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Superior Patellar Sleeve Avulsion Fracture-Rare form of Osteochondral Injury in the Pediatric Population: A Case Report

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ABSTRACT

Chondral or osteochondral avulsion injuries of the inferior pole of the patella in skeletally immature patients are common; however, superior pole injuries are very rare. Recognition of these injuries is important as the displaced bone-forming fragment will continue to enlarge and ossify, and may in some cases duplicate the patella. Moreover, these injuries often involve the extensor mechanism which is integral to the function of the lower extremity. We present a case of superior patellar sleeve avulsion fracture in an 8-year-old boy and review the radiographic and magnetic resonance imaging features and management of this injury.

Keywords: Superior pole; Patella; Periosteum; Periosteal sleeve, Osteochondral, MRI

INTRODUCTION

The extensor mechanism plays a vital role in the function of the lower extremity, providing dynamic stabilization and minimizing friction through the range of motion of the knee joint. With the knee in extension, this mechanism functions as a decelerator and stabilizer of the lower extremity [1]. The extensor mechanism about the knee consists of the quadriceps tendon, patella, and patellar tendon. The patella increases the efficiency of this mechanism by acting as a fulcrum, lifting the patellar and quadriceps tendons and diminishing the amount of force required for knee extension [2]. The patella also protects the anterior cartilage-bearing surfaces of the femur and tibia. Pediatric musculoskeletal injuries are unique because of the increased vulnerability of the osteochondral junction at tendinous insertions in this patient population as opposed to the fully ossified entheses of their adult counterparts. Although inferior pole patellar sleeve avulsion fractures are common in the pediatric population and in adults with underlying osseous metabolic diseases such as osteogenesis imperfecta, superior pole patellar sleeve avulsion fractures are very rare [3].

In this article, we describe a rare case of superior patellar sleeve avulsion and review the imaging features and clinical management of this injury. The patient and his family were informed that anonymized data related to the case would be submitted for publication. Our Institutional Review Board (IRB) does not require approvals for case reports.

CASE REPORT

A healthy 8-year-old boy presented to the emergency department with persistent left knee pain 2 days after crashing his bike. He had sustained multiple abrasions at the time of the crash (Figure 1). Upon physical examination, he demonstrated focal tenderness over the quadriceps tendon, 1+ effusion, mild swelling of the soft tissues about the knee, and inability to fully extend his left knee. He was unable to complete the straight leg raise test. However, he was able to contract his quadriceps muscle without noticeable gap along the quadriceps tendon (sulcus generation).

Radiographs of the left knee obtained at the time of presentation were remarkable for a medium-sized effusion with a minimally displaced osseous fragment adjacent to the superior pole of the patella (Figure 2) suggestive of superior patellar sleeve avulsion. MRI of the affected knee demonstrated osteochondral fracture at the superior pole of the patella with minimal displacement of the avulsed fragment (Figure 3).

As there was little displacement of the avulsed fragment and no significant tendon injury, the patient was managed conservatively with immobilization in knee extension and non-weight bearing for 6 weeks. Subsequent radiographs obtained 6 weeks following the initial injury (Figure 4) demonstrated progressive healing of the fracture without increased displacement. The patient's symptoms and range of motion improved over time.

Figure 1: Clinical photograph taken at the time of presentation shows multiple superficial abrasions on the anterolateral aspect of the left knee and shin, with surrounding erythema and swelling, sustained during the crash.

Figure 2: Cross-table lateral radiograph of the left knee at the time of the initial injury. There is a mildly displaced fracture of the superior pole of the patella (arrow). There is a large knee joint effusion (star).

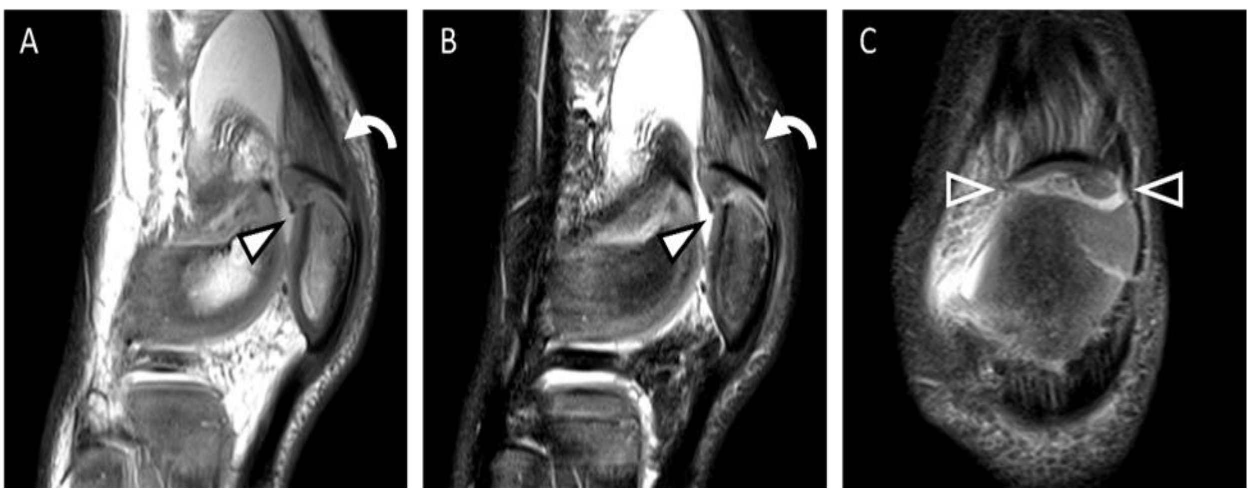

Figure 3: Unenhanced MRI of the left knee. (A-B) Sagittal PD (A) and T2 fat-suppressed (B) MR images reveal an osteochondral fracture involving the periosteum and non-ossified superior patellar cartilage (solid arrowheads). The distal quadriceps tendon (curved arrows) attaches to the displaced fragment and is intact. (C) Coronal PD fat-suppressed MR image demonstrates a 2.5 mm osteochondral fracture cleft through the superior pole of the patella (open arrowheads).

Figure 4: Upright lateral radiograph of the left knee 6 weeks after the initial injury. There has been progressive healing of the superior patellar fracture without interval displacement (arrow). The joint effusion has resolved.

DISCUSSION

Patellar fractures in children are uncommon and comprise less than 1% of all pediatric fractures [4-6]. Less than 2% of all patellar fractures occur in skeletally immature patients, and over 50% of pediatric patellar fractures are sleeve fractures [6]. Most reported cases of patellar sleeve fractures involve the inferior pole and there is a male predominance [7]. Patellar sleeve fractures were first described in 1979 by Houghton and Ackroyd, [8]. To our knowledge, less than fifteen superior patellar sleeve avulsions in the pediatric population are reported in the literature [3,9-17].

The superior and inferior poles of the patella contain abundant cartilage during childhood and adolescence and thus are more susceptible to avulsive-type injury. In contrast, knee injuries from direct impaction in adults often result in stellate fractures. In patellar sleeve fractures, avulsion of an osseous fragment (often with associated overlying chondral surface) along with a sleeve of periosteum occurs [4,8]. In the largest reported case series to date, Grogan et al. evaluated 47 patellar fractures in skeletally immature patients, 7 of whom demonstrated superior patellar pole fractures [14].

The peak incidence of sleeve fractures in children and adolescents is 12.7 years with an age range of 8 years to 16 years [5]. Ossification of the patella begins at approximately 3 years to 5 years and is complete by about 10 years of age [18,19]. Increasing participation in sports activities and the inherent weakness of the peripheral ossifying patella places the adolescent population at increased risk for these injuries [18].

The mechanism of injury in our patient resembled the mechanism in previously reported cases of patellar sleeve fracture; namely, acute forceful contraction of the quadriceps muscle against resistance [2]. Our patient's inability to actively extend his knee and point tenderness over the extensor mechanism are also indicators of extensor mechanism injury. It should be noted that in delayed presentation of these injuries, children often compensate for the decrease in extensor mechanism function by internally rotating the extremity via the tensor fascia lata to generate extension at the knee [6]. Radiographs are the most valuable initial imaging exam in the workup of acute musculoskeletal injury, but findings of patellar sleeve avulsion can be subtle. Radiographs may demonstrate the avulsed osseous fragment, effusion, and in cases of high-grade tendon injury, patella baja or alta in superior and inferior sleeve avulsions respectively [2,20]. The avulsed fragment is best seen on lateral radiographs adjacent to the superior or inferior poles of the patella-at the quadriceps or patellar tendon attachments, respectively. When the avulsed fragment is predominantly cartilaginous, the diagnosis may be occult on radiographs and the extent of injury underestimated. Kumar and Knight proposed that anterior tilt of the patella may be an additional radiographic sign of superior patellar pole sleeve avulsions due to abnormally increased mobility of the patella [13].

MR imaging is recommended if diagnosis or management is still unclear following physical examination and radiographic evaluation. MR imaging is superior to radiographs in delineating extent of injury by demonstrating the size of avulsed fragment, the extent of articular surface involved, and the relationship of the patellar fragments [4]. MRI can also further depict tendon injury and coinciding ligamentous and meniscal tears. MRI can be especially of value for preoperative planning in cases requiring surgical intervention.

Treatment of these injuries ranges from nonoperative management to open reduction and internal fixation. It is important to consider the extent of injury involving potentially osteogenic tissue and degree of displacement. Initially nondisplaced fragments may later migrate due to the distracting force of the quadriceps tendon, and assessment for progressive displacement on routine follow-up radiographs is imperative. Conservative treatment usually consists of cast immobilization for 4 weeks to 6 weeks and is reserved for sleeve fractures that are less than 2 mm displaced [6,8]. Surgical treatment with open reduction and internal fixation is performed when fracture fragments are displaced or there is concern for secondary displacement. Close operative approximation of fracture fragments is essential in preventing extensor lag and deformity. Stabilization of fragments may be achieved by suture fixation, tension band wiring, or transosseous sutures [8,13,16].

Despite their extremely low incidence, superior pole patellar sleeve fractures are serious injuries that require prompt diagnosis and management. Failure of timely diagnosis of this entity can result in permanent disability and knee instability, extensor lag, quadriceps atrophy and weakness, post-traumatic osteoarthritis, and in rare cases patella magna or even duplication of the patella [21]. Due to the abundance of cartilage at the superior pole of the patella, these injuries may not be readily evident on radiographs at presentation and more advanced imaging may be needed to confirm the diagnosis. The constellation of detailed medical history, including mechanism of injury, focused physical examination, and knowledge of radiographic and MR findings of this entity aids in early diagnosis and appropriate treatment.

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