LETTER / Musculoskeletal imaging

Sleeve-like avulsion fracture of the superior pole of the patella in a healthy adult

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Patellar fractures represent 1% of the fractures occurring in adults [1]. This injury can originate either from direct or indirect mechanisms. The most common types of patellar fractures are transverse fractures and avulsion fractures related to the quadriceps muscle [2,3]. An unusual type of patellar fracture, the sleeve fracture, has been described in children and adolescents [4,5]. In this type of injury, which represents 50% of patellar fractures occurring in children, cartilage and bone are avulsed along with a sleeve of periosteum [1]. The fracture line is not visualized in its integrity on conventional radiographs, and it usually extends though the anterior margin of the patella beneath the extensor mechanism of the knee, which remains in continuity [6].

Due to the predominant cartilaginous nature of the immature skeleton, the extent of the injury is very hard to assess with conventional radiography, and advanced imaging methods such as MR or US play a role in the diagnosis of this condition [6–8]. The identification of this injury is clinically important because it may result in elongation of the patella and the extensor mechanism of the knee. These complications can lead to permanent disability with patella alta, extensor lag, and quadriceps muscle wasting and weakness [1].

Patellar sleeve fractures are more common in the lower pole of the patella [6,8,9]. Similar injuries of the superior pole are very rare with only five cases reported in the English literature [8–11]. Additionally, in all of the reported cases, the injury occurred in the immature or weakened skeleton. We present an unusual case of a sleeve fracture of the superior patellar pole in a 22-year-old healthy skeletally mature man which, to the best of our knowledge, has not yet been reported in the literature.

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Case description

A 22-year-old man sustained a hyperextension injury of the left knee during a recreational soccer match. The injury was produced by forceful contraction of the quadriceps muscle in a frustrated attempt to kick the ball. Immediately after the injury, the patient presented with intense anterior knee pain, swelling, and an extension deficit of the knee. The clinical examination revealed joint swelling and preserved passive motion of the knee. The patient was otherwise in good health. Serologic calcium and phosphate levels were normal. Three months earlier the patient had been admitted with a history of sports related trauma to the same knee. The radiographs taken at the time were interpreted as normal, and patient was discharged.

With regard to the extent of the injury the patient underwent radiographic evaluation the next day which demonstrated a superior pole patellar fracture with a thin linear bone avulsion extending through the whole length the anterior border of the patella and, an associated joint effusion. Retrospective analysis of the radiographs taken at the time of the first injury demonstrates that a discrete bone irregularity of the superior patellar pole was already present (Fig. 1).

MR imaging was performed 3 days after the injury and showed an avulsion fracture at the superolateral portion of the patella, with a clear extension to the anterior patellar border and intense reactive bone marrow edema-like change. The fracture line reached the proximal aspect of the patellar articular surface near its base. The avulsed bone was displaced 1 mm approximately. There was no significant chondral abnormality. A joint effusion was present and the lateral portion of the distal quadriceps tendon was slightly irregular with high signal intensity in T2 weighted fat saturated images suggestive of a posttraumatic tendon injury. No other abnormality was detected in the MR images (Fig. 2). No alterations in the calcium metabolism were found.

This patient was treated conservatively with a leg cast and non-steroidal anti-inflammatory medication. Response to conservative treatment was satisfactory and 3 weeks later, the patient was asymptomatic, had regained full range active knee motion and resumed normal physical activities.

Discussion

Patellar sleeve fracture is a rare form injury of the immature skeleton in which an osteochondral fragment is avulsed together with a strip of periosteum [8]. These lesions were first described with regard to the inferior pole of the patella which remains the most common site of this type of injury [12]. The pathogenesis related to a forceful contraction of the quadriceps muscle in a flexed knee [1–3]. A sleeve fracture of the upper pole is even rarer.

In 1990, Grogan et al. presented a large series with 47 cases of patellar avulsion injuries. Although this series included some cases of superior pole fractures, there is no mention if these later injuries represented sleeve fractures [13]. The few cases reported in the literature of superior pole patellar sleeve avulsions occurred in children and adolescents, with the exception of one report of this type of injury in an adult with osteogenesis imperfecta [10]. However, in this last case, bone fragility related to this disease might have played a causative role. The case presented is very unusual because the patient was a healthy adult.

Although this injury resembles a sleeve fracture both morphologically and radiographically, it is not clear if it can be described as a true sleeve fracture because the skeleton is mature and there is no periosteal stripping. We hypothesize that the anatomy of the quadriceps enthesis may have

Figure 1. a: profile radiograph of the first traumatic event showing a discrete irregularity of the superior patellar pole (arrow), no joint effusion is seen, anterior surface of the patella is unremarkable; b: profile radiograph demonstrating a superior pole patellar fracture after the second traumatic event (fat arrow). Note the thin bone avulsion at the anterior border of the patella compromising most of its length (thin arrow) and joint effusion (arrowheads).
influenced the morphology of this fracture. The quadriceps entheseal zone does not stop at the upper pole; it continues though the anterior margin of the patella, as does the quadriceps patellar continuation [14]. The mechanism of injury in our case involved a forceful contraction of the quadriceps muscle with the knee in hyperextension. This might explain why the fracture line extends inferiorly parallel to the anterior border of the patella.

Although the pathogenesis is believed to differ from the classical patellar sleeve fractures, the alterations in knee mechanics and the possible dysfunction generated by this injury are similar. Sleeve fractures are usually treated surgically in an attempt to restore knee biomechanics [1]. This enforces the importance of correct diagnosis of this injury, which leads to alterations in the extensor mechanism of the knee, with potentially serious clinical consequences for the patient [1,8]. In our case, a small fracture related to the extensor mechanism was probably already present at the time of the first traumatic event. The diagnosis was missed and physical activity was resumed leading to a second injury resulting in a full blown fracture of the patella. There was only minimal displacement of the bony fragment (1.0 mm), but even with this amount of displacement a certain degree of waviness of the lateral fibers of the quadriceps tendon was observed. This finding demonstrates the impact that this type of injury might have with regard to the function of the extensor mechanism of the knee. Since, bone displacement was negligible and the extensor mechanism of the knee remained in continuity, conservative treatment was prescribed for this patient with satisfactory clinical results.

In conclusion, we present the radiographic and MR imaging aspects of a rare form of patellar fracture in an adult, that has not been previously described. As illustrated by this case, the correct identification of this type of patellar fracture is important to prevent its progression and has implications in patient management.

**Disclosure of interest**

The authors declare that they have no conflicts of interest concerning this article.
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