An Institution-Specific Analysis of ACL Reconstruction Failure

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Abstract

The purpose of this study was to determine the most common causes of failed anterior cruciate ligament reconstruction (ACLR) using modern reconstructive techniques at a single, high-volume institution. In addition, the clinical outcomes of patients undergoing revision ACLR will be reported. The surgical logs of four senior knee surgeons were retrospectively reviewed for all patients who had undergone ACLR between 2002 and 2009. Patients were excluded if they did not have both the primary and revision surgery on the same knee with the same surgeon. Out of 1944 ACL reconstructions, 28 patients (56 reconstructions) were included in the study. Radiographic studies, operative reports, KT-1000 scores, and chart notes were used to identify all potential factors that may have led to failure. All patients were invited to return for a follow-up examination and survey. Of the 28 patients, the mean age at the index and revision procedure was 22 ± 11 (range, 12 to 50) and 24 ± 11 (range, 14 to 57), respectively. In 20 cases, the cause of failure was determined to be acute trauma (sports, work, or accident); in 1 case, the cause was biologic failure; while in 7 cases, the cause was technical error. During the study period the surgeons performed a combined total of 1944 procedures, for an overall failure rate of 1.8%. Twenty patients (71%) were available for follow-up at a mean 30.2 ± 17.7 months. The overall postrevision outcomes were good to excellent for a majority of patients, with an average Lysholm score of 84 ± 15.5 and International Knee Documentation Committee score of 77.2 ± 13.8. The pre- and postoperative KT-1000 scores were 12.1 ± 2.8 and 6.7 ± 2.8, respectively. The results from this study suggest that traumatic re-injury, and not surgical/surgeon error, is the most common cause of ACLR failure using anatomic reconstructive principles and strong fixation. In addition, good to excellent outcomes following revision ACLR can be expected in the majority of patients.

Keywords
- anterior cruciate ligament reconstruction
- revision
- failure
- bone tunnel

Anterior cruciate ligament (ACL) tears remains one of the most common knee injuries in the United States, with over 200,000 anterior cruciate ligament reconstructions (ACLRs) performed each year.[1,2] It has been shown that satisfactory reconstruction of the ACL is critical for maintaining normal knee function as well as for decreasing risk of subsequent injury to the menisci and/or articular cartilage, which may lead to osteoarthritis if left untreated.[3] The surgical technique of ACLR has evolved over the last 40 years from open, extra-articular procedures to arthroscopically assisted intra-articular procedures. Recently, several reports in the literature have stated the success rate of primary intra-articular ACLR surgery ranges from 75 to 90%.[4–9]

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Despite these excellent reported outcomes, considering the numbers of ACLRs performed annually, many patients will require a revision procedure.

Failed ACLR can be defined as a knee with persistent pathological laxity, a knee with persistent pain, and/or a knee without laxity but with a limited range of motion.[10] With regard to persistent laxity, potential etiologies of ligament failure include new trauma, technical errors during the index operation, biological failure of graft incorporation, failure to address concomitant instability pathologies, and poor patient compliance with regard to the rehabilitation protocol postoperatively. Typically, if a primary ACLR fails within 6 months and trauma has been ruled out, a technical issue is the likely explanation.[4] Specific technical errors include incorrect bone tunnel placement, inappropriate graft tensioning, and inadequate graft fixation. It has been shown in recent years that correct anatomic tunnel placement is crucial to the success of any ACLR, whether primary or revision.[4,11–14]

While several studies in the literature report the various causes of failed ACLR leading to a revision procedure, to our knowledge, there are no published studies that describe both the primary and revision procedures when both operations are performed by the same surgeon.[4,15–18] Among the potential factors causing ACLR failure, surgical technique and/or surgeon error remain the most commonly reported causes in the literature.[4,11–14] The purpose of this study was to determine the causes of failed primary ACLRs performed by experienced surgeons at a single, high-volume orthopedic surgery institution. In addition, postrevision outcomes as determined by KT-1000 and physical examination as well as knee-specific outcomes surveys, including the Knee Injury and Osteoarthritic Outcome Score (KOOS), the International Knee Documentation Committee (IKDC) Subjective Form, Western Ontario and McMaster University Osteoarthritis (WOMAC) index, modified Cincinnati Scale (10-point), and Lysholm score, are reported.

Methods

This study was approved by the institutional review board (IRB) at our institution prior to initiation. The surgical logs of four senior, sports medicine fellowship-trained knee surgeons were retrospectively reviewed to find all patients who had undergone ACLR between January, 2002, and December, 2009. This list was further narrowed to include only patients who had subsequently required revision ACLR on the ipsilateral knee by the same surgeon within the 8-year time period. Patients who had undergone their index procedure with another surgeon were excluded from the study. Patients who had undergone more than one revision (7 patients within the 8-year time period) were included in the statistical analysis of overall failure; however, these patients were not included in the clinical follow-up portion of the study.

Chart Review

Out of 1944 ACLRs, 28 patients (56 reconstructions) were included in the study. For each patient, the medical chart was thoroughly reviewed to collect pre-, postoperative, and intraoperative information pertinent to both the index and revision ACLR. Careful review of both the primary and revision operative note was performed to determine whether any evidence of tunnel malposition, biologic failure, inadequate fixation, or other technical errors existed. Additionally, the characteristics of the ACL graft including laxity of graft (if not torn), location of tear (if any), and quality of graft were noted at the time of revision surgery to help determine the etiology of failure. Demographic information, graft selection, clinic notes, physical examination measures including KT-1000 scores, and operative data including concomitant pathology and procedures were analyzed to determine any potential mechanism of failure. Particular attention was paid to the time between the index ACLR and failure as well as to any radiographic studies available between the index and revision procedures.

Radiographic Analysis

Radiographic measurements were obtained on both anteroposterior (AP) and lateral views on radiographs obtained between the primary and secondary reconstruction (►**Figs. 1** and **2**). Diameters of both the femoral and tibial tunnels were measured on both AP and lateral radiographs. In addition, the position of the center of the tibial tunnel on the lateral radiograph was measured in relation (%) to the entire AP depth of the tibia. The tibial tunnel was considered too posterior (too vertical) if the percentage was $>50\%$.[19] The angle of the tibial tunnel in relationship to the tibial plateaus (degrees) was measured and considered malpositioned if <55 or >75 degrees.[20] The angle of the femoral tunnel was measured in relationship to the anatomic axis of the femur on the AP radiograph. The femoral tunnel was considered too vertical if this measurement was <10 degrees.[21] The position of the center of the femoral tunnel on the lateral radiograph

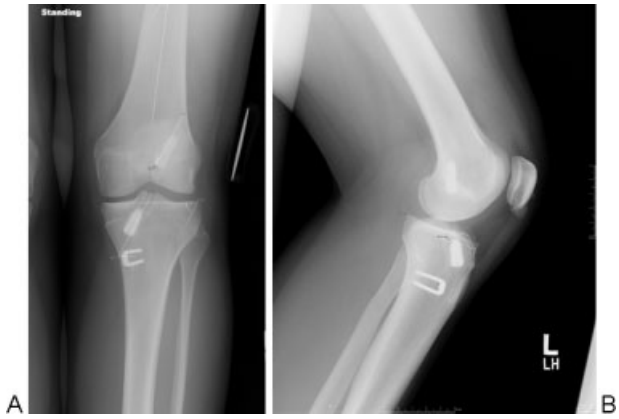

Figure 1 Radiographs of properly position ACL femoral bone tunnel. Tibial and femoral tunnel diameters were measured on both anterior and posterior radiographs in addition to the location of the center of the tibial tunnel on the lateral radiograph. Femoral tunnel position was measured on the lateral radiograph in relationship to Blumensaat line. Angle of the femoral tunnel was measured in relationship to the anatomic axis of the femur, whereas the angle of the tibial tunnel was measured in relationship to the line parallel to the medial and lateral tibial plateau. (A) Anteroposterior view; (B) Lateral view.

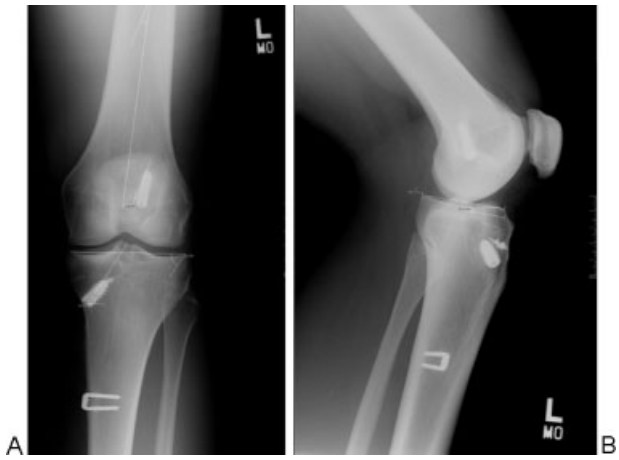

Figure 2 Radiographs of vertically placed femoral bone tunnel. Tibial and femoral tunnel diameters were measured on both anterior and posterior radiographs in addition to the location of the center of the tibial tunnel on the lateral radiograph. Femoral tunnel position was measured on the lateral radiograph in relationship to Blumensaat line. Angle of the femoral tunnel was measured in relationship to the anatomic axis of the femur, whereas the angle of the tibial tunnel was measured in relationship to the line parallel to the medial and lateral tibial plateau. (A) Anteroposterior view; (B) Lateral view.

was also measured in relationship to the length of Blumensaat line (%). The femoral tunnel was considered too far anterior if >15%.

An additional analysis of radiographs available between the primary and revision reconstruction was performed to determine the extent of radiographic osteoarthritis based on the Kellgren-Lawrence classification system.[22]

Clinical Follow-Up

Following the chart review, each patient was invited by telephone to return to clinic for a follow-up examination. During the clinic visit, both knees were examined by a single orthopedic research fellow, including inspection, palpation, and range of motion. Provocative testing, including the Lachman test, posterior drawer test, pivot shift, varus and valgus stress tests, and anterior drawer test were performed on each knee. Arthrometric evaluation with the KT-1000 arthrometer (MEDmetric, Inc., San Diego, CA) was also performed on both the operative and contralateral knee. As previously well described in the literature,[23–25] this test was performed with the patient relaxed in the supine position. For each examination, a passive anterior Lachman test with a force of 15 pounds, a passive anterior Lachman test with a force of 20 pounds, and a maximum manual test with a maximum anterior force were performed. Side-to-side differences were then compared between the operative and contralateral knees. Each patient was also asked to complete a follow-up survey containing demographic data and outcomes assessments, including the San Francisco 12 surveys, KOOS, the IKDC Subjective Form, WOMAC index, modified Cincinnati Scale (10-point), and Lysholm score.

Definition of ACLR Failure

The primary purpose of our retrospective analysis of our institution's experience was to determine the most likely cause of failure in our own patients. For the purpose of this study, the cause of failure was categorized into three groups: iatrogenic, biologic, and traumatic.

Iatrogenic or surgeon technical failure was defined based on strict guidelines. Failure due to surgeon error was considered if inadequate fixation or graft malposition was thought to be the cause of failure. Failure was classified as a technical surgeon error if radiographs indicated that the femoral and/or tibial tunnels were too vertical, the femoral tunnel was too anterior, or the tibial tunnel was too posterior. Furthermore, failure was contributed to iatrogenic causes if at the time of revision surgery, intraoperative findings indicated tunnel malposition or inadequate fixation.

Biologic failure, for the purpose of this study, was diagnosed based on intraoperative definitive findings of failure of incorporation, allograft rejection, or notch impingement from regrowth. Additionally, failure within the first 6 months following initial reconstruction in patients with a properly placed and well-fixed graft was considered to be biologic in nature if there was no report of a recurrent traumatic event.

Traumatic failure was considered only if other causes of failure could be ruled out. To be considered a traumatic failure, patients had to have a distinct traumatic reinjury after patients had returned to full activity in their sport or recreational activity. Intraoperative findings of traumatic failure showed a midsubstance tear or tear off the femur/tibia with good tissue remaining opposite the tear. Only those patients who met these three criteria (clinical history, exclusion of other causes, and intraoperative findings) were included as traumatic failures. In addition to intraoperative findings, a radiographic determination of cause of failure was performed in those patients who had radiographs between their primary and revision procedures to ensure that tunnels were appropriately placed.

Statistical Analysis

Statistical analysis was performed using SPSS (SPSS, Chicago, IL) statistical software. Descriptive data analysis was performed using frequencies and percentages for discrete data and mean and standard deviations for continuous data. Correlations for postrevision outcomes were estimated by the Pearson Correlation Coefficient. Inferential analyses were performed using *t*-tests to conduct univariate analyses of the KT-1000 scores prior to and after revision ACLR. Results were considered statistically significant for all analyses when $p < 0.05$.

Results

Chart Review and Radiographic Analysis Results

From January, 2002 through December, 2009, all four senior knee surgeons at our institution were performing arthroscopic assisted ACLR with a transtibial technique. During the 9-year time frame, we are aware of 28 revisions of patients who were done primarily at our institution that required

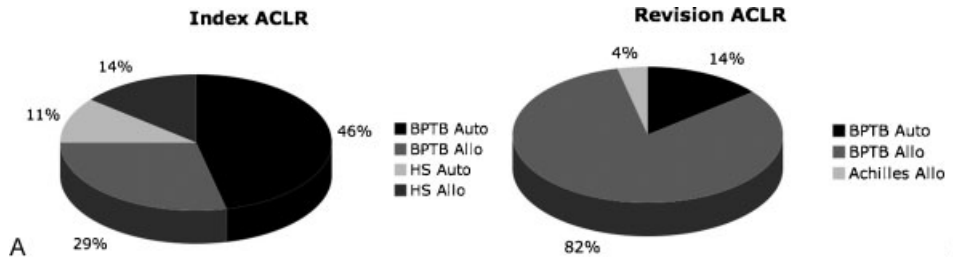

Figure 3 Pie chart portraying graft selection in both index (A) and revision (B) ACL reconstruction. BPTB autografts were most commonly used in the index procedures while BTPB allografts were more commonly used in the revision. Allo, allograft; auto, autograft; BPTB, bone-patellar tendon-bone; HS hamstring.

revision ACLR for symptomatic knee instability. During this same time period, a total of 1944 primary ACLRs were performed; for a total revision rate of at least 1.8% (includes only patients of whom we are aware of needing a revision reconstruction, incorporating all excluded patients).

The average age at the index procedure was 22 ± 11 (range, 12 to 50 years) and the average age at the revision procedure was 24 ± 11 (range, 14 to 57 years), with an average 21.7 ± 16.6 months between index and revision. In 9 patients (32%), the revision procedure was performed within 12 months of the index procedure. There were 15 males and 13 females in this patient cohort. The left knee was involved in 61% of the cases. KT-1000 measurements taken between the primary and revision ACLRs were reported in 22 of the 28 patients (79%). The KT-1000 examinations were performed an average 17.4 ± 18.4 months (range, 1.6 to 80.7 months) after the index procedure, and an average 4.9 ± 5.9 months (range, 0.5 to 20.3 months) prior to the revision procedure. Prior to revision, the average KT-1000 measurement (maximal manual testing) for the affected knee was 12.1 ± 1.4, while for the nonoperative knee the average value was 6.7 ± 1.3.

Patellar tendon autograft was used for the index reconstruction in 13 patients, patellar tendon allograft in 8, hamstring autograft in 3, and hamstring allograft in 4. Overall, autograft was used in 16 index cases (57%), while allograft was used in 12 cases (43%). For the revision procedures, patellar tendon autograft was used in 4 cases, patellar tendon allograft was used in 23 cases, and Achilles allograft was used in 1 case. Overall, autograft was used in 4 revision cases (14%), while allograft was used in 24 cases (86%) (►**Fig. 3A**, **B**). In 16 cases (57%), autografts were converted to allografts, while in 4 cases (14%) allografts were converted to autografts. In the remaining 8 cases (29%), allografts were converted to new allografts. During the index ACLR, 5 patients (18%) underwent concomitant partial meniscectomy, 6 patients (21%) underwent meniscal repair, 1 patient (4%) underwent partial lateral meniscectomy and medial meniscus repair, and 1 patient (4%) underwent concomitant open medial collateral ligament (MCL) repair. During the revision procedure, 6 patients (21%) underwent concomitant partial meniscectomy, 4 patients (14%) underwent meniscal repair, and 4 patients (14%) underwent partial lateral meniscectomy and medial meniscus repair.

Radiographs of the operative knee between the primary and revision ACLR were available for 22 of the 28 (79%) patients. Radiographic measurements were used in part to determine if the cause was iatrogenic (as described in the methods section). Furthermore, a blinded analysis of the operative reports (both primary and secondary) was performed to determine if any evidence of inadequate fixation or other iatrogenic causes existed leading to a failure of the primary reconstruction. Based on the radiographic guidelines, there were 7 patients (25%) with radiographic evidence of an iatrogenic cause (tunnel location) of failure from their primary reconstruction. Of those patients who had iatrogenic failures there were two patients who had patellar tendon autograft, three who had patellar tendon allograft, one who had hamstring autograft, and one who had hamstring allograft. All radiographic results are summarized in ►**Table 1**.

Of the 28 patients in our series, there was only 1 patient (4%) who had definitive failure secondary to biologic reasons. This patient had a hamstring allograft for her index ACLR. This patient was noted to have regrowth of the notch resulting in attenuation of the graft at this site. Finally, traumatic failure was confirmed in 20 of the 28 patients (71%). Of the 28 traumatic failures, the failures occurred at an average of 24.8 (range, 5.5 to 82.5) months after the initial procedure, one of

Table 1 Summary of Radiographic Measurement Results

Measurement	Mean Value
Average of ACL position (mm)	21.9 ± 5.2
Average of tibia width (mm)	53.1 ± 7.9
Average of position of posterior ACL on tibial width (%)	38.2 ± 6.1
Average of tibial tunnel diameter (lat) (mm)	11.4 ± 1.6
Average of tibial tunnel diameter AP (mm)	10.8 ± 1.7
Average of femoral tunnel diameter (lat) (mm)	9.9 ± 1.2
Average of femoral tunnel diameter AP (mm)	10.1 ± 1.0
Average of femoral angle AP (degrees)	161.7 ± 6.4
Average of posterior femoral distance (mm)	5.0 ± 1.5
Average of length of Blumensaat line (mm)	33.9 ± 5.3

which failed within 6 months postoperatively. Of those patients who had traumatic failures, there were 11 patients who had patellar tendon autograft, 5 who had patellar tendon allograft, 2 who had hamstring autografts, and 2 patients who had hamstring allograft.

Based on the Kellgren-Lawrence method[22] to determine arthritis, only one patient (<5%) was identified as having any abnormalities. This patient was graded as having Grade II (minimal arthritis) in the medial compartment only on radiographs obtained between the primary and index procedure.

Clinical Follow-Up Results

Of 28 patients, 20 (71%) were available for follow-up examination. The results of the follow-up examination and outcome surveys are summarized in ►**Table 2**. The average length to follow-up was 30.2 ± 17.7 months (range, 7.3 to 72.9 months). The average score at final follow-up postrevision was Lysholm score 84.0 ± 15.5 (range 52 to 100), IKDC score 77.4 ± 14.2 (range 52 to 99) and Cincinnati score 8.4 ± 1.6 (range 4 to 10). There were 65% of patients who had a good or excellent result based on Lysholm score.

Preoperatively, 4 patients had a Grade I Lachman examination, 17 patients had a Grade II, and 2 patients had a Grade III. Postrevision, 10 patients had a negative Lachman, 4 patients had a Grade I, and 4 patients had a Grade II with no patients with a Grade III. Preoperatively, 11 patients had a Grade I pivot shift, and 2 patients had a Grade II pivot shift. Postrevision, 16 patients had a negative pivot shift whereas 2 had a Grade I pivot shift. No patients had a Grade II or III pivot shift on follow-up examination.

Table 2 Summary of Follow-Up Outcomes Results as Determined by Survey Responses

Measurement	Mean Value
SF-12 Physical	45.1 ± 5.6
SF-12 Mental	56.2 ± 5.6
Lysholm	84.0 ± 15.5
IKDC	77.4 ± 14.2
KOOS symptoms	82.9 ± 15.3
KOOS pain	88.0 + 11.4
KOOS activities of daily living	95.9 ± 7.3
KOOS sport	41.1 ± 12.5
KOOS quality of life	89.5 ± 10.4
Cincinnati Satisfaction Rating (best is 10)	8.4 ± 1.6
WOMAC pain	1.3 ± 2.1
WOMAC stiffness	1.5 ± 1.5
WOMAC function	2.3 ± 4.3
WOMAC total	5.1 ± 7.4
KT operative knee	6.8 ± 2.8
KT nonoperative knee	5.9 ± 2.8
KT difference between operative and nonoperative knees	1.4 ± 1.2

Twenty patients had prerevision KT-1000 evaluations. Only 3 patients (15%) had a side-to-side difference of <3 mm. Fifteen patients (75%) had a side-to-side difference of ≥5 mm. Postrevision reconstruction, KT-1000 evaluations were obtained in 19 patients. A side-to-side difference of <3 mm was obtained in 15 (79%). There were no side-to-side differences greater than 5 mm. Notably, the average KT-1000 measurement of the operative knee following revision surgery at the time of follow-up was 6.8 ± 2.8 (range, 2 to 11); that of the nonoperative knee was 5.9 ± 2.8 (range, 2 to 12). The average difference between the operative and nonoperative knee on the KT-1000 testing was 1.5 ± 1.2 (range, 0 to 4). Compared with prerevision KT-1000 measurements (12.1 ± 1.4), the postrevision KT-1000 measurements (6.8 ± 2.8) on the operative knee were significantly lower ($p < 0.001$).

Based on the follow-up survey assessments, higher IKDC scores were correlated with younger patients at both primary and revision surgery ($p < 0.0001$). Greater differences in postrevision KT-1000 scores between the operative and nonoperative knee was associated with elevated KOOS pain and symptomatic values ($p < 0.0001$). Furthermore, a shorter time period between index and revision ACLR was associated with better KOOS pain scores. Those patients who had surgery within 18 months of their primary reconstruction had KOOS pain scores of 96.0 versus 84.2 in patients who had their reconstruction later than 18 months ($p = 0.0001$).

Discussion

ACLR is performed in over 200,000 patients each year. It is thought that 5 to 15% of those patients will fail the primary reconstruction and require a revision reconstruction.[4,11,26] Historically, the most common reason cited for revision reconstruction has been technical surgeon errors. Reviews of ACL revision reconstruction cite several studies done in the mid-1990s to support the claim that technical errors led to the majority of revision reconstructions. However, most of these studies were published during a time period when ACLR may not have been performed anatomically, with either the femoral tunnel too vertical or the tibial tunnel too posterior. The results of this study indicate that trauamatic rerupture is the most common cause of graft failure following index ACLR.

Commonly cited studies to support the claim that technical errors account for the majority of revision ACLRs include three studies published in one issue of Clinical Orthopedics and Related Research.[18,26,27] These three articles include the surgical experience from Miami, Pittsburgh, and Cincinnati. Despite these studies being commonly cited, it is difficult to draw conclusions as to definitive etiologies of failure based upon these three studies because specific numbers on causes of failure other than iatrogenic are not always provided. Johnson et al[27] is the only study where concrete numbers were given to describe their experience in 25 patients in whom revision ACLR was performed. In these patients 13 or 52% were due to technical errors. Biologic failure was cited as the cause in 20% and trauma in 28% of patients.

One other study which has been cited frequently to support the assumption that technical error is the most common cause of failure after ACLR is an abstract whose results to our knowledge have yet to be published in a peer-reviewed journal.[28] In this study presented at a national arthroscopy meeting, 77% of patients undergoing revision ACLR were due to technical errors such as tunnel malposition, inadequate fixation, or inadequate/insufficient graft. Despite this high percentage of technical errors, there was no definition of what constituted tunnel malposition, inadequate fixation, etc. This is in direct contrast to our study where we found that 71% of primary ACLR failures were due to traumatic recurrent ACL tears after a successful reconstruction. In our series there was one biologic failure (4%) and seven iatrogenic failures (25%) due to tunnel malposition or inadequate fixation.

When comparing our results of revision reconstruction to other studies previously published, our results compare similarly. Denti et al[29] reported on their experience with ACL revision reconstruction in 66 patients. The primary grafts used in their series were either autograft patellar tendon or quadrupled hamstrings. In their series of patients, 70% of patients had good/excellent Lysholm scores. Their result compares favorably to 65% of our patients who had good/excellent Lysholm scores, with an average score of 84 (good). Denti et al reported 68% of their patients had negative Lachman examinations after revision reconstruction but did not comment on their pivot shift examination. Of our total patients, 56% had a negative Lachman, and an additional 22% had a Grade I Lachman on final examination after revision reconstruction. The authors in their series report that 56% of patients had a side-to-side difference of $<$3 mm with the KT-1000 arthrometer, compared with 79% in our patient population. They also reported that 34% of patients had a side-to-side difference of 3 to 5 mm and 10% had up to 10 mm difference with KT-1000. In contrast, none of our patients had a side-to-side difference of $>$5 mm after revision reconstruction and only 21% had a difference of 3 to 5 mm.

Salmon et al[30] reported on their experience with ACL revision reconstruction in 50 consecutive patients at an average of 9 years postreconstruction. The authors in this study primarily used hamstring autograft. They defined failure based on the Lachman and pivot shift examination, with a functional graft defined as $<$3 mm on KT-1000 testing and a negative pivot shift. A partially functional graft was defined as 3 to 5 mm on KT-1000 testing and a trace pivot. Finally, failure of their revision grafting was defined as $>$5 mm on KT-1000 testing and positive pivot shift. Based on these definitions, the authors described a failure rate of 10%. Applying their same definitions for our patient series, we would have a failure rate of 12.5%. The average Lysholm score for their patient population was 85 points, which is very similar to the average of 84 points reported in the current study. The authors additionally reported on the method of failure of the primary ACLR. Despite not giving accurate definitions to determine their causes of failure, they reported similar incidences of failure (65% recurrent trauma and 35% biologic or technical). In our study we found that 71% were from trauma and 29% were due to biologic or technical errors.

There were several limitations to the current study. We acknowledge that all failures might not have presented to our institution after a failure, falsely lowering our rate of revisions. Further, some patients who may be classified as a clinical failure may not have elected to undergo revision surgery and therefore would not have been identified during our case log review. However, the 28 patients do provide insight into several key aspects of revision ACLR, such as probable cause of failure. Another limitation was all patients did not have radiographs to determine radiographical tunnel placement. This could lead to a falsely lowered number of patients who failed the initial reconstructive attempt secondary to technical error. Additional limitations regarding our outcome results include the retrospective nature of the study and the lack of a control group. Furthermore, the limited number of patients in our study could possibly bias the outcome-based surveys in a negative direction since one bad outcome could not be averaged out among many results. We chose to limit our inclusion criteria to only those patients who had the primary and revision reconstruction at our institution to critically look at our failures and outcomes.

There were several advantages to the current study. This study is unique in that specific radiographic, clinical and intraoperative criteria were used to define the cause of failure in a group of patients undergoing ACL revision reconstruction in patients who had their primary ACLR at the same institution. This allows a retrospective review of patients who presented with a failed primary reconstruction to categorize their failure as biologic, traumatic, or iatrogenic. During the study period we performed arthroscopic transtibial ACLR with a variety of grafts paying attention to anatomic placement of both femoral and tibial tunnels with known fixation techniques. With strict attention to good principles of ACLR, a lower failure rate can be expected with the majority of the failures coming as traumatic reinjuries.

In conclusion, in our patient series, failed ACLRs occurred most commonly after traumatic reinjury. Surgeon error or biologic failure is increasingly less common as more anatomic reconstructions are attained during the primary reconstruction. Additionally, for patients needing revision reconstruction, the results for revision reconstruction are still promising with a failure rate of less than 13%.

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