have a variety of primary and secondary fixation options available to deal with technical challenges. In the case of poor bone stock appreciated intraoperatively, screws may provide inadequate fixation, and the use of post-washer or button fixation may be appropriate.

Traumatic failure

A common reason for graft failure after primary ACL surgery is new trauma. Traumatic failure may occur in the early postoperative period, or later, after return to full activity. Early failure occurs before complete graft incorporation and may be due to too aggressive rehabilitation or noncompliance with postoperative activity restrictions. Late failure results from a traumatic episode after complete healing has occurred and has been noted to occur in 5% to 55% of ACL reconstruction failures (7,8). In either early or late traumatic failure, technical error must always be considered as a possible underlying factor.

Biologic failure

Biologic failure is the lack of complete incorporation and ligamentization of the graft material during the healing phase of ACL reconstruction, and is generally the result of infection or allograft rejection response. Biologic failure should be considered when instability occurs without a clear trauma or an identifiable technical error. With regard to allograft use, ligamentization has been shown to be delayed and less uniform, and bone-tunnel osteolysis may occur. Freeze-dried allografts cause some level of immune reaction in 60% of cases; fresh allografts may also incite a rejection response, and processing with gamma irradiation, freeze drying, or ethylene oxide sterilization biomechanically weakens the grafts and delays incorporation (5).

Infection

Septic arthritis following ACL reconstruction is uncommon, with a reported cumulative incidence of 0.1%–0.9% (9). The difficulty of correctly diagnosing such infections at an early stage is well established; the classic symptoms of infection, such as erythema, warmth, severe restricted motion, and severe pain, often are absent. However, mild local pain and effusion associated with an increased C-reactive protein level rate that extended beyond the 1st postoperative week were common findings in a series of 10 patients with septic arthritis after ACL graft reconstruction (10) MRI may be used to validate a clinical diagnosis of infection as well as to determine the extent of infection and the presence of potentially drainable fluid collections or abscesses. MRI findings of infection include synovitis, bone erosion, peri-articular edema, marrow edema, sinus tracts, and soft-tissue abscesses.

Infection is generally treated with operative irrigation and debridement, intravenous antibiotics, and occasionally with graft removal and delayed revision reconstruction.

Arthrofibrosis

Failure to obtain full range of motion in the postoperative period equal to that which was present preoperatively may be considered arthrofibrosis. This may vary among patients but is usually assessed in comparison with the uninjured knee. The etiology of anterior arthrofibrosis appears to be multifactorial (11). The fibroproliferative nodule may arise from the drilling debris of the tibial tunnel, the remnants of the native ACL, broken graft fibers, or from hypertrophied graft caused by impingement

Arthrofibrosis has been associated with ACL reconstruction in the acute phase and with prolonged postoperative immobilization. It may also be due to technical error, with an overconstrained knee resulting from improperly positioned tunnels or a graft placed in excess tension. Regardless of the cause, full range of motion must be obtained before proceeding with revision ACL reconstruction, and 2-staged surgery may be necessary in this scenario.

Accompanying injuries

ACL reconstruction failure can also be due to untreated secondary instabilities (12). It is well recognized that a deficiency due to posterolateral corner injury, a meniscal root detachment, or a lack of the posterior horn of the medial meniscus are causes of failed ACL surgery. Other accompanying injuries include an unrecognized posterior cruciate ligament (PCL) injury, medial knee injury, alignment issues in patients who have developed knee arthritis.

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