Original Article With Video Illustration

Anterior Cruciate Ligament Preservation: Early Results of a Novel Arthroscopic Technique for Suture Anchor Primary Anterior Cruciate Ligament Repair

Gregory S. DiFelice, M.D., Christine Villegas, M.B.S., and Samuel Taylor, M.D.

Purpose: To propose a technique of arthroscopic suture anchor primary anterior cruciate ligament (ACL) preservation for patients with proximal avulsion ACL tears that maintain excellent tissue quality. **Methods:** We performed a retrospective review and early follow-up of 11 consecutive cases of ACL preservation. Patients were included if they had a proximal avulsion tear and excellent tissue quality confirmed to be adequate for repair during arthroscopy. Patients were excluded if these criteria were not met or if patients had multiligamentous injury patterns or significant arthrosis. The ACL was reinforced with a No. 2 FiberWire (Arthrex, Naples, FL) and a No. 2 TigerWire (Arthrex) and was anchored to the femoral footprint by two 4.75-mm BioComposite SwiveLock suture anchors (Arthrex). The surgical procedures were performed at 3 different hospitals by a single surgeon. Anterior stability was determined with a KT-1000 arthrometer (MEDmetric, San Diego, CA). Clinical outcomes were measured using the Lysholm score, modified Cincinnati score, Tegner activity score, Single Assessment Numeric Evaluation, and subjective and objective International Knee Documentation Committee (IKDC) scores. **Results:** Ten of eleven patients had good subjective and clinical outcomes after ACL preservation surgery at a minimum of 2 years' and mean of 3.5 years' follow-up. The mean Lysholm score was 93.2; the mean modified Cincinnati score was 91.5; the preoperative Tegner activity score was maintained postoperatively in 8 of 10 patients; the mean Single Assessment Numeric Evaluation score was 91.5; the mean subjective IKDC score was 86.4; and the objective IKDC score was A in 9 of 11 patients, B in 1 patient, and C in 1 patient. KT-1000 measurements were available in 8 of 11 patients, with 7 of 8 showing a side-to-side difference of less than 3 mm on maximum manual testing and 1 showing a 6-mm difference. **Conclusions:** Preservation of the native ACL using the described arthroscopic primary repair technique can achieve short-term clinical success in a carefully selected subset of patients with proximal avulsion—type tears and excellent tissue quality. **Level of Evidence:** Level IV, therapeutic case series.

See commentary on page 2172

Robson,[1] Palmer,[2] and Campbell[3] were some of the earliest recorded surgeons to describe primary repair of the anterior cruciate ligament (ACL). In the 1950s and 1960s, work by O'Donoghue et al.[4-6] was instrumental in further defining the interest in this technique. The discussion of primary repair of the ACL became more mainstream in the 1970s with the figure-of-8 technique of Feagin and Curl[7] and the multiple-loop suture technique of Marshall et al.[8,9] Although the results of ACL repairs were initially promising, inconsistent midterm results of such repairs[7,10-14] steered the field in the direction of augmentation and, eventually, reconstruction.[11,15-18] Through the years, these techniques yielded more predictably successful results. However, risks associated with reconstruction such as loss of native tissue proprioceptive properties, physeal disruption, donor-site morbidity, and graft-associated infections exist. Currently, objective outcomes[19,20] and return-to-play data[21,22] suggest that the problem has not been completely resolved and that there is, in fact, room for improvement.

In light of the limitations of our current reconstructive techniques and their associated morbidity, we aimed to revisit the discussion regarding primary repair for certain carefully selected ACL injuries. We believe that

From Orthopaedic Trauma (G.S.D.) and Sports Medicine (S.T.) Services, Hospital for Special Surgery, New York, New York; Orthopaedic Trauma Service, New York Presbyterian Hospital (G.S.D.), New York, New York; and Rutgers New Jersey Medical School (C.V.), Newark, New Jersey, U.S.A.

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Address correspondence to Gregory S. DiFelice, M.D., Hospital for Special Surgery, 535 E 70th St, New York, NY 10021, U.S.A. E-mail: difeliceg@hss.edu

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the inconsistent results reported for primary ACL repair were influenced by multiple variables including limitations in knowledge and the diagnostic and technologic standards of the time. For example, repairs were performed acutely, by arthrotomy, and on "all comers," regardless of concomitant injuries or ACL injury pattern. Historically, the procedure was essentially abandoned, and no further refinement was pursued.

In their landmark study on primary ACL repair, Sherman et al.[13] categorized patients extensively, including by ACL tear type (Fig 1) and tissue quality. They strongly suggested that more consistent results could be obtained through careful patient selection, specifically taking into account tissue injury type (type 1, proximal avulsion tears) and tissue quality.[13] Today, advanced imaging, surgical techniques, instrumentation, and hardware make it possible to identify ACL injury patterns preoperatively with magnetic resonance imaging (MRI), confirm diagnoses arthroscopically, and repair some ligaments primarily with biomechanically sound constructs. It has been noted in past literature that if good stability and functional results can be accomplished by arthroscopy, "primary repair might reduce the number of patients needing later reconstructions."[23]

The purpose of this study was to propose a technique of arthroscopic suture anchor primary ACL preservation for patients with proximal avulsion ACL tears that maintain excellent tissue quality. We hypothesized that ACL preservation, when its application is limited to patients with proximal avulsion tears and excellent tissue quality, will yield successful outcomes as defined by good to excellent patient-reported outcomes scores, stable objective laxity measurements, and no need for revision surgery. We report on the clinical outcomes of 11 of these patients with at least 2 years' follow-up postoperatively.

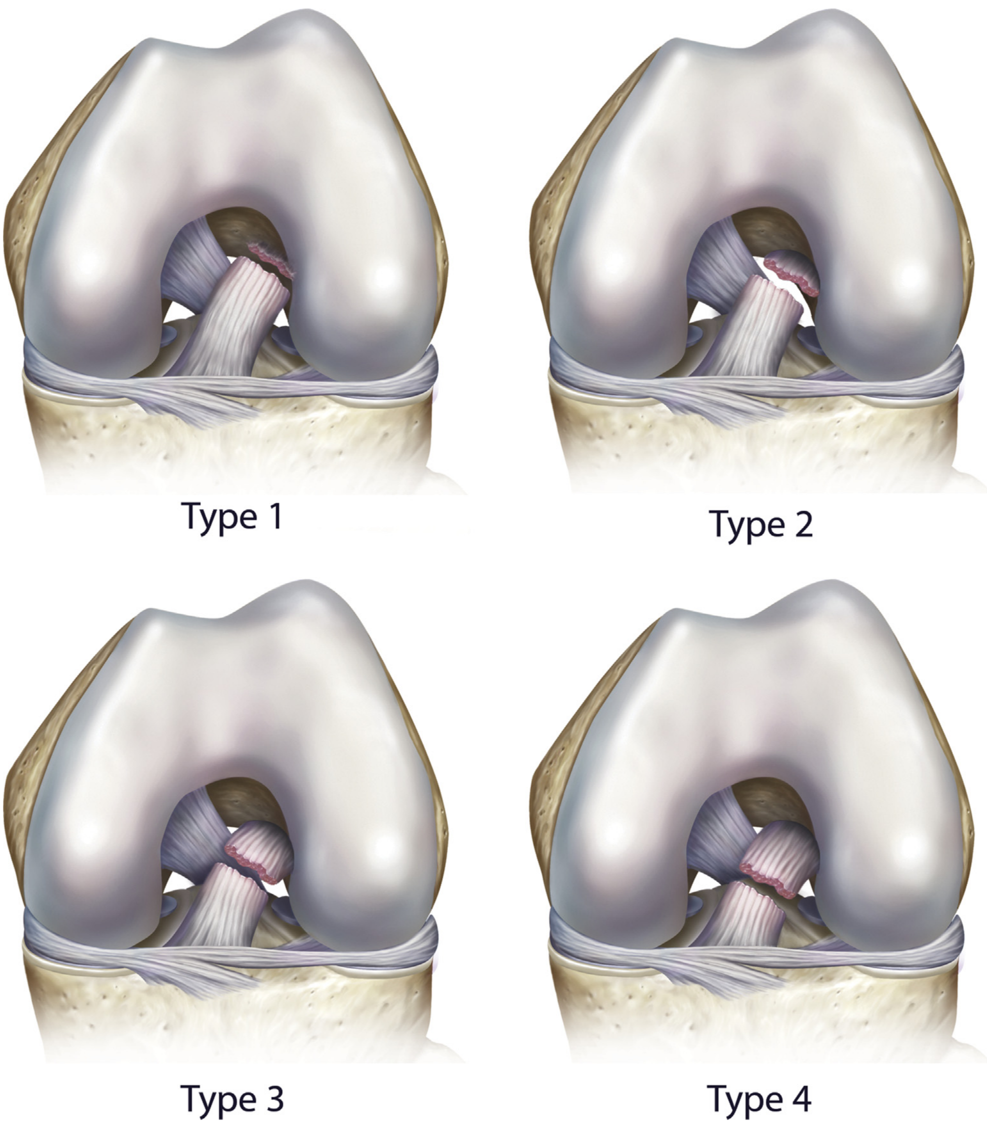

Fig 1. Original anterior cruciate ligament tear type classification of Sherman et al.[13] Type 1 tears were true soft-tissue avulsions with minimal ligament tissue left on the femur. Type 2 tears had up to 20% of the tissue left on the femur. Type 3 tears had up to 33% of the ligament tissue left on the femur. Type 4 tears were true midsubstance tears with up to 50% of the ligament tissue left on the femur. Modified with permission of SAGE Publications.[13]

Methods

This retrospective review was approved by our institutional review board (Hospital for Special Surgery Institutional Review Board No. 14075). We included the first 11 consecutive patients who underwent arthroscopic primary ACL preservation by the senior surgeon (G.S.D.) between 2008 and 2012. In all patients primary repair of the ACL was indicated based on careful preoperative and intraoperative screening. Indications for surgical intervention for all patients included clinical examination findings consistent with ACL deficiency (abnormal Lachman, pivot-shift, or anterior drawer test findings) and a desire to return to an active lifestyle that included cutting sports. Potential candidates for primary repair of the ACL underwent preoperative MRI (Fig 2) that identified a proximal avulsion ACL tear with a mostly normal appearance of the distal ligament. All patients consented to undergo arthroscopic primary repair of the ACL, with possible ACL reconstruction in the event that intraoperative assessment determined that inadequate tissue quantity or quality was present. Intraoperatively, the ligament was assessed by direct visualization and probing. Patients with excellent ACL tissue quality (as defined by a broad stump with mild interstitial tearing and the ability to hold sutures) at arthroscopy underwent primary repair of the ACL; those with inadequate tissue were converted to ACL reconstruction. There were no specific age restrictions. Patients were excluded if they had significant arthrosis of the knee (chondromalacia greater than grade 3) or a multiligamentous injury pattern (≥3 ligaments involved). Data from medical records and operative notes were obtained. Per the standard of care of the senior surgeon, patients were evaluated clinically using the Lysholm score, modified Cincinnati score, Tegner activity score, Single Assessment Numeric Evaluation score, subjective and objective International Knee Documentation Committee (IKDC) scores, and KT-1000 measurements. The scores were patient reported, clinical examination was performed by the senior surgeon, and KT-1000 measurements were performed by an independent examiner, all at the latest follow-up visit.

Fig 2. T1-weighted sagittal magnetic resonance image of a right knee with a proximal avulsion anterior cruciate ligament tear, with a mostly normal appearance of the distal ligament with proximal disruption.

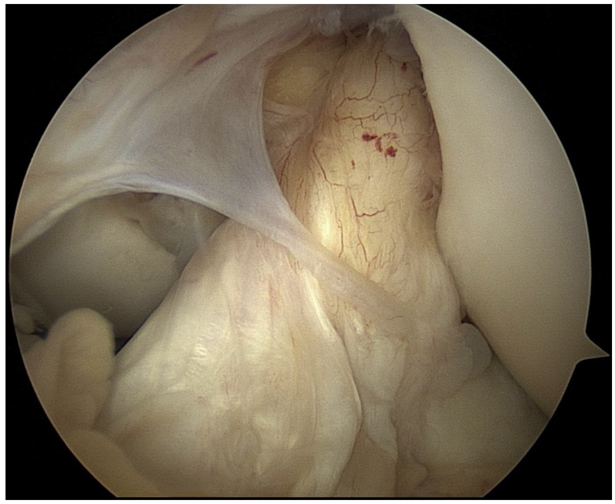

Fig 3. Initial arthroscopic image of a left knee, viewed from the anterolateral portal, with a proximal avulsion tear. The visualized tissue maintains the proper length and quality. The patient is supine, and the knee is at 90° of flexion.

Surgical Technique

The patient was placed in the supine position, and the operative leg was prepared and draped in standard fashion for knee arthroscopy (Video 1, available at www.arthroscopyjournal.org). Anterolateral and anteromedial portals were created, and diagnostic arthroscopy was undertaken. A malleable Passport cannula (Arthrex, Naples, FL) was placed in the anteromedial portal to facilitate suture passage, management, and ligament repair. An assessment of the ligament confirmed a proximal avulsion tear and excellent tissue quality such that it was reasonable to attempt a repair (Figs 3 and 4). Suture passage into the ligament remnant was performed with a Scorpion suture passer (Arthrex) using a No. 2 TigerWire stitch (Arthrex) (Fig 5). Suturing was started at the intact distal end of the ligament and was advanced in an alternating, locking Bunnell-type pattern toward the avulsed end. The initial stitch was placed roughly into the anteromedial bundle fibers of the ACL remnant. In general, 3 to 4 passes can be made before the final pass exits out of the avulsed end. The surgeon

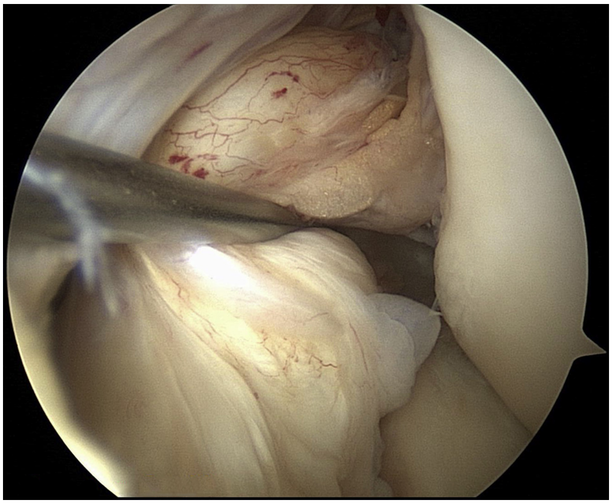

Fig 4. The proximal anterior cruciate ligament avulsion tear is being confirmed by using a probe to displace the anterior cruciate ligament from the femoral footprint (arthroscopic image of a left knee, viewed from the anterolateral portal, with the patient supine and the knee at 90° of flexion).

then repeated the same process with a No. 2 FiberWire suture (Arthrex), attempting to place the second stitch roughly into the posterolateral bundle fibers of the ACL remnant. Great care was taken to not transect the previously passed FiberWire stitch.

Once the sutures were passed (Fig 6), they were docked using an accessory stab incision, slightly above the medial portal, to retract the ligament away from the femoral footprint. Attention was then turned toward preparation of the femoral footprint with a shaver or burr to induce some bleeding. With the knee flexed, an

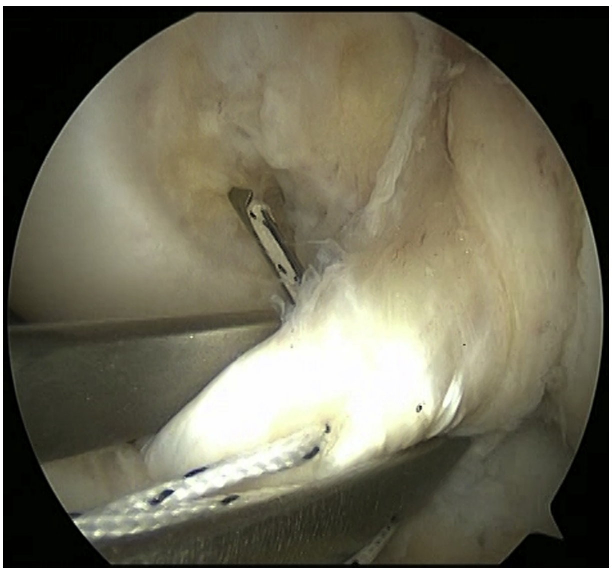

Fig 5. A No. 2 TigerWire is being passed through the anterior cruciate ligament remnant using a Scorpion suture passer (arthroscopic image of a left knee, viewed from the anterolateral portal, with the patient supine and the knee at 90° of flexion).

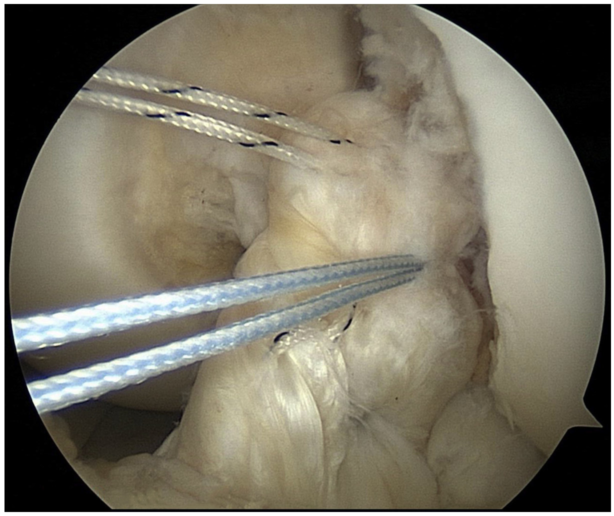

Fig 6. No. 2 TigerWire and No. 2 FiberWire locking stitches are placed in the anteromedial and posterolateral bundles, respectively (arthroscopic image of a left knee, viewed from the anterolateral portal, with the patient supine and the knee at 90° of flexion).

accessory inferomedial portal was created under direct visualization.

Initially, with the knee at 90° of flexion, a 4.5 × 20—mm hole was drilled, punched, or tapped (if there was exceptionally dense bone) into the origin of the anteromedial bundle of the native ACL footprint. The TigerWire sutures were then retrieved through the accessory portal and passed through a 4.75-mm vented BioComposite SwiveLock suture anchor (Arthrex). With this technique, the repair must be performed in flexion to visualize the placement of the anchors. Objective laxity testing results would suggest that this is acceptable; however, further research is warranted. With the knee at 90°, the first suture anchor was deployed into the femur, thus tensioning the ACL remnant back up to the wall with a visual gap of less than 1 mm given the type 1 tear pattern (Fig 7). This procedure was then repeated for the FiberWire stitches; however, the knee was held at approximately 110° to 115° of flexion to optimize the angle of approach and avoid perforating the posterior condyle. The drill hole and anchor were placed lower on the wall, into roughly the origin of the posterolateral bundle of the native ACL footprint. Once the anchors were fully deployed and flush with the wall, the handle was removed, the core stitches were unloaded, and the free ends of the repair suture were cut with an open-ended suture cutter so that they were flush with the bone. Once both anchors were deployed, the repair was complete (Fig 8). The ACL remnant had excellent tension and stiffness; this was confirmed with a probe. Range of motion confirmed anatomic positioning without impingement, and manual laxity testing showed minimal translation with a firm endpoint on Lachman examination intraoperatively.

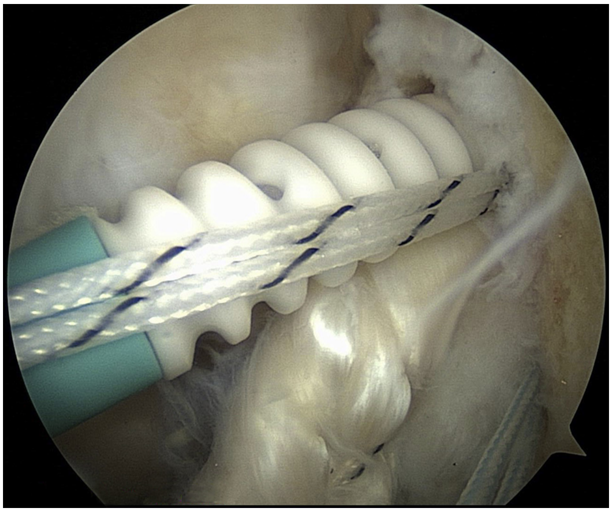

Fig 7. The first suture anchor is being deployed into the femur toward the anteromedial bundle origin to tension the anterior cruciate ligament remnant up to the wall (arthroscopic image of a left knee, viewed from the anterolateral portal, with the patient supine and the knee at 90° of flexion).

Rehabilitation Protocol

Postoperatively, the main objectives were controlling swelling and early range of motion. A brace was worn for the first month, with weight bearing as tolerated. Initially, the brace was locked in extension until volitional quadriceps control had returned. The brace was then unlocked for ambulation. Range-of-motion exercises were initiated in the first few days after surgery in a controlled fashion. Formal therapy did not start until after the first month. After 1 month, the patient was quickly weaned off of the brace. At 4 to 6 weeks postoperatively, the patient was advanced to gentle strengthening and placed on a standard ACL rehabilitation protocol.

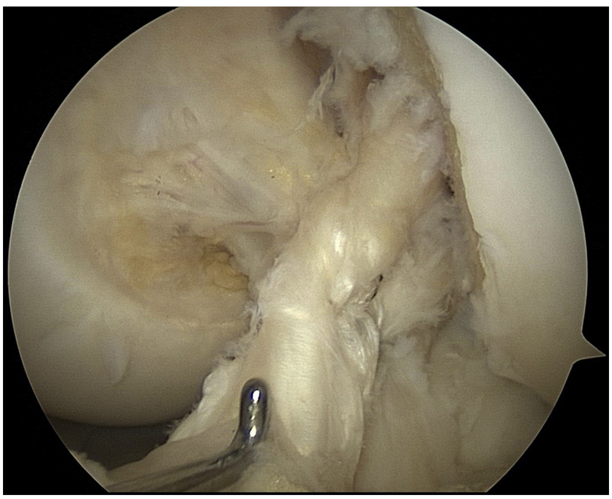

Fig 8. Arthroscopic image of a left knee, viewed from the anterolateral portal, of a completed suture anchor primary anterior cruciate ligament repair. The probe is on the preserved anterior cruciate ligament tissue. One should note that there is no significant gap between the tissue and the bone. The patient is supine, and the knee is at 90° of flexion.

Results

Demographic Characteristics

During the study period (between 2008 and 2012), 190 patients had operatively treated knee injuries that included ACL tears (Fig 9). Of this group, 179 patients were excluded or did not meet the inclusion criteria and underwent reconstruction. This left 11 patients who met the inclusion and exclusion criteria and underwent review. It was unclear from our records how many patients met the MRI criteria but not the intraoperative tissue quality criteria and thus underwent reconstruction; however, this was believed to be fewer than 3 patients in hindsight. The mean age at surgery was 37 years (range, 17 to 57 years). There were 10 male patients and 1 female patient. The mean delay from injury to surgery was 39 days (range, 10 to 93 days). The mechanisms of injury were sports related (football, rugby, wrestling, basketball, softball, and skiing). The mean time to follow-up was 41 months (range, 25 to 75 months). No patients were lost to follow-up. Five patients had concomitant injuries, including chondromalacia, acute chondral injury, meniscus tears, or conservatively treated medial collateral ligament (MCL) injuries (or some combination thereof).

All of the patients cooperated with the aforementioned postoperative instructions and rehabilitation guidelines except 1 (patient 9). This patient, although

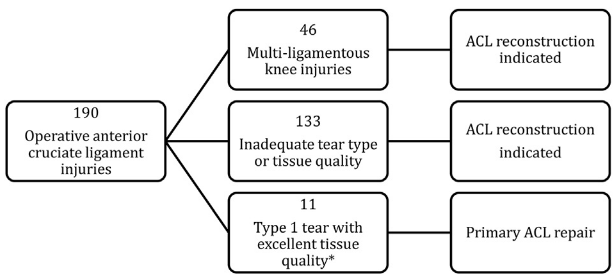

Fig 9. Inclusion and exclusion flowchart. One hundred ninety patients presented with a torn anterior cruciate ligament (ACL) within the period covered by the study. Of the excluded patients, 46 had a multiligamentous knee injury and went on to reconstruction. One hundred thirty-three patients had an inadequate tear type or inadequate tissue quality and went on to reconstruction. Finally, 11 patients had a type 1 tear with excellent tissue quality and underwent primary ACL repair. All 11 patients were included in the study; these patients represented 7.6% of isolated ACL injuries and 5.7% of overall ACL injuries (asterisk).

admittedly noncompliant with brace wear and physical therapy throughout the postoperative period, was actually doing well until 3 months postoperatively, when he experienced an atraumatic pop while descending stairs that resulted in deterioration in his stability examination findings; this patient represents the only clinical failure. At the most recent follow-up, 91% of patients had stable knees by examination and instrumented laxity testing and normal or nearly normal objective IKDC scores (Table 1).

Clinical Assessment

The mean Lysholm score was 93.2; the mean modified Cincinnati score was 91.5; the preoperative Tegner activity score was maintained postoperatively in 8 of 10 patients; the mean Single Assessment Numeric Evaluation score was 91.5; the mean subjective IKDC score was 86.4; and the objective IKDC score was A in 9 of 11 patients, B in 1 patient, and C in 1 patient (Table 2). Satisfaction and subjective scores were generally high (Table 2), with the exception of 1 patient (patient 8), a 50-year-old skier and yoga instructor, who had a concomitant MCL injury, who struggled to regain motion and whose main complaint was stiffness, not instability. KT-1000 assessment in the 7 patients with successful outcomes showed a side-to-side difference of less than 3 mm on maximum manual testing. Two patients (patients 1 and 4) had an injury to the contralateral knee preventing meaningful comparisons, and 1 patient (patient 8) refused testing; the other patient (patient 9) was the surgical failure and had a 6-mm side-to-side difference on maximum manual testing. Postoperative MRI studies were only obtained in 3 patients because of insurance issues. The results showed heterogeneous signal in the ligament due to artifact from the sutures, but the ligament was appropriately positioned with irregular scar tissue at the femoral repair site (Fig 10).

Safety

There were no postoperative complications. None of the patients have required additional surgical procedures.

Discussion

We found that 91% of patients with proximal avulsion tears and excellent tissue quality of the remnant ligament who underwent primary repair of the ACL achieved a clinically stable knee with instrumented laxity measurements of less than 3 mm and excellent validated outcome measures at a minimum of 2 years' follow-up. Primary repair is not a novel concept, yet the orthopaedic community has been reticent to reconsider this procedure based on the historical experience detailed in the literature. We believe that primary ACL repair was prematurely discarded. There have been profound advances in diagnostic and therapeutic capabilities in the ensuing decades since primary repair faded, without reassessment. Strand et al.,[23] when reporting their long-term follow-up results, even opined, "if the same results could be accomplished by a smaller, arthroscopic procedure, primary repair might reduce the number of patients needing later reconstructions with small 'costs' in the way of risk and inconvenience for the patients. We therefore believe that further research and development of methods for closed (arthroscopic) repair are justified."

We believe that there exists a subset of ACL-injured patients who can benefit from the described ACL preservation technique. Dramatic improvements in our collective understanding and diagnostic abilities have come to the fore and allow us to be more focused in our indications. The arthroscopic nature of this technique, combined with the suture anchor fixation, not only maximally leverages technologic advances to the patients' benefit but exponentially decreases the morbidity of the procedure. If revision is necessary, it is more like a primary ACL reconstruction because no

Table 1. Demographic Characteristics of First 11 Patients in Whom Primary ACL Repair Was Indicated, With at Least 2 Years' Follow-up, in Single-Surgeon Series

	Age, yr	Sex	Mechanism of Injury	Other Injuries	Most Recent Follow-up, mo
Patient 1	37	Male	Skiing	Chondromalacia	75.0
Patient 2	38	Male	Wrestling		62.9
Patient 3	22	Male	Basketball		62.6
Patient 4	57	Male	Softball	Chondromalacia, MCL injury	47.5
Patient 5	51	Male	Skiing	Medial meniscus tear	40.1
Patient 6	23	Male	Rugby		30.9
Patient 7	41	Male	Football		30.7
Patient 8	50	Female	Skiing		27.13
Patient 9	35	Male	Basketball	Lateral meniscus tear	28.4
Patient 10	17	Male	Rugby	MCL injury	24.9
Patient 11	38	Male	Soccer		26.1
Mean ± SD	37 ± 13				41.5 ± 17.9

ACL, anterior cruciate ligament; MCL, medial collateral ligament.

Table 2. Objective and Subjective Measures of Clinical Outcomes of 11 Patients After Suture Anchor Primary Repair of ACL at Latest Follow-up

	Lysholm Score	Modified Cincinnati Score	Tegner Activity Score		SANE Score	Subjective IKDC Score	IKDC Physical Examination Rating	Difference on KT-1000 Maximum Manual Testing at 30°
			Pre	Post				
Patient 1	100	100	8	8	90	100	A	NA*
Patient 2	90	92	5	5	95	90.8	A	1 mm
Patient 3	95	92	8	8	95	90.8	A	1 mm
Patient 4	83	63	8	6	90	95.4	B	NA*
Patient 5	94	96	7	7	95	83.9	A	1 mm
Patient 6	100	100	9	9	95	100	A	2 mm
Patient 7	100	100	7	7	95	87.3	A	2.5 mm
Patient 8	79	77	5	5	75	51.7	A	NA†
Patient 9	90	91	7	6	85	86.2	C	6 mm
Patient 10	100	100	9	9	100	90.8	A	1 mm
Patient 11	94	95	7	6	95	73.5	A	1 mm
Mean ± SD	93.2 ± 7.2	91.5 ± 11.6	7.2 ± 1.3	6.9 ± 1.4	91.8 ± 6.8	86.4 ± 13.7		

ACL, anterior cruciate ligament; IKDC, International Knee Documentation Committee; NA, not available; Post, postoperative; Pre, preoperative; SANE, Single Assessment Numeric Evaluation.

*The patient had an injured contralateral knee; a side-to-side comparison was not possible.

†The patient was not willing to undergo an additional follow-up visit.

bridges have been burned by the repair procedure. In addition, advanced approaches to rehabilitation focusing on early motion mostly solve the high rates of stiffness and debilitating patellofemoral pain caused by lengthy periods of immobilization that plagued the outcomes of the historical approaches. This series of patients undergoing arthroscopic ACL preservation represents the initial 11 patients to be identified who were believed to have the highest reward-to-risk ratio in this regard. A fully transparent discussion of these topics was held with each patient before we proceeded with surgery.

Fig 10. T1-weighted sagittal postoperative magnetic resonance image of the right knee of patient 10, taken 24 months after repair. One should note the anatomic direction of the ligament fibers, as well as the heterogeneous signal of the ligament, especially at the proximal portion.

Any discussion of ACL repair leads one to quickly refer to the well-quoted study of Feagin and Curl[7] that describes high failure rates at midterm follow-up in a cohort of West Point cadets who underwent primary ACL repair. Sherman and Bonamo[24] offered good insight regarding the study by Feagin and Curl, stating that "a total condemnation of the primary repair procedure is not warranted based on this study alone." It can be argued that the study by Feagin and Curl, as well as other studies that followed and compared similar surgical techniques, did not control for variables that likely affected the outcomes, such as tear types and concomitant ligamentous or meniscal injuries.[10-12,25,26]

Certainly, we acknowledge the difficulty of comparing historical literature with present-day findings due in large part to different standards of care and data interpretation. For example, the best results of Sherman et al.[13] were in knees with a 5° flexion contracture and type 1 tears, whereas their poorer results were in knees in which there was an earlier return to motion. Nevertheless, we believe that there is real value in some historical literature: In particular, we reiterate that the series of Sherman et al.[13] was distinctive in that it was the only study that performed a multivariate analysis, with the key finding of their work and the basis of our work being that proximal avulsion tears with excellent tissue quality yielded the highest likelihood of good outcomes. When historical clinical results are viewed through the lens that perhaps it was not the technique but rather the tear pattern that resulted in high rates of failure, then a different assessment of the data becomes possible. In fact, a closer look at some of the ACL repair data from these uncontrolled studies finds that an undeniable percentage of the outcomes were indeed positive. Grouping the results from multiple studies with follow-up periods ranging from 5 to 30 years using the historical repair techniques shows that anywhere from 50% to 75% of patients, on average, had satisfactory subjective and objective outcomes.[8,13,16,23,27,28] The positive outcomes cited in these long-term follow-up periods would not represent acceptable percentages if this was our only method of treating ACL deficiency. However, they do encourage us to hypothesize that the percentages may likely have been much higher if the historical ACL repairs were only performed on patients with proximal avulsion tears and excellent tissue quality. If that were the case, perhaps this approach would not have been abandoned in the first place.

A review of the published literature over the past decade shows that most research on the topic of ACL repair has been based on porcine studies, using a transection model, led by Dr. Martha Murray. We applaud this award-winning body of research that has elegantly shown that the ACL lacks the innate healing of the MCL that is provided by stable clot formation. Furthermore, the Murray group showed that a bio-enhanced healing environment using a platelet-enriched collagen sponge, combined with suture repair, a younger age, and early intervention, could produce meaningful histologic and biomechanical healing of the ACL.[29,30] Recently, they showed, in a porcine model, that primary repair reduced the magnitude of osteoarthritic changes when compared with other forms of surgical stabilization.[31] Although we agree with many of the Murray group's findings, we believe strongly that proximal avulsion ACL tears behave differently than the intrasubstance tears studied in their model. This assertion was supported by Nguyen et al.,[32] who studied human biopsy samples from ACLs that were scarred to the posterior cruciate ligament at the time of reconstruction. Histologic and immunohistochemical analysis showed that the healing process of these proximal tears very closely resembled that of the MCL. Furthermore, it is believed that the described technique of primary ACL repair directly apposes the ligament stump to the bleeding bony bed of the femoral origin that optimizes the healing potential within the knee by minimizing the deleterious effects of the synovial fluid environment.

The early clinical success of the patients in our series should be interpreted with cautious optimism given the small sample size and should inspire reconsideration of primary ACL repair in appropriately selected patients with proximal avulsion tears and adequate tissue quality as Sherman et al.[13] suggested. At the latest follow-up, all but 1 of the patients had stable examination findings, had returned to full activities, and reported satisfaction with the outcome of their surgery. Two patients in the series should be reviewed because they seem to be outliers. The single objective failure was not related to any technical variables that could be identified. This patient's stability examination findings deteriorated when he felt a pop while descending stairs at approximately 3 months postoperatively. Although he was poorly compliant with all brace and therapy recommendations, he regained full range of motion and the Lachman examination was actually stable until the episode in question. Subsequently, he modified his activities to adapt to this, as shown objectively by the decrease in the Tegner score, although his subjective scores remained rather high. This finding reinforces the well-accepted notion that activity modification can yield acceptable subjective results for certain patients. Another case of note is the only patient whose subjective measurements were significantly below average. Her stability was restored with the operation, although some stiffness prevented her from fully engaging in her yoga practice, which frustrated her. She was also 1 of the 2 patients who had a concomitant grade 3 MCL injury that was allowed to heal before undergoing surgery, and such injuries historically have been associated with stiffness.

Although it would seem reasonable to focus the described procedure on lower-demand patients, and our cohort is admittedly mixed in this regard, we would like to draw attention to our 2 youngest patients. They underwent ACL preservation surgery, returned to full contact sports on their own volition within 4 months postoperatively, and had excellent objective and subjective outcomes. We recognize the historical deterioration in outcomes between short-term and midterm follow-up and agree that more patients and longer follow-up data are essential. We are also encouraged to note, however, that for our initial 3 patients, the postoperative period is between 4 and 5 years and they continue to function well. Equally encouraging is that Taylor et al.[28] noted, "one of the most interesting findings in our study was that the 5 year results were a good predictor of the subjective results at more than 30 years."

Finally, we highlight that the average delay until surgery was 39 days. This was because of administrative delays such as obtaining clearances and insurance approvals, and 2 patients' operations were delayed to allow the MCL to heal. We draw attention to this fact because according to past literature, the key to a successful primary ACL repair is to perform it acutely, preferably within a few days.[4,6,14,15] Our data showed favorable outcomes at a minimum of 2 years postoperatively, despite a considerable delay until surgery for some patients. Given these successful outcomes, our results beg the question as to whether the acuity of surgery is the most important variable or whether adequate tissue length and quality are the true predictors of success. The concept of improving outcomes with acute repair is based on the work of O'Donoghue et al.[6] in dogs in 1966, where they showed that resorption occurs as early as 2 weeks after injury, making repair impossible. However, a more recent investigation about the morphology of the torn ACL showed that few torn ACLs resorbed and "nearly three quarters of disrupted ACLs showed some intra-articular attachment."[33] This reattachment is indeed a noteworthy finding because Nguyen et al.[32] described the healing properties of proximal ACL tears to be similar to those of the MCL. Certainly, the use of a minimally invasive, anatomically correct, biologically sound method of ACL preservation performed in a highly selected group of patients that maximally integrates decades of advances in diagnostic, surgical, and rehabilitative medicine seems to be worthy of further study.

Limitations

Our small sample size resulted from the strict criteria for patient selection and is a side effect of the broad nature of the senior surgeon's practice. Although only a single surgeon's retrospective experience is presented, credibility is improved by reporting the first 11 consecutive patients (including the learning curve), as well as the fact that no patients were lost to follow-up. Follow-up MRI scans and second-look arthroscopy would add to the knowledge base going forward. Longer-term follow-up is warranted.

Conclusions

Preservation of the native ACL using the described arthroscopic primary repair technique can achieve short-term clinical success in a carefully selected subset of patients with proximal avulsion tears and excellent tissue quality.

Acknowledgment

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