HSSJ (2011) 7: 190–193
DOI 10.1007/s11420-011-9197-0

CASE REPORT

Arthroscopic Avulsion Repair of a Pediatric ACL with an Anomalous Primary Insertion into the Lateral Meniscus

Jason O. Toy, BA · Brian T. Feeley, MD · Lawrence V. Gulotta, MD · Russell F. Warren, MD

Received: 7 June 2010/Accepted: 3 February 2011/Published online: 11 March 2011

Abstract *Background:* Injury to the anterior cruciate ligament (ACL) in the pediatric population is becoming more common, with the majority of ruptures occurring at the tibial insertion site. However, to our knowledge, there are no reports of avulsion in which the primary ACL insertion site is the anterior lateral meniscal root. *Methods:* We report a rare case of a pediatric ACL/anterior horn of the lateral meniscus avulsion, which was successfully repaired arthroscopically. *Results:* In this patient, neither a mid-substance tear, nor a tibial eminence fracture was noted. Instead, the patient avulsed the tibial insertion of the ACL from its small footprint, which included an extensive attachment to the lateral meniscus. *Conclusions:* We believe this developmental anomaly may provide further support of the shared embryological origin between the ACL and menisci. In this case report, we review the literature on anterior cruciate ligament injury and repair in the pediatric population.

Keywords ACL repair· meniscus repair· pediatric

Each author certifies that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution has approved the reporting of this case, that all investigations were conducted in conformity with ethical principles of research.

B. T. Feeley, MD · L. V. Gulotta, MD · R. F. Warren, MD
Department of Orthopedic Surgery, Hospital for Special Surgery,
535 East 70th Street,
New York, NY 10021, USA

J. O. Toy, BA (✉)
School of Medicine, Case Western Reserve University,
10900 Euclid Avenue,
Cleveland, OH 44106, USA
e-mail: Jot@Case.edu

B. T. Feeley, MD
Department of Orthopaedic Surgery, University of California, San Francisco, 1500 Owens Street,
San Francisco, CA 94158, USA

Introduction

As the number of young children competing in athletics continues to rise, the rates of anterior cruciate ligament (ACL) injuries in this population will rise as well [1]. Many surgeons recommend delaying reconstruction of the ACL until the physes near closing to avoid injury to the growth plates. However, delayed treatment may result in recurrent instability with subsequent meniscal and chondral injury. McCarroll et al. reported that seven out of eight pediatric patients with an ACL rupture who returned to athletic activity following non-operative treatment developed a new meniscal tear [16]. A similar study of 39 skeletally immature patients reported a higher incidence of medial meniscal tears associated with a delay in surgical treatment [17]. This is likely due to the medial meniscus's role as a secondary restraint to anterior tibial translation [14].

Unlike adults, skeletally immature patients vary in how the ACL is ruptured. Bony avulsion injuries typify ACL failure in skeletally immature patients, but mid-substance injuries have also been reported [22, 24]. This variation in ACL injuries is due to increased mid-substance ligament strength in relation to the ACL tibial insertion site [26]. Furthermore, loading conditions may also determine the pattern of ACL injury [18]. Regardless of injury pattern, multiple pediatric studies have reported significant rates of concomitant meniscal damage occurring at the time of ACL injury [1, 17, 26]. Similarly, this association has been reported in adults [7].

Anatomical studies of the ACL have shown it to consist of two functional bundles: the anteromedial and postero-lateral. Their anatomic origin and insertion sites have been well studied, with their names reflecting their relative anatomic insertions on the tibia [11, 19]. The native ACL attaches proximally to the posterior aspect of the medial wall of the lateral femoral condyle and inserts anterior and

lateral to the spine of the tibia [3, 4]. This distal insertion is located at the border of the articular cartilage of the medial tibial plateau and extends to the lateral tibial plateau [20]. Normally at the most anterior region of this distal insertion, the ACL travels beneath the transverse ligament and minimally attaches the anterior horn of the lateral meniscus [4, 20]. In this case report, we describe an avulsion of the ACL off the tibial spine where the anterior horn of the lateral meniscus appeared to be the principle insertion site for the ACL.

Case Report

A 14-year-old male presented in May 2008 with a chief complaint of right knee pain, instability, and intermittent swelling. The initial event was a contact injury to the lateral aspect of the leg 8 months prior to presentation. At the time of injury, he developed swelling and discomfort and felt a pop. The patient was initially managed with a course of physical therapy focusing on range of motion followed by quadriceps strengthening exercises. He continued to have intermittent pain in his knee although he was able to continue to participate in lacrosse, football, and other sports.

Upon presentation to the senior author (RFW), his physical examination demonstrated no limp and a genu valgum of his right knee. He had no effusion and his range of motion was 3–140° with mild pain at extreme flexion. Additionally, the patella was noted for some crepitation. Anterior drawer was negative. His Lachman test was a 2B, and he had a grade 2 pivot shift. He had no medial or lateral joint line tenderness. He had no posterior instability and no instability to varus or valgus stress at zero or 30°. Anterior–posterior and lateral radiographs of the knee revealed open growth plates with no tibial spine avulsion. MRI demonstrated a subchondral edema pattern in the lateral femoral condyle consistent with a pivoting event. The ACL had a wavy pattern indicating that tension had been taken off of it. There was no discreet signal within the ACL to signify intrasubstance rupture. The anterior horn of the lateral meniscus appeared to be small. The medial meniscus appeared normal. There were no chondral defects. There was evidence of edema at the medial collateral ligament (MCL) origin, although the MCL was intact. The PCL and posterolateral structures were intact.

Given his persistent symptoms, instability on his ACL exam in the office visit, and abnormalities on his MRI, the patient and family elected to proceed with surgical intervention.

Surgical Procedure

After a spinal block was performed, the patient was placed supine on the operating table. Exam under anesthesia demonstrated a grade 2B Lachman and grade 2 pivot shift. A standard anterolateral portal was established, as was a superiolateral outflow portal. An anteromedial portal was established under direct vision. Arthroscopic examination demonstrated intact patellofemoral, medial, and lateral cartilaginous surfaces. The medial meniscus was intact, as was the posterior horn of the lateral meniscus. The patient had an extremely narrow femoral intercondylar notch. The anterior horn of the lateral meniscus was attached to the ACL. This combined structure of the distal ACL and the anterior horn of the lateral meniscus were avulsed from the tibial insertion and was subluxed into the notch. Tissue quality of the ACL was noted to be of good quality proximally, with no attachment distally.

Given the good overall quality of the native ACL tissue, it was felt that direct repair of the ACL and the attached anterior horn of the lateral meniscus would be the best treatment option for this patient. The narrow intercondylar notch, which originally measured approximately 3 mm, was widened to 6 mm with a motorized shaver. A small incision was made on the proximal medial tibia and the tibial guide was used to advance two guide wires into the ACL footprint on the tibia, approximately 7 mm apart. Using a curved Spectrum suture passer (ConMed Linvatec, Utica, NY), #1 polydioxanone suture (PDS; Ethicon, Somerville, NJ) was passed through the native ACL as well as some of the anterior root of the lateral meniscus. This was done in two separate locations which were then used to shuttle a #2 FiberWire (Arthrex, Naples, FL). The FiberWire suture was then retrieved and passed through the drill holes in the proximal tibia. This afforded an excellent reduction of both the ACL and the anterior horn of the lateral meniscus. The sutures were tied down over the bone bridge on the anteromedial tibia. An anterior drawer demonstrated the repair to be intact.

Postoperatively, the patient remained toe touch weight bearing on crutches for 6 weeks with the knee locked in extension. By 8 weeks, he had begun physical therapy and was bearing full weight. He was later re-evaluated at 3 months and physical examination demonstrated a 1A Lachman with no pivot. At 6 months, physical examination demonstrated a negative drawer and negative Lachman with no pivot. By 12 months, the patient had returned to full activities, including participation in lacrosse and football, and was pain free (Figs. 1, 2, 3, and 4).

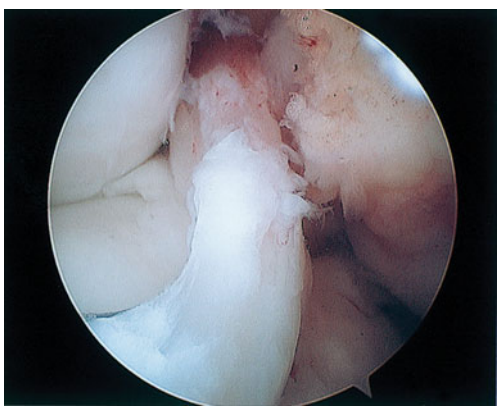

Fig. 1. ACL variant with an attachment to the anterior horn of the lateral meniscus

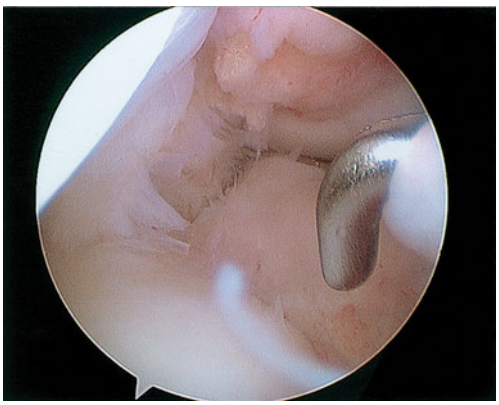

Fig. 2. A small ACL tibial footprint is noticed (note the probe is 3-mm long)

Discussion

In our patient, exploration revealed an avulsion of the ACL off the tibial footprint. The bulk of the disrupted portion of the ACL was in continuity with the anterior horn of the lateral meniscus, with minimal attachment to the tibia. To date, we are not aware of any previous case reports of this nature. Embryological studies have reported that the tibial insertion of the ACL develops from the same blastema as the menisci [9]. Even in adults, a few fascicles of the anteromedial bundle of the adult ACL are known to blend with the anterior attachment of the lateral meniscus; however, this contribution is usually minimal [4, 10]. In contrast, it appeared that the main attachment of the ACL to the tibia was via the anterior horn of the lateral meniscus. These developmental observations may explain the injury pattern observed in this patient.

Pediatric ACL injuries typically manifest as avulsion fractures from the tibial eminence or the femur, since the weak point is the ligament–bone insertion. Tibial eminence fractures may heal without surgery if they are minimally displaced, or may require open or arthroscopically assisted reduction with internal fixation. This provides for bone–bone healing that results in a generally good outcome [25], with occasional reports of objective knee laxity [12], retropatellar knee pain [23], and arthrofibrosis [21].

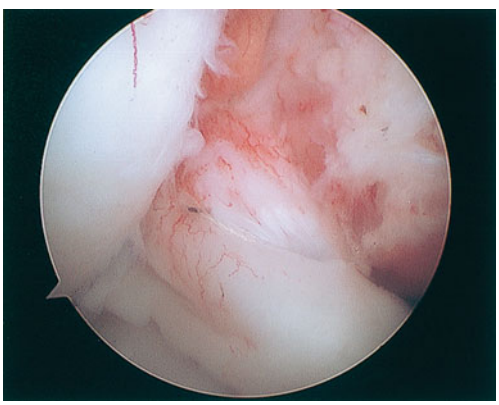

Fig. 3. ACL and anterior horn of lateral meniscus following repair

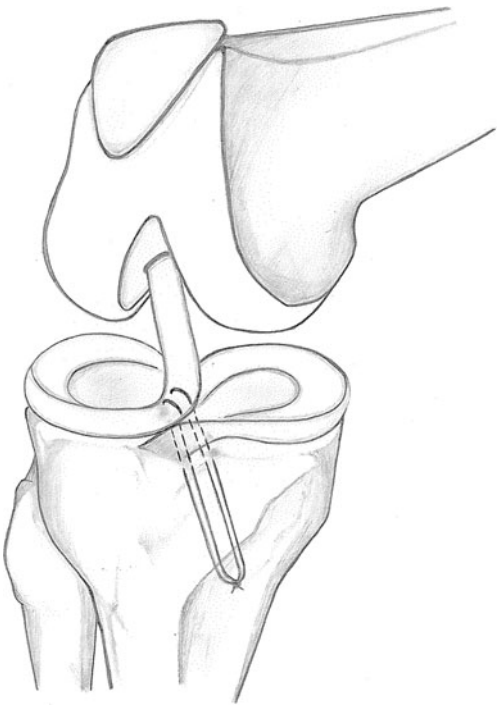

Fig. 4. Surgical technique for anatomic reduction of the avulsed ACL and lateral meniscus

In this patient, neither a mid-substance tear nor a tibial eminence fracture was noted. Instead, the patient avulsed the tibial insertion of the ACL from its small footprint, which included an extensive attachment to the lateral meniscus. Intraoperatively, the tissue was of good quality and was felt to be adequate for direct repair back to the tibial footprint with sutures that were brought through drill holes.

Several studies have investigated posterior meniscal root avulsions, an injury pattern commonly associated with signs of degenerative arthritis [6, 13]. The anterior and posterior root attachments maintain proper meniscal position and function, as well as prevent extrusion [5]. Therefore, primary repair of the attachment site is felt to be the best option to restore function and potentially avoid subsequent degeneration [15]. However, the majority of studies describing root avulsions have focused on the posterior root [2, 8, 15]. To our knowledge, there are no studies that report an anterior lateral meniscal root avulsion as seen in this patient [2, 8]. Since anterior lateral meniscal pathology is uncommon following ACL injuries, and since the connection between the ACL and the anterior horn of the lateral meniscus was so robust during the surgery, we conclude that this represents a developmental variant for this patient. Alternatively, it is possible that the lateral meniscus and the ACL footprint were independently avulsed and later scarred together in continuity. Lastly, the connection of the ACL lateral meniscal variant to the very narrow intercondylar notch is unknown, but one could hypothesize it is part of the same dysplastic process. There were no other structural anomalies noted during arthroscopic evaluation of the knee.

In conclusion, we report a case of an ACL tibial avulsion with the anterior horn of the lateral meniscus attached to it in an adolescent patient. We feel this is a developmental anomaly given the dysplastic intercondylar notch and seamless transition from ligament to meniscus. It was treated by directly repairing the ACL and anterior meniscal root to the tibial footprint with sutures brought through two drill holes in the anterior tibia and tied over a bone bride. At 12-month follow-up, the patient is doing well clinically.

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