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Operative Techniques in
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Technical Considerations in Revision Anterior Cruciate Ligament Reconstruction for Operative Techniques in Orthopaedics

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As the incidence of anterior cruciate ligament (ACL) reconstruction continues to increase, the rate of revision surgery continues to climb. Revision surgery has inherent challenges that must be addressed to achieve successful results. The cause of the primary ACL reconstruction failure should be determined and careful preoperative planning should be performed to address the cause(s) of failure. Each patient undergoing revision surgery should undergo a thorough history and physical examination, receive full-length alignment radiographs, lateral radiographs, 45° flexion weight-bearing posteroanterior radiographs, and patellofemoral radiographs. The 3-dimensional computed tomography scan should be performed to assess tunnel position and widening. Magnetic resonance imaging should be used to assess for intra-articular soft tissue pathology. Meniscal tears, meniscal deficiency, anterolateral capsule injuries, bony morphology, age, activity level, connective tissue diseases, infection, graft choice, and tunnel position can all affect the success of ACL reconstruction surgery. Meniscal lesions should be repaired, and in cases of persistent rotatory instability, extra-articular procedures may be indicated. Furthermore, osteotomies may be needed to correct malalignment or excess posterior tibial slope. Depending on the placement and condition of the original femoral and tibial tunnels, revision surgery may be performed in a single procedure or in a staged manner. In most cases, the surgery can be performed in one procedure. Regardless, the surgeon must communicate with the patient openly regarding the implications of revision ACL surgery, and the treatment plan should be developed in a shared fashion between the surgeon and the patient.

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Background

As the incidence of anterior cruciate ligament (ACL) reconstruction continues to increase,[1,2] the rate of revision surgery continues to climb. Despite technical and rehabilitation advances in primary ACL surgery, the rate of retear remains higher than desired.[3-6] In fact, some of the highest risk groups have been reported to have a 34% retear rate after ACL reconstruction,[7] and half of these failures occur within 12 months after surgery.[8] Age is an important risk factor for retear, with a recent registry study demonstrating a nearly 8-fold increase in retear risk for patients <21 years of age as compared with those >40 years of age.[9] In fact, not only is the ipsilateral side at risk of tear after ACL reconstruction, but also many studies have shown a similar or even higher risk of ACL tear on the contralateral side.[8,10] Similarly, the return-to-play

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rate is lower after revision ACL reconstruction compared with primary surgery.[11]

Failure of ACL reconstruction can have significant implications for the health of the knee. Data from the Multicenter Orthopaedic Outcomes Network and Multicenter ACL Revision Study (MARS) groups demonstrated that patients undergoing revision ACL reconstruction have 1.7 times greater risk of outerbridge grade 3 or 4 patellofemoral or lateral compartment cartilaginous lesions than those undergoing primary ACL reconstruction.[12,13] Similarly, Trojani et al[14] reported that the cumulative incidence of meniscal tears increases with each ACL surgery, and Chen et al reported a greater incidence of medial and patellofemoral compartment chondral damage in patients undergoing multiple revision surgeries as compared with those undergoing only one revision.[15] Additional data from the MARS group have shown that 90% of patients undergoing revision ACL reconstruction have meniscal or chondral damage at the time of revision surgery,[16] although data from the Danish ACL registry only reported cartilage damage in 31% of revision cases.[17] Patient-reported outcomes and patient activity levels have also been shown to be worse after revision ACL reconstruction compared with primary ACL reconstruction.[18]

Factors Contributing to Primary ACL Reconstruction Failure

Although the reasons for failure of primary ACL reconstruction can be multifactorial, numerous studies have reported on contributing factors.[9,12,15,16,19-24] Understanding the causes of primary ACL reconstruction is necessary to perform successful revision surgery. Chen et al reported that the most common reason for failure in ACL reconstruction cases requiring a single revision was because of the patient sustaining some type of traumatic event leading to graft tear. However, when cases requiring multiple revisions were examined, technical failure was cited as the most common risk factor for revision.[21]

Femoral tunnel malposition has been repeatedly identified as the most common technical error in ACL reconstruction. Trojani et al[14] reported that anterior positioning of the femoral tunnel was responsible for failure in 36% of revision cases. Morgan et al[25] examined the MARS data and reported that femoral tunnel malposition was a contributing factor to failure in 47% of cases and the only cited reason for failure in 25% of cases.

Graft choice has also been shown to play an important role in ACL reconstruction success.[26-28] Numerous studies have shown an exceedingly increased rate of failure in young patients reconstructed with allograft. Engelman et al[28] reported a 4.4 hazard ratio in allograft as compared with autograft patients (age 11-18 years). Similarly, Kaeding et al[26] reported a 4 times greater risk of graft failure with allograft compared with autograft. In addition, Li et al[29] reported greater serum inflammatory marker levels and greater anteroposterior knee instability in allograft patients compared with autograft or hybrid patients. In fact, allograft is not considered within the standard of care for most young, active patients undergoing ACL reconstruction.

Graft size has been associated with risk of failure. Magnussen et al[15] retrospectively examined outcomes among hamstring autograft patients and reported that a graft diameter of 8 mm or less in young active patients was resulted in an increased retear risk. Conte et al performed a systematic review and stated that hamstring autograft sizes of 8 mm or more reduced the failure rate. Spragg et al[30] examined patients in the Kaiser Permanente ACL revision registry and reported a 0.82 times lower risk of revision for every 0.5 mm increase in hamstring autograft diameter in patients with a median age of 17 years. Interestingly, Mariscalco et al[31] reported lower patient-reported outcomes with smaller diameter grafts. However, it is important that graft size be individualized according to the patient, as increased graft sizes in patients with a small notch or smaller bony morphology may result in an increased retear rate.[32,33]

Numerous other factors can contribute to primary ACL reconstruction failure. Although some autograft types have been promoted as superior to others, studies have failed to show consistent differences in survival between the most commonly used autografts (hamstring, quadriceps tendon, and patellar tendon).[34-38] However, recent data from the Danish and Norwegian Knee Registries suggest that there may be a higher failure rate with hamstring compared with patellar tendon autografts.[39,40] Anatomical ACL reconstruction has been widely shown to result in improved knee joint kinematics, resulting in better knee health, but has been also reported to be associated with an increased retear rate due to increased in situ graft forces.[41-44] Furthermore, graft fixation methods, time to return to sports, activity level, trunk and lower extremity muscle function, generalized ligamentous laxity, age, sex, presence of associated injuries such as underappreciated meniscal tears or anterolateral rotatory instability, and bony morphology of the knee and extremity can all contribute to graft survival in primary ACL reconstruction.[14,21,45-49]

Technical Considerations for Revision ACL Reconstruction Surgery

Preoperative Planning

Preoperative planning is crucial to ensure successful revision surgery. A thorough history should be obtained, with a special emphasis on activity level, mechanism of injury, and antecedent symptoms.[50] The reason for failure of the primary reconstruction surgery must be determined to avoid the same outcome with revision surgery.[20] The patient should also be queried for information regarding previous joint injuries, history of coagulation disorders, osteoporosis risk factors, and any history of generalized ligamentous laxity or connective tissue disorders. It is important to communicate openly with the patient about their postsurgical expectations and planned