Primary Versus Revision Anterior Cruciate Ligament Reconstruction: Patient Demographics, Radiographic Findings, and Associated Lesions

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Purpose: The purpose of this study was to evaluate the differences in intra-articular pathology, demographic characteristics, and radiographic characteristics of the knee associated with primary anterior cruciate ligament reconstruction (ACLR) versus revision ACLR at the time of initial presentation with either a native anterior cruciate ligament tear or an anterior cruciate ligament graft tear. Secondarily, we aimed to investigate risk factors for concomitant medial and lateral meniscal tears and cartilage injuries at the time of ACLR. **Methods:** This was a retrospective review of patients who underwent primary or revision ACLR by a single surgeon. The exclusion criteria were as follows: skeletally immature patients; patients with an intra-articular fracture; patients with an ipsilateral knee infection; or patients who underwent an osteotomy, cartilage restoration procedure, or meniscal transplantation either previously or concomitantly with the ACLR. Detailed patient demographic data, radiographic long-standing alignment, tibial slope, and intraoperative findings including articular cartilage injury grade and meniscus integrity were documented at surgery. **Results:** There were 487 patients included in this study (363 with primary ACLR and 124 with revision ACLR). There were no significant differences in age ($P = .119$), sex ($P = .917$), body mass index ($P = .468$), allograft versus autograft reconstruction ($P = .916$), or prevalence of meniscal tears ($P = .142$) between the primary and revision groups. Patients who underwent revision ACLR had a significantly increased medial tibial slope ($P = .048$) and a higher prevalence of chondral defects on both the medial ($P < .001$) and lateral ($P = .003$) femoral condyles when compared with primary ACLR patients. Logistic regression showed that a decreased tibial slope was correlated with femoral medial-sided chondral injuries and that varus or valgus coronal-plane malalignment was correlated with lateral meniscal tears in both groups. **Conclusions:** The findings of this study show that patients undergoing a revision ACLR have significantly more chondral lesions, as well as higher-grade chondral lesions, at the time of presentation. Furthermore, coronal malalignment and a decreased tibial slope may contribute to injury patterns of the lateral meniscus and medial compartment cartilage, respectively. **Level of Evidence:** Level III, retrospective case-control study.

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Patterns of articular and meniscal pathology associated with primary anterior cruciate ligament reconstruction (ACLR) have been previously reported.[1-9] Prior literature has shown that 30% to 60% of primary anterior cruciate ligament (ACL) tears are associated with meniscal or chondral injury and that lateral meniscal tears are more common than medial tears.[9-12] Further studies have shown male patients to be at an increased risk of injury to both the meniscal and cartilage structures, but neither age nor sports participation level has been correlated with specific injury patterns.[13,14] Despite these previous studies, there have been limited data presented in the recent literature comparing injury patterns seen at the time of tears to the native ACL versus those found in patients presenting with recurrent instability and ACL graft

tears. Furthermore, there is a paucity of literature discussing certain patient or demographic characteristics as risk factors for injury in revision ACLR patients in comparison with primary ACLR patients.[1,13,15-17]

With approximately 200,000 ACL tears occurring in the United States annually,[15] injuries to the meniscal and chondral structures seen at the time of ACLR are common.[18-20] Studies have shown that intra-articular pathologies noted at the time of primary or revision ACLR have led to inferior patient-reported outcomes compared with patients with intact menisci and cartilage surfaces.[13,18,19,21-24] A recent study of 4,691 patients identified through the Norwegian Knee Ligament Registry showed lower postoperative patient-reported outcome scores in patients with ACLR and associated medial or lateral meniscal repairs when compared with those with a meniscectomy at a minimum 2-year follow-up, indicating that the results of meniscectomies are not apparent until midterm follow-up.[25] Wu et al.[26] reported on 63 patients at approximately 10 years after ACLR. Subjects who had undergone any degree of meniscal resection had more subjective complaints than those who had intact menisci at the conclusion of ACLR. Furthermore, other studies have shown that high-grade chondral lesions similarly lead to decreased patient-reported outcomes.[18] Understanding patient factors associated with these injury patterns can also assist surgeons in counseling patients on possible future expectations and improve intraoperative diligence in examining for certain patterns of injury.

Although these studies do provide adequate groundwork for further studies, their utility is limited because of evaluation using binary outcomes (tear vs no tear or cartilage lesion vs intact cartilage) rather than specific descriptions of severity, location, or treatment intervention.[27] Furthermore, these studies have not fully evaluated other potentially important patient factors such as demographic characteristics, coronal-plane alignment, sagittal-plane tibial slope, or concomitant ligamentous injury. These demographic and radiographic descriptors are of importance because prior studies have shown improved patient-reported outcomes in primary versus revision ACLR and such factors may play a role in these differences.[16,18,27] Understanding the effect of these patient factors is crucial for prognosis. Furthermore, addressing factors that increase the risk of failure at primary ACLR may potentially increase the survival of the reconstruction.

The purpose of this study was to evaluate the differences in intra-articular pathology, demographic characteristics, and radiographic characteristics of the knee associated with primary ACLR versus revision ACLR at the time of initial presentation with either a native ACL tear or an ACL graft tear. Secondarily, we aimed to investigate risk factors for concomitant medial and lateral meniscal tears and cartilage injuries at the time of ACLR. We hypothesized that there would be an increased prevalence and severity of concurrent meniscal and articular cartilage injuries with revision ACLR when compared with primary ACLR. Furthermore, we hypothesized that these injury patterns would be correlated with standing limb alignment, tibial slope, and other patient demographic characteristics such as age, sex, and body mass index (BMI).

Methods

Patient Selection

This study was approved by our institutional review board. Patients who underwent primary or revision ACLR by a single surgeon (R.F.L.) from May 2010 to January 2016 were eligible for inclusion. The exclusion criteria were skeletally immature patients or patients who underwent an alignment-correction procedure, cartilage repair or transplant procedure, or meniscal transplantation either previously or concomitantly with ACLR. Other exclusion factors included an intra-articular fracture or history of an ipsilateral knee infection. Patients were evaluated using prospectively collected data that were stored in an outcomes registry and retrospectively analyzed.

Patient Details

Demographic and patient characteristic data included age, sex, BMI, prior surgical procedures, treatment history, additional pathologies, adjuvant treatments, and operative complications. The number of previous ACLR surgical procedures, location of the ACL tear at the time of surgery, and graft choice for both primary and revision ACLR were also recorded. The type of injury sustained (high or low energy) was recorded in addition to the type of activity at the time of injury (sport or non-sport).

Evaluation of Concomitant Injuries

For each patient, detailed descriptions of operative data and intraoperative findings were documented at the time of surgery. Meniscus integrity was recorded, and if a tear was present, the specific zone[19] and morphologic characteristics were noted. Articular cartilage surface pathology was recorded in each patient. Each compartment of the knee (medial femoral condyle, lateral femoral condyle, medial tibial plateau, lateral tibial plateau, patella, and trochlea) was examined. If pathology was noted, the location, size, and Outerbridge grade[28] were documented.

Radiographic Measurements

Radiographic variables considered in this study were coronal-plane alignment on long-standing radiographs and sagittal tibial slope on lateral