

Review of Literature: Revision Anterior Cruciate Ligament Reconstruction

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Abstract

There has been an increasing number of primary Anterior Cruciate Ligament (ACL) reconstructions in the past two-three decades leading to increasing need of revision ACL reconstructions as well. The exact etiology and pathophysiology of the failure of ACL reconstruction is multifactorial and still unclear. Poor surgical technique, 'biological failure' of the graft, injury and patient's factors like smoking have been attributed as the few leading causes responsible for unsuccessful outcome. Improper tunnel placement is the cause of 70 - 80% of ACL reconstruction failures and the most common error is malpositioning of the femoral tunnel³. Elaborate history taking and careful preoperative planning is of paramount importance for successful revision surgery. Over the past 15 years there has been a lot of published studies about primary ACL reconstruction, however there is relatively little literature on revision ACL reconstruction. The majority of these authors concluded that revision ACL reconstruction has a worse outcome than primary ACL reconstruction. Revision reconstruction has been described as a 'salvage procedure'¹⁶ and it has been suggested that significant time should be spent counselling patients and discussing their expectations prior to surgery.

INTRODUCTION

The Anterior Cruciate Ligament (ACL) is commonly injured, particularly whilst participating in sports, and it is estimated that between 100,000 and 200,000 ACL reconstructions are carried out in the USA each year^{1,2}. There has been marked improvement in ACL reconstructive surgery over the last 20 years, and many studies have shown good to excellent results making it the treatment of choice for patients with functional instability. Although 75 to 95% of patients show good to excellent results, in terms of stability and pain relief³, 0.7 - 10% of patients suffer recurrent instability due to graft failure⁴. The large numbers of ACL reconstructions now being performed means that, due to this failure rate, a substantial number of patients will undergo a revision ACL reconstruction (RACLR).

The purpose of this article is to review what causes failure of primary ACL reconstructions (PACLR), the considerations that need to be taken when planning and performing revisions, and the outcome of revision surgery.

There have been many definitions of what counts as a 'failure' after an ACL reconstruction. Different objective and subjective variables have been used to determine what is an unsatisfactory result, including increased pain, decreased

motion, recurrent episodes of instability, reduced level of athletic activity, positive Lachman or pivot shift test, or greater than 5mm side to side difference on arthrometric testing⁵.

The cause of failure is typically split into 3 categories^{3,4,6}. The three classes are

1. surgical technique,
2. failure of graft incorporation or 'biological failure' and
3. traumatic failure.

In order to ascertain to cause of the failure, the surgeon needs to know detailed history along with a physical examination and radiographical evaluation. Operative reports from the primary reconstruction, (type of graft, fixation method, and injuries to any other ligaments) are also required while considering revision.

TRAUMATIC FAILURE

Traumatic failures are generally split into early (before graft incorporation) or late (over 6 months after rehabilitation). Early failure may occur if the graft is traumatised before

biological incorporation, and overaggressive rehabilitation*** or returning to athletics before the neuromuscular control has been restored may leave the knee more prone to a recurrent injury ⁷

In the late phase instability may be the result of a force of similar energy to the trauma sustained in the original ACL tear. Often this reinjury is followed by an immediate effusion of the knee which may help during evaluation of the patient ³. 5-10% of patients who have returned to their preinjury level of sport suffer this type of late failure caused by recurrent trauma.

BIOLOGICAL FAILURE

Biological failure should be considered when a patient with an unstable knee following a reconstruction gives no history of new trauma and no technical error can be identified.

When an ACL is reconstructed with an autograft or allograft, it undergoes a complex biological process, known as ligamentisation. Initially inflammation and necrosis of the tendon occurs. This is followed by revascularisation and repopulation with fibroblasts. The last stage involves modification of the collagenous structure and remodelling of the graft ⁸. If any of these processes fail, it may lead to extensive necrosis, hypocellularity, poor vascularisation, disintegration, fragmentation or disorganisation of the collagen structure which in turn can lead to failure of the graft to incorporate ⁴. Immunological factors and stress shielding have also been linked with biological failure of the reconstructed ACL.

The complex pathological processes involved in biological failure are not yet fully understood and further human studies are required on the subject. The biological incorporation of the graft is related to the biochemical and mechanical environment, and the surgeon is responsible for these factors, which makes it difficult to appreciate what exactly biological failure of the graft is and what has caused it.

SURGICAL ERROR

Errors in surgical technique are the most common cause of failed ACL reconstructions ^{1,3,4,6,9,10}. Errors include poorly positioned tunnels, inadequate notchplasty, improper graft tensioning, and graft fixation failure.

Improper tunnel placement is the cause of 70 - 80% of ACL reconstruction failures, and the most common error is malpositioning of the femoral tunnel ³. This can lead to

stretching, weakening and then rupture of the graft. The graft should ideally be placed as posteriorly in the notch as possible without compromising the posterior cortical wall. The most common mistake is positioning the graft too far anteriorly, which leads to excessive tension during flexion of the knee, causing tension on the graft fixation site and stretching of the graft ⁷. If the tunnel is placed too far posteriorly the posterior wall may blow out ³. This positioning can also cause excessive tension to be placed on the graft on extension, and leads to slight looseness on flexion although it is disputed as to whether this is harmful to the graft ^{6,7}.

If the tunnel is positioned vertically this may provide anterior stability (a normal Lachman test) but it may lead to poor rotational stability. ^{3,7}

Although less common, Tibial placement of the tunnel is also important, and malpositioning can lead to graft failure. If placed too far anteriorly this can lead to impingement and loss of full extension ¹¹, but if too posterior it can lead to laxity in flexion and impingement on the posterior cruciate ligament. Again if the tunnel is too vertical this can result in poor rotational stability ⁷.

Adequate notchplasty is necessary for a successful reconstruction as it is needed for sufficient visualisation of the back wall and the 'over the top' position. Failure to achieve a satisfactory notchplasty can lead to impingement of the graft, particularly in extension. Magnetic Resonance Imaging MRI is a useful tool for evaluation of impingement, by three months after the surgery the change in signal between impinged and unimpinged grafts can be detected ³.

Another important element of surgery that has been attributed to graft failure is correct tensioning of the graft. The optimal tension is still not known, however, the angle of the knee at the time of fixation appears to be important, and it should be made tissue specific. Excessive tension can lead to loss of motion, stretching of the graft, poor revascularisation and graft degeneration ¹².

In the early postoperative period, the graft fixation sites are more susceptible to load failure than the graft itself. It is therefore vital that the graft is fixed securely enough to prevent it from moving in the tunnels whilst biological incorporation is taking place ^{3,7}. Bone density, tunnel integrity and size, graft type and fixation method all contribute to the overall strength of the fixation. There are a variety of fixation devices but irrespective of which method

is used, careful technique is imperative for ensuring a strong fixation which is essential if the graft is to withstand aggressive rehabilitation protocols³.

ASSOCIATED KNEE PATHOLOGY

Capsular and ligamentous injury frequently occur at the same time as the injury to the ACL. If these go unrecognised and untreated this can cause increased load on the graft leading to failure. One study found 86% of their patients undergoing revision ACL reconstruction had associated injuries of other knee structures and required surgical treatment¹³. Posterolateral instability may be seen in 10-15% of chronic ACL-deficient knees and careful examination of this prior to the operation as it is often overlooked³.

SMOKING

It has long been known that smoking is an important risk factor in the development of complications after surgical procedures¹⁴. A trial looking at the effect of smoking on ACL reconstruction¹⁵ found that the group who smoked had a significantly worse mean International Knee Documentation Committee (IKDC) score, greater frequency and intensity of pain, a greater side to side knee laxity score, and were less likely to return to their preinjury level of sport than the group that did not smoke. The trial did not report how many of each group underwent revision surgery but one might hypothesise that with a lower mean IKDC score and fewer returning to preinjury level of sport, that smoking may be a predictor for poor outcome and therefore more likely to undergo revision surgery. More research is required to test this hypothesis.

PLANNING FOR REVISION SURGERY

Careful preoperative planning is crucial for successful revision surgery. This begins with determining the cause of the failure of the primary surgery. Revision surgery is more complex and the literature suggests that revision surgery has poorer results than primary procedures¹⁶, and in order to be successful this requires a thorough preoperative evaluation.

The history should include subjective complaints including pain, instability, swelling, locking or giving way and stiffness. It is important to distinguish pain from instability. Whether the surgery initially alleviated symptoms and whether the symptoms are the same as before the primary surgery needs to be asked, along with the patient's activity level and rehabilitation protocol. The primary ACL reconstruction records need to be carefully examined,

particularly for the source of graft and fixation type along with associated knee injuries and treatment.

The physical examination must be thorough, and include more than just assessing the ACL. Any other knee pathology needs detecting, including meniscal injuries, ligamentous deficiencies, capsular damage, in particular the posterolateral structures need careful examination. Gait should be examined for varus thrust as this may require surgical intervention.

Before surgery radiographs should be reviewed to assess the location of tunnels and hardware. Magnetic resonance imaging (MRI) can be useful in assessing graft integrity, and also for associated pathology in the menisci, articular cartilage or ligaments.

After all the necessary information has been gathered the surgeon can begin to plan the procedure. Each patient will be different and require slightly different techniques. Factors including the previous surgery and causes of failure will influence decision making for the revision. The surgeon may decide to do a staged procedure but this may depend on findings discovered during the procedure, and so this must be discussed with the patient beforehand. A staged procedure may be considered if the patient has flexion contracture of greater than 5° or a loss of flexion of greater than 20°, and may also be considered if a bone tunnel is wider than 15mm, or if bone loss or osteolysis cannot be remedied during revision surgery⁷.

Despite the best planning the surgeon may come across unforeseen challenges during the procedure and may need to adapt to this by using a wide range of surgical skills.

CONCLUSION

Over the past 15 years there has been a lot of published studies about primary ACL reconstruction, however there is relatively little literature on revision ACL reconstruction. There have been several case series describing surgeons' experiences in revision reconstructive surgery, but these are generally of evidence levels III or IV. The majority of these authors concluded that revision ACL reconstruction has a worse outcome than primary ACL reconstruction. Revision ACL reconstruction has been found to be a strong predictor for a lower perceived knee-related quality of life² with a significant difference in median scores between primary reconstructions and revision reconstructions (P value = 0.001). Revision reconstruction has been described as a 'salvage procedure'¹⁶ and it has been suggested that

significant time should be spent counselling patients and discussing their expectations prior to surgery³.

Despite this studies have shown that revision surgery can be comparable to those achieved in primary reconstruction, with only little less satisfactory results⁶. This however was again only level of evidence IV, and it highlights the need for high evidence level trials involving prospective controlled trials.

The Multicenter ACL Revision Study (MARS)² has set out to do this. MARS intends to develop a prospective longitudinal cohort, to provide the highest level of evidence so that it can guide clinical practice on revision ACL reconstruction. A collaboration of approximately 70 surgeons intends to identify prognosis and independent predictors of poor outcomes on revision ACL reconstruction.

It is clear that more high level research needs to undertaken with regards to revision ACL reconstruction and the results of the MARS could help determine the best practices for revision ACL reconstruction and hopefully improve results of this surgery in the future.

LIST OF ABBREVIATIONS USED

anterior cruciate ligament (ACL)

revision ACL reconstruction (RACL).

primary ACL reconstructions (PACL),MRI (magnetic resonance imaging)

International Knee Documentation Committee (IKDC) score

Multicenter ACL Revision Study (MARS)

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