



Risk of Reinjury or Subsequent Injury After Anterior Cruciate Ligament Reconstruction

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Anterior cruciate ligament (ACL) tears are one of the most common injuries seen by orthopaedic surgeons. The standard of care following an ACL tear in a physiologically young, active patient is an ACL reconstruction. This can be accomplished with one of a variety of grafts through a multitude of techniques. With the growing number of ACL tears that are treated with reconstruction, the number of failures, including both graft rupture and functional instability, is increasing. Reinjury following an ACL reconstruction places a significant physical and physiological burden on the patient, but also creates a societal burden with lost time at work as well as use of health care resources. To better educate patients and to prevent subsequent ACL injuries, it is imperative that orthopaedic surgeons understand the risk factors for reinjury or an injury to the contralateral knee. These include patient-related factors such as age, gender, and activity level, as well as technical considerations such as graft type, size, and position. Furthermore, treating physicians must be able to counsel patients on ways to avoid a reinjury through rehabilitation, functional sports assessments, and others.

Oper Tech Sports Med 24:65-72 © 2015 Elsevier Inc. All rights reserved.

KEYWORDS anterior cruciate ligament (ACL), return to sport, reinjury, contralateral injury, revision

Introduction

More than 250,000 anterior cruciate ligament (ACL) tears occur annually in the United States, and more than half of these tears undergo an ACL reconstruction (ACLR), considered to be the standard of care in physiologically young, active patients who wish to return to sport.¹⁻⁴ Although the results following ACLR are generally encouraging, patients who undergo an ACLR have a reported risk between 1.7% and 29.5% of sustaining a subsequent ipsilateral ACL injury and also are at a significantly increased risk of sustaining a tear in the contralateral knee.⁵⁻⁹ Sustaining an initial ACL injury is devastating to a young athlete, and undergoing an ACLR and the subsequent rehabilitation is a long and arduous process. Frequently, patients have questions regarding their chances of sustaining a second ACL injury to either knee. Several recent studies have helped elucidate the potential risks of a subsequent

reinjury to their graft, as well as the likelihood of sustaining a contralateral ACL injury.^{7,10-17} Variables that have been reported to contribute to a second ACL injury include non-modifiable factors such as age and sex, as well as some that can be modified such as graft type, graft size, activity level of the patient, and the timing of return to sports. This article reviews the risk factors associated with sustaining a subsequent ACL tear to either knee after undergoing a primary ACL reconstruction.

Anatomy

There are preexisting conditions within the knee that appear to increase a patient's risk of sustaining a primary ACL injury, as well as an increased risk of failure following ACLR or an injury to their contralateral knee. Several studies have demonstrated a negative correlation with intercondylar notch width and an increased number of ACL injuries.¹⁸⁻²⁰ Although the notch width itself is implicated as a possible cause of ACL rupture,²¹⁻²³ it may more likely be a surrogate measure for the size of the patient's native ACL.^{24,25} A smaller intercondylar notch likely results in a smaller native size ACL, which has decreased tensile strength and an increased risk of injury compared with those of a larger ACL. Recent studies have also found that an increased posterior tibial slope places more stress on the ACL, leading to

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potentially a higher risk of failure following ACLR. Li et al²⁶ found that medial or lateral posterior tibial slope greater than or equal to 5° was associated with increased rates of ACLR failure. Goshima et al²⁷ compared groups of patients who underwent ACLR with a family history of ACL injury and those without a family history of ACL injury. They found that the group with a family history of ACL injury had a significantly larger posterior tibial slope, which would indicate a genetic predisposition toward anatomical risk factors for ACL injuries. Additionally, recent cohort study of data from the Kaiser Permanente ACLR registry performed by Maletis et al¹⁰ revealed that a lower body mass index was also associated with a higher risk of both revision ACLR and injury to the contralateral ACL. The status of the meniscus can also play a significant role in the success of an ACLR.²⁸ The posterior horn of the medial meniscus acts as a secondary stabilizer to anterior tibial translation. Thus, a patient with a deficient medial meniscus may experience higher stress on the ACL graft, theoretically leading to an increased risk of ACL failure.²⁹

The importance of surgical technique and proper tunnel placement in the success of an ACLR is well documented in the literature. The most common cause of failure after an ACLR is often reported to be secondary to nonanatomical placement of the femoral tunnel. Most commonly the femoral tunnel is placed too high in the intercondylar notch, and not below the intercondylar ridge and in the middle of the bifurcate ridge, which more accurately reproduces the native ACL's footprint.³⁰ A graft that is too vertical fails to control rotational motions and can predispose the reconstruction to fail.^{31,32} The tibial tunnel can also be malpositioned, leading to an increased risk of failure. The tibial tunnel should ideally be placed within the anatomical footprint with the center of the tunnel at the posterior aspect of the anterior horn of the lateral meniscus on the medial half of the tibial eminence.³³ Aside from improper tunnel placement, the graft may become damaged during harvest or preparation. This can lead to undersized bone plugs or an undersized tendinous portion of the graft, predisposing the patient to subsequent rupture.³⁴ Additionally, loss of range of motion secondary to tunnel malposition or arthrofibrosis can lead to clinical failure following an ACLR. Studies have shown that a loss of just 5° of extension or 15° of flexion compared with the contralateral knee can lead to an increase in rates of revision surgery.³⁵ Aside from an increase in the revision rate, the loss of motion can cause early quadriceps fatigue, weakness, and knee pain.³⁶

Incidence of Subsequent ACL Injuries to Either Knee

Several recent studies have looked into the incidence of sustaining a second ACL injury following an ACLR and the potential risk factors that may have led to a subsequent injury. A number of studies have shown no difference between a subsequent ACL reinjury and a contralateral injury, although others have shown a higher injury rate to the contralateral leg. In a large Scandinavian database study of 45,402 patients who largely underwent hamstring autograft reconstructions, Gifstad et al³⁷ found that within 5 years of a primary ACL surgery,

2.6% of patients underwent a subsequent revision procedure. Similarly, using the large Kaiser Permanente ACL Registry, Maletis et al¹⁰ found that of 17,463 patients, with a high predominance of hamstring autografts and allografts, there was a 2.45% revision rate and a 1.92% rate of injury to the contralateral ACL. Salmon et al¹⁷ evaluated 612 patients who had previously undergone an ACL reconstruction with either a bone-patellar tendon-bone (BTB) autograft or a quadrupled hamstring autograft and found that within 5 years of their primary procedure, 6% of patients sustained a graft rupture whereas 6% sustained a contralateral ACL injury. Wright and the Multicenter Orthopaedic Outcomes Network (MOON) found similar results when evaluating the outcomes of ACL reconstructions in 235 individuals.¹³ They found that within 2 years of an ACL reconstruction, 3% of patients sustained a graft reinjury and 3% sustained a contralateral ACL injury. In a subsequent MOON study, Hettrich et al⁶ demonstrated a 7.7% revision rate and a 6.4% rate of a contralateral ACL injury between 2 and 6 years after surgery. When all patients were evaluated regardless of age, sex, or activity level, Shelbourne et al⁷ found that within 5 years of an ACL reconstruction with a BTB autograft, out of 1415 patients, 4.3% sustained a reinjury and 5.3% of patients sustained an injury to the contralateral knee. There was no statistical significance between a reinjury and a contralateral ACL tear. When sex was evaluated separately, however, women were statistically more likely to sustain a contralateral injury, whereas men were just as likely to injure either knee. Other studies have subsequently shown that the contralateral knee may be at a higher risk than the ACL-reconstructed leg. In 561 patients who had undergone an ACL reconstruction, Webster et al³⁸ also found that 4.5% of patients sustained a reinjury to their ACL graft, whereas 7.5% sustained an injury to the contralateral knee. A systematic review by Wright et al¹⁴ found that there was a 5.8% incidence of subsequent graft rupture and an 11.8% incidence of sustaining a contralateral ACL tear. Bourke et al³⁹ reported on 673 patients at a minimum of 15 years from an index ACL reconstruction with either a BTB autograft or a hamstring autograft and found that at 15 years, 23% of patients had sustained a subsequent ACL injury to either knee. Of these, 11% sustained a graft re-tear whereas 14% sustained an injury to the contralateral ACL.

Sex

The risk of sustaining a primary ACL injury in women is significantly higher than that in men, with the cited risk in the range of 2-8-fold higher in women. However, several studies have now shown that women are at a higher risk of sustaining a contralateral ACL than a re-rupture of a reconstructed ACL after undergoing an ACL reconstruction. Men may be at an equal or higher risk for reinjuring their graft. Salmon et al¹⁷ found that female patients were at no higher risk of re-tearing their ACL graft, and although not statistically significant in their study ($P = 0.1$), women more commonly sustained a contralateral ACL injury than men. Shelbourne et al⁷ found similar but statistically significant results ($P = 0.0459$) that women were more likely to sustain a contralateral injury (7.8%), than they

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