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Case Report

Avulsion fracture of the tibial eminence in an adult with a unique mechanism of injury[☆]

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ABSTRACT

Tibial eminence avulsion fractures are not infrequent in the pediatric population; however, they are rare in the adult population. These injuries typically occur in skeletally immature patients between the ages of 8 and 14 years. We report the unique clinical history, imaging findings, and operative results of a 48-year-old female who presented with severe knee pain. Imaging findings revealed an anterior tibial eminence fracture with an intact anterior cruciate ligament tendon attached to the avulsed fragment. The patient underwent knee arthroscopy, with direct repair of the tibial eminence fracture.

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Introduction

The magnetic resonance imaging (MRI) appearance and the clinical presentation of anterior cruciate ligament (ACL) avulsion fractures in skeletally immature patients is well documented in the literature [1–4]. These injuries are commonly encountered in children between the ages of 8 and 14 years, and are usually sports-related injuries occurring especially during cycling and skiing [5]. In skeletally mature patients, ACL avulsion fractures are extremely unusual; and are commonly secondary to high velocity motor vehicle trauma [6]. In the adult population ACL avulsion fractures have a high incidence of associated injuries [5,6].

We present the atypical mechanism of injury, imaging findings, and operative technique of a 48-year-old female with an ACL avulsion of the anterior tibial eminence. According to our literature search, only 9 cases of ACL avulsions of the anterior tibial eminence in skeletally mature patients have been reported [7].

Case report

A 48-year-old female presented with severe left knee pain. She was out of town on a “team building” program that involved go-cart racing. While she was racing with her colleagues she

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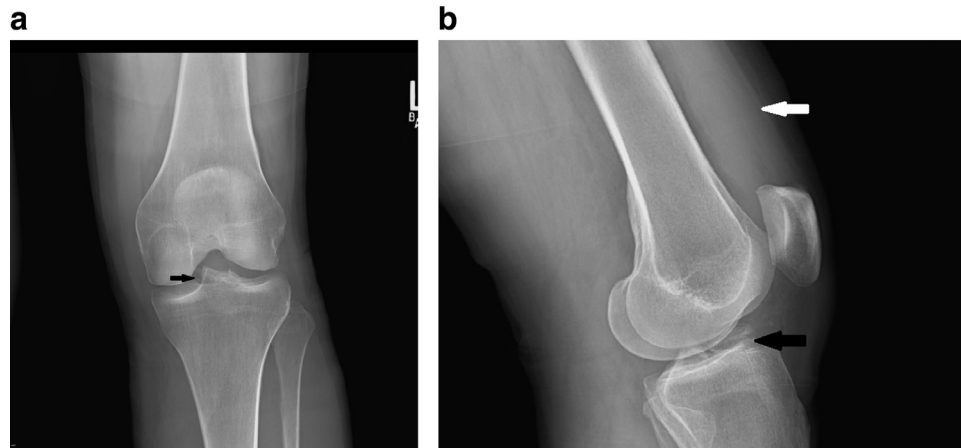


Fig. 1 – A 48-year-old female who presented with severe knee pain. Preliminary (a) AP view and (b) lateral view of the left knee were obtained demonstrating an avulsion fracture of the tibial eminence (black arrow). The lateral view (b) revealed a moderate size knee joint effusion (white arrow). AP, anteroposterior.

lost control of the go-cart and crashed into a wall. After the injury, she was evaluated at a local health care facility. She was told that she had internal derangement, and was instructed to follow-up with a local orthopedic surgeon. Additional clinical history revealed that she was not ejected from the go-cart and did not sustain direct blunt force trauma to her knee. While bracing for the crash, she had locked her knee in extension. Immediately after the collision, her knee was swollen and painful. She denied a history of previous knee injuries or surgeries.

Physical examination demonstrated moderate left knee effusion. She tolerated gentle range of motion from 0° to 80°. She had no opening varus or valgus stress, but did have a positive Lachman test. The orthopedic surgeon suspected an ACL tear. A preliminary two view x-ray examination of the left knee was obtained and surprisingly demonstrated a medial tibial eminence fracture (Figs. 1a and b). The fracture was minimally displaced, and there was a small knee joint effusion noted (Fig. 1b). The patient subsequently underwent an MRI with a presumed diagnosis of ACL avulsion of the tibial eminence. MRI of the left knee revealed a tibial eminence avulsion fracture with preservation of the integrity of the ACL fibers (Figs. 2a–c). The fracture involved the ACL insertion on medial tibial spine. The posterior cruciate ligament was intact with sparing of lateral tibial spine. Additional findings included a medial meniscus tear (Fig. 2d). MRI revealed that the medial collateral ligament, lateral stabilizing structures, and lateral meniscus were unimpaired.

Ten days after the initial event, the patient underwent arthroscopic surgery. Direct arthroscopic visualization confirmed the integrity of the ACL fibers attached to a single avulsed fragment (Fig. 3a). Utilizing a suture pass technique with a Hewson suture passer, the medial tibial eminence fracture was reduced (Fig. 3b). A complex flap tear of the medial meniscus was also repaired. The knee was evaluated arthroscopically and it was determined that anatomic restoration was achieved (Fig. 3c). Eleven days postoperatively, her examination demonstrated increased stability of the knee.

Postoperative x-rays confirmed anatomic alignment of the tibial eminence (Figs. 4a and b).

Discussion

The ACL is attached to the tibia via a broad depressed area anteriorly, including the anterior tibial eminence [8]. Avulsion fractures of the tibial eminence, first described by Poncet in 1875, are not an infrequent intra-articular knee injury in the pediatric population [9]. They can result from similar mechanisms of injuries as ACL tears in adults [5]. In children, this injury usually occurs secondary to forced flexion of the knee with internal rotation of the tibia and is typically an isolated knee injury [1–5].

The mechanism of injury often varies between children and adults [6]. Between the ages of 14 and 16, there is transformation of chondroepiphyseal junction which ossifies and fuses at the site of the ACL tibial insertion [1,10]. Once this transformation occurs, the ACL typically lacks the tensile strength to avulse the skeletally mature tibial ACL attachment. After this age, high-energy forces applied to the knee will overcome the ultimate tensile strength; this applied tension results in disruption of the ACL fibers [11]. In skeletally mature adults, overcoming the tensile bone strength at the ACL attachment requires high-energy trauma. The most common mechanism of injury is severe hyperextension, usually associated with high speed motor vehicle collisions [5,6]. Consequently, adults with tibial eminence fractures have a higher prevalence of associated injuries, including “kissing” bone contusions and tears of the medial collateral ligament, meniscus, and posterior cruciate ligament [6,12].

With regard to imaging findings, it is crucial for the radiologist to identify the ACL avulsion injury in these patients so that they may be worked up appropriately, including consultation with an orthopedic surgeon and additional imaging as circumstances dictate [12,13]. ACL avulsion fractures of-

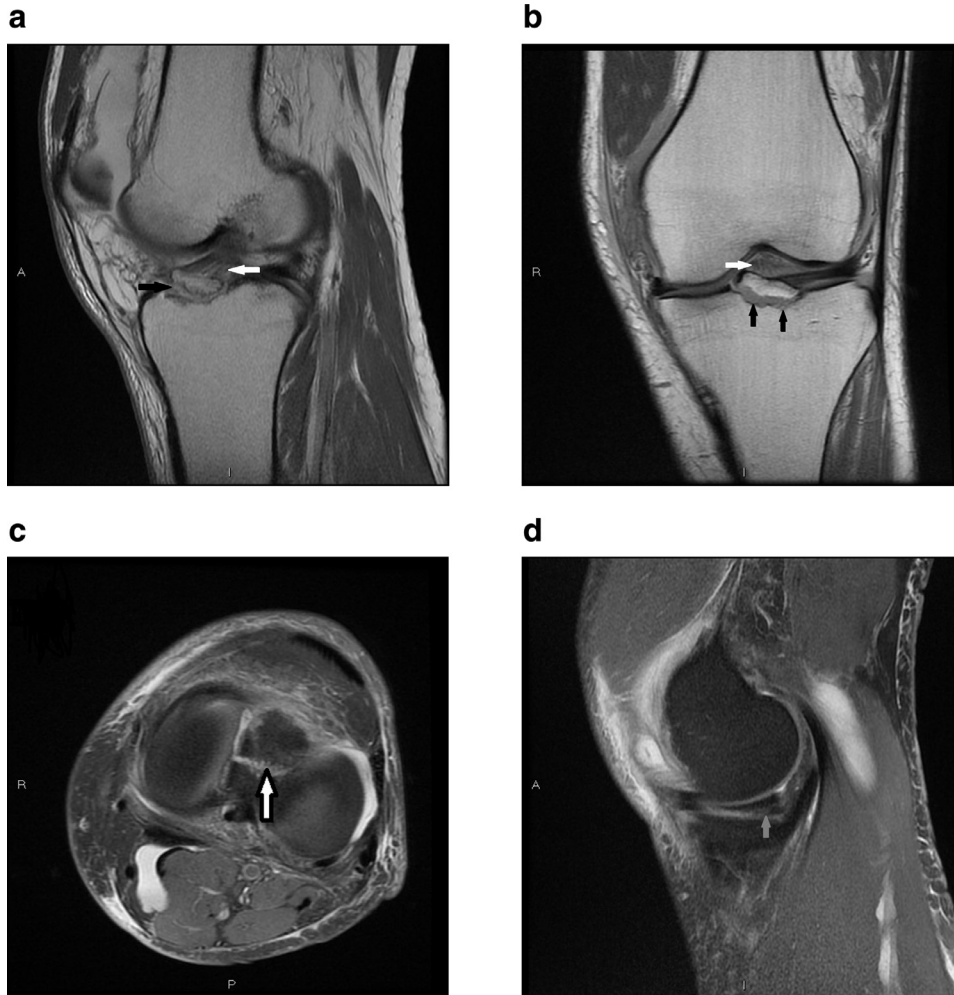


Fig. 2 – A 48-year-old female who presented with severe knee pain. (a) Sagittal proton density-weighted image and (b) coronal proton density-weighted image of the left knee revealed a tibial eminence avulsion fracture (black arrows) with preservation of the integrity of the ACL fibers (white arrows). (c) An axial T2-weighted image with fat suppression reveals the footprint of the avulsion fracture (hollow arrow) on the anterior tibial plateau. (d) Sagittal proton density-weighted image with fat-suppression reveals a medial meniscus tear (grey arrow).
ACL, anterior cruciate ligament.

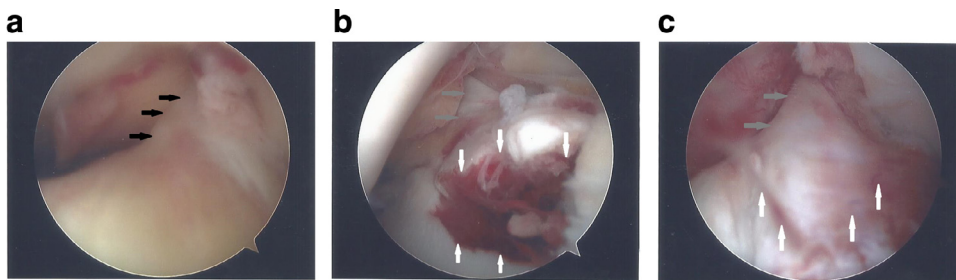


Fig. 3 – (a) An intraoperative images demonstrate an intact ACL (black arrows) on a lateral arthroscopic view. (b) An arthroscopic medial view demonstrates the avulsed tibial eminence (grey arrows). The fracture line is clearly evident (white arrows). (c) A frontal arthroscopic view postfracture reduction, demonstrates anatomic restoration of the tibial eminence (grey arrows). The fracture gap is reduced and the fracture line is less evident (white arrows).
ACL, anterior cruciate ligament.

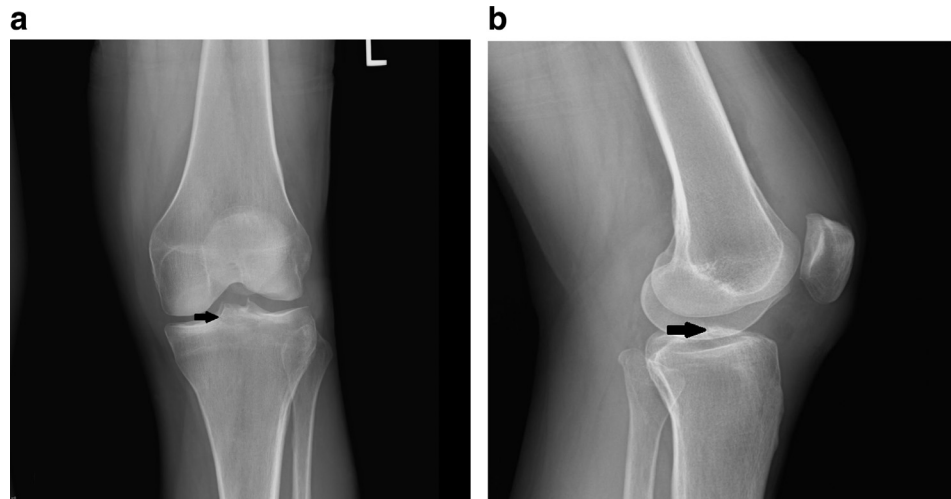


Fig. 4 – A 48-year-old female who presented with severe knee pain. (a) Postoperative AP view and (b) lateral view of the left knee were obtained which confirmed that anatomic restoration was achieved (black arrow). The fracture line is much less evident.

AP, anteroposterior.

ten manifest radiographically as tiny osseous fragments located adjacent to the expected ACL attachment site, although occasionally large avulsed fragments may be seen [5,12,13]. The relatively benign appearance of these small fragments may erroneously lead to a conclusion that these are incidental findings, when in fact they are a portent of potentially more severe underlying pathology [14]. Often, the only additional findings with conventional radiography are joint effusions or soft-tissue swelling, which may also be present after minor trauma, and consequently, may be easily disregarded. MRI is well known for its supreme soft tissue contrast, and it is invaluable for defining the extent of damage and associated injuries [15]. In order to assess bone integrity at the avulsion site, CT scans with superior spatial resolution are often a useful adjunct in preoperative planning [14,15].

Meyers and McKeever described a classification apparatus for classifying ACL avulsion injuries. These fractures are categorized into four types. In both type I and type II fractures, the anterior edge of the tibial spine is elevated, with a greater degree of elevation occurring in type II fractures. In type IIIA injuries, the tibial spine is separated both anteriorly and posteriorly, and in type IIIB fractures, the spine is both separated and rotated [9]. In pediatric patients, type I nondisplaced fractures with no associated injuries are managed conservatively, whereas, type II and III patients are managed surgically [8,9]. Any fracture involving displacement of the entire tibial spine should undergo surgical fixation and anatomic reduction. Surgical management is almost always required in adults, due to the high prevalence of associated injuries and entrapment of soft tissues [5,6]. Because the avulsed bone fragment remains attached to the ligament, typically the surgery is less complex and the outcome is favorable in comparison to an ACL tear. Cannulated screw and k-wire fixation provides good strength and fracture stabilization, but the potential for hardware impingement coupled with the possibility of additional surgery for hardware removal, has led to the development of less

cumbersome surgical techniques [16]. Arthroscopic reduction with suture fixation has advanced to become the preferred method of treatment for displaced or comminuted avulsion fractures of the tibial eminence [17]. Direct intra-articular viewing allows for anatomic reduction and treatment of any concomitant pathology. This surgical method demonstrates early mobilization of the knee, reduced period of rehabilitation, and approximate anatomic restoration.

In conclusion, prompt diagnosis of these typically destabilizing injuries is the first step in preventing the long-term consequences of delayed surgical treatment, specifically the chronic morbidity associated with post-traumatic osteoarthritis.

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