CASE REPORT

Successful Arthroscopic Primary Repair of a Chronic Anterior Cruciate Ligament Tear 11 Years Following Injury

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Received: 7 July 2016/Accepted: 4 October 2016/Published online: 18 November 2016
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Keywords anterior cruciate ligament · repair · primary repair · chronic injury · suture repair · arthroscopic primary repair

Introduction

Approximately 120 years ago, Mayo Robson performed the first treatment of an anterior cruciate ligament (ACL) injury using open primary repair of a proximal ACL and posterior cruciate ligament (PCL) tear [26]. Over the ensuing decades, the surgical treatment of primary ACL repair was further popularized by Palmer in the 1930s and 1940s [24] and O'Donoghue in the 1950s and 1960s [20–22] and, initially, the short-term results of open primary ACL repair were excellent [15, 17, 29].

It was, however, noted that the outcomes of open primary ACL repair deteriorated with time and were considered to be unpredictable at mid-term follow-up [6, 7, 13, 15, 21, 30]. A possible explanation for these unpredictable results followed in 1991, when Sherman et al. reported an extensive subgroup analysis of primary ACL repair outcomes and found that better results were associated with proximal tears and excellent tissue quality. Several other studies also noted better results in the subset of patients with proximal tears [9, 11, 14, 23, 37]. Other factors that could have contributed to these mixed results were invasive

surgery (i.e., arthrotomy) and the postoperative regimen (i.e., immobilization for 6 weeks) [18].

Modern developments such as magnetic resonance imaging (MRI), arthroscopic surgery, and early postoperative motion protocols enable better patient selection, less invasive treatment, and more optimal postoperative management. Not surprisingly, a recent case series of arthroscopically repaired proximal ACL tears has reported excellent results [5], and it seems that there is a recent resurgence of interest in primary ACL repair [1, 4, 31, 34]. Several advantages of ACL preservation with primary repair exist, when compared to ACL reconstruction, including maintaining proprioceptive function [25, 28] and the native ACL kinematics [27].

Traditionally, treatment of primary ACL repair was performed in the acute setting [2, 20–22, 36] as it was advocated that “in all types of injury early repair (under two weeks) gives much better results than late repair or reconstruction” [21]. It was thought that performing repair in the acute setting provided optimal tissue quality and prevented ligament retraction and/or reabsorption [2, 21, 22, 36]. Therefore, primary ACL repair was not performed in the non-acute setting as surgeons tended to prefer ACL reconstruction under these circumstances. Not surprisingly, no studies or cases of performing ACL repair in the non-acute setting could be found when reviewing the literature. Therefore, we would like to present a case of successful arthroscopic primary repair of a chronic ACL tear in a 38-year-old male.

Electronic supplementary material The online version of this article (doi:10.1007/s11420-016-9530-8) contains supplementary material, which is available to authorized users.

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Case Report

A 38-year-old male came into the clinic with right knee locking and pain after a twisting injury. After anterior laxity was noted on the Lachman exam, the patient explained that he had suffered an ACL tear 11 years ago while playing racquetball. At that time, a complete proximal ACL tear was diagnosed on MRI and surgery was recommended. The patient was concerned about the outcome of the surgery and opted for conservative treatment. He stopped participating in sports that required cutting, such as racquetball and soccer, and was able to keep his symptoms mild during the

ensuing 11 years until the recent episode 2 weeks prior when he sustained a lateral hit to his right knee resulting in a twisting injury. He came into the clinic with medial knee pain, limited range of motion (ROM), and an increased sense of instability.

Physical examination revealed normal leg alignment, a right knee with mild effusion, ROM of 20° to 135° of flexion, and medial joint line tenderness. Laxity examination revealed a grade 2 Lachman test without endpoint, but the pivot shift was not reliable due to guarding of the patient. The knee was stable to varus and valgus stress at full extension and 30° of flexion. The posterior drawer test was within normal limits and the patient was neurovascularly intact.

Radiographs of the right knee showed slight medial joint line narrowing (Fig. 1), and the MRI revealed a displaced bucket-handle medial meniscus tear and a complete (type I) [30] proximal ACL tear with good tissue length that had scarred to the PCL (Fig. 2). Treatment options were discussed, and it was agreed that the meniscal tear would be either repaired or debrided depending on the tissue quality. Arthroscopic primary ACL repair would be attempted in the case of sufficient tissue quality and length.

Laxity examination was repeated under anesthesia and a grade 2 with soft endpoint Lachman exam and 2+ pivot shift were noted. Arthroscopic evaluation revealed a displaced macerated bucket-handle tear of the medial meniscus, which was debrided in standard fashion. The ACL was torn proximally and the medial and posterior sides of the ACL were scarred to the PCL (Fig. 3). After freeing the ACL from the PCL, sufficient tissue quality and length were noted and primary ACL repair commenced as previously described [4]. Sufficient tissue quality was noted as the ligament was completely avulsed off the femoral wall, all fibers were in the same direction, there was no retraction or reabsorption of the ligament and, most importantly, the fibers did not end in

a mop-end pattern. The length of the ligament was approximately 90–95% of the length of the ligament.

A #2 FiberWire (Arthrex, Naples, FL, USA) suture was passed through the anteromedial (AM) bundle using a Scorpion Suture Passer (Arthrex, Naples, FL, USA). The first pass was made as distal as possible and the suture passing was advanced in an alternating, interlocking Bunnel-type pattern towards the proximal avulsed end of the ligament. A total of four passes were made before the final pass exited the avulsed AM bundle proximally towards the femur (Fig. 4). Then, the same process was repeated for the posterolateral bundle (PL) using a #2 FiberWire suture (Arthrex, Naples, FL, USA). Great care was taken to not transect the previously passed sutures and the Suture Passer was repositioned when too much resistance was experienced. The sutures were then docked using an accessory portal in order to provide good visibility of the femoral footprint and a burr was used to roughen the former femoral ACL footprint in order to promote bleeding [12, 32, 33].

With the knee in 90° of flexion, two 4.5 × 20 mm holes were drilled, punched, or tapped, depending on the bone density, into the origin of the AM bundle and PL bundle of the femoral footprint. After passing the TigerWire sutures of the AM bundle through the eyelet of a 4.75-mm Vented BioComposite SwiveLock suture anchor (Arthrex, Naples, FL, USA), the first suture anchor is deployed into the femur towards the AM origin, while tensioning the ACL remnant to the wall without a visual gap. The procedure was then repeated for the PL bundle at 110° to 115° of flexion to ensure an optimal angle of approach to the femoral notch wall and avoids perforation of the posterior condyle with the suture anchor. The ACL repair was then complete and intra-operative Lachman exam was negative with a good endpoint (Fig. 5). The patient was taken to the recovery room in a

Fig. 1. Anteroposterior (*left*) and lateral (*right*) radiograph of the right knee are shown. Slightly medial joint space narrowing is seen on the anteroposterior radiograph.

Fig. 2. Preoperative MRI shows a discontinuity of the ACL at the proximal region. The ACL is attached onto the PCL (arrow).

brace locked in extension. The patient was explained to wear the brace for the first four weeks with weight bearing as tolerated. ROM exercises should be initiated in the first few days after surgery in a controlled fashion but formal physical therapy was not started until after one month. Gentle strengthening and a standard ACL rehabilitation protocol should then be started four to six weeks postoperatively.

Three days postoperatively, the patient returned for standard follow-up reporting no pain. Physical examination showed a moderate effusion with clean, dry, and intact incisions. ROM was 0° to 90° of flexion and the Lachman exam was negative. Arthrocentesis was performed and 75 cm³ of blood was aspirated from the knee. The patient made an excellent early recovery and independently discontinued the brace at 10 days postoperatively because

he felt fine. In addition, he advanced his activities on his own progressing to biking and leg pressing within the first 2 week after surgery.

At 2 weeks follow-up, physical examination revealed no effusion, ROM of 0° to 130°, and a negative Lachman with soft endpoint. Five weeks postoperatively, the patient was ambulating without any assistive devices and was fully weightbearing. He reported some mild difficulties climbing stairs, which later resolved. At 9 weeks postoperatively, physical examination revealed a grade 1A Lachman exam with soft endpoint, a grade 1+ pivot shift, and an otherwise stable knee. Patient was told to slow down in the rehabilitation and follow the ACL rehabilitation protocol as this could endanger the stability of his knee.

At 2 years and 2 months follow-up, the patient reported feeling fine and was fully participating in sporting activities, including racquetball and soccer. Physical examination showed excellent ROM from 10° of hyperextension to 130° of flexion, which was similar to the contralateral leg. The Lachman test still showed a grade 1A but the pivot shift was now negative. Patient reported a Lysholm score of 100, modified Cincinnati score of 100, preoperative Tegner level of 5 and postoperative Tegner level of 7, subjective IKDC score of 100, a Knee injury and Osteoarthritis Outcome Score (KOOS) of 98, and rated his knee as 99% of normal (SANE score). KT-1000 testing at 30° of flexion showed side-to-side differences at 15, 20, and 30 psi of 2, 3, and 3 mm, respectively. At 90° of flexion, the side-to-side differences were 1, 1, and 2 mm, respectively. MRI showed continuity of the ACL (Fig. 6).

Discussion

This case report has shown that a good outcome of arthroscopic primary repair of a chronic ACL tear may be possible. Several studies have demonstrated that the ACL has

Fig. 3. Arthroscopic image is shown of the right knee. The ACL (arrow) is reattached onto the PCL (asterisk).

Fig. 4. Arthroscopic image is shown of the right knee. Sutures are passed through the anteromedial and posterolateral bundles. In the background, it is clearly visible there is a gap between the anatomic femoral footprint and the ACL (asterisk).

Fig. 5. The ACL repair is finished and the ligament with sufficient tissue length and excellent tissue quality is reattached to the femoral wall (*asterisk*) using suture anchors.

poor potential healing capacity [10, 22, 38, 39] and suggested, therefore, that primary ACL repair should only be performed in the acute setting, or ACL reconstruction should be performed [9, 12, 20, 21, 30, 32, 33]. To our knowledge, this is the first study reporting primary ACL repair in the non-acute setting. Optimal conditions for primary ACL repair were present with (1) a proximal tear, (2) excellent tissue quality, and (3) sufficient tissue length [5, 30]. While these conditions are typically observed in the acute setting, this case suggests that the injury and tissue characteristics may be more important for successful arthroscopic primary ACL repair than the injury acuity itself.

A likely explanation for these optimal circumstances (i.e., sufficient tissue length and excellent tissue quality) could be the scarring of the ACL onto the PCL, which was observed during arthroscopy. It is possible that this reattachment contributed to maintaining good tissue quality and length. Historically, it was believed that not repairing the ACL in the acute setting would cause retracting and/or reabsorption of the ACL. This concept was primarily based on an animal study by O'Donoghue et al., in which the authors observed that the tissue retracted or reabsorbed in many cases after ACL transection [22]. In another clinical study, O'Donoghue stated "All of the patients might well have been divided into two groups only, early repair and late repair – a division which would show even more dramatically the advantage of early repair" [21].

More recently, some studies reported other findings during arthroscopy of chronic ACL tears. Lo et al. performed arthroscopy prior to ACL reconstruction in 101 patients and reported their findings. In 73% of their patients at mean of 29.4 months (range, 1 to 240 months) after injury, they found scarring or reattachment of the ACL onto the PCL [16]. The authors reported firm reattachment of the ACL to the PCL in most cases, which was substantial enough to prevent pulling the ACL off the PCL. Other studies reported lower but significant incidences of reattachment of the ACL to the PCL (14–38%) [3, 8, 35]. Crain and colleagues reported that in 18 out of 48 patients (38%) reattachment to the PCL was seen and measured anteroposterior laxity

Fig. 6. Coronal view of the postoperative MRI shows that the proximal part of the ACL (*arrow*) is approximated to the femoral wall using a suture anchor (*asterisk*).

before and after debriding the ACL from the PCL [3]. They found a 1.3-mm average increase in laxity after debridement of the ACL. They concluded that this reattachment contributed to anteroposterior stability by a small degree. Interestingly, our patient reported only minor instability in the 11 years following the ACL injury. It is possible that the reattachment of the ACL onto the PCL, as observed during arthroscopy, resulted in his only experiencing mild symptoms in this regard. The patient in this case experienced an increase in instability symptoms after his recent injury while the ACL was still reattached to the PCL, as noted at arthroscopy. This increased instability could be explained by the medial meniscal tear and associated quadriceps inhibition since it has been shown that the medial meniscus is an important secondary stabilizer to anteroposterior stability [19]. However, we could not confirm this as a Lachman exam or pivot shift was not repeated after the partial meniscectomy or after dissecting the ACL off the PCL.

In our literature search, no studies could be identified that reported repair in the non-acute setting. Recently, a case series of arthroscopic primary repair of proximal ACL tears was reported in which the mean time from injury to repair was 39 days (range 10 to 93 days) [5]. Although this delay to repair was longer than the generally recommended a 2-week timeline to perform surgery [2, 20, 21, 36], excellent outcomes were reported. In their study, the optimal conditions of (1) proximal location of the tear, (2) sufficient tissue length, and (3) excellent tissue quality were present in all patients. Despite the suboptimal time to surgery, the authors reported only one clinical failure (9%), mean Lysholm scores of 93, and KT-1000 testing of <3 mm side-to-side differences in the 7 out of the 8 patients in whom tests were obtainable. Therefore, the authors stated, "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.” Similarly, the current case did not qualify for a repair in the acute setting but did qualify with regard to the optimal conditions for arthroscopic ACL repair of (1) proximal location of the tear, (2) sufficient tissue length, and (3) excellent tissue quality. The case presented suggests that maybe it is not the time from injury to repair that is critical for ACL repair as traditionally suggested [2, 20, 21, 36], but that the conditions of the ligament may actually be more important. These conditions are indeed frequently seen in the acute setting but can also be seen in the non-acute setting.

In conclusion, this case reported on a successful arthroscopic primary repair of a proximal ACL tear 11 years following the ACL injury. After reviewing the literature and this case, it is likely that the conditions, such as proximal tear location, sufficient tissue length, and excellent tissue quality, could potentially be more important for successful outcomes of arthroscopic primary ACL repair than acuity of the surgery. Future studies are necessary to assess the quality of tissues in the acute and non-acute settings in order to determine eligibility for arthroscopic primary repair of proximal ACL injuries.

Compliance with Ethical Standards

Conflict of Interest: Jelle van der List, MD, has declared that he has no conflict of interest. Gregory S. DiFelice, MD, reports personal fees from Arthrex, outside the work.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was waived from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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