

Late MRI-detected patellar sleeve fracture: A case report and review of the literature

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ABSTRACT

This is a detailed report of a case and a review of literature concerning the patellar sleeve fracture. The diagnosis of this type of fracture is often missed in the emergency room, which the mentioned case also stresses. The fracture is a subtype of patellar fractures, and is mostly seen among children between eight and sixteen years of age. The trauma mechanism is an indirect powerful extension of the knee with a simultaneous contraction against a resistance of the quadriceps muscle group. Inflicted patients have often been trampolining, skateboarding or playing soccer. A bruised, painful and immobile knee is the typical clinical presentation. Ultrasound or/and magnetic resonance imaging are alternatives when plain radiographs are inconclusive. The treatment is often an open surgical fixation of the bone fragment. Early treatment is essential for a good prognosis.

Keywords: Pediatrics, Patella fracture, Osteosynthesis, Trauma

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INTRODUCTION

Patellar fractures among children and adolescents are relatively rare. They represent 1% of all fractures in this particular age group [1–3]. A subtype of patellar fractures is the so-called patellar sleeve fracture, mostly observed in children between eight and sixteen years of age [4, 5].

The sleeve fracture was first described in 1979 by Houghton and Ackroyd as an avulsion of a subchondral osseous fragment of the distal pole of the patella, together with a large piece of articular surface forming an extensive sleeve pulled from the patellar bone [6].

The following case report describes an inferior patellar sleeve fracture of, an otherwise, healthy boy. Initial ultrasound (US) imaging revealed a slight avulsion with a clinically intact quadriceps ligament. Therefore, the initial treatment was conservative. Continuous pain and extension defect after six weeks led to a magnetic resonance imaging (MRI), which revealed an infrapatellar sleeve fracture. This late diagnosis resulted in prompt corrective surgery on the patient.

With this article our aim is to present a difficult case of a patellar sleeve fracture, where the initial

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ultrasound, being the preferred method of diagnosis, was invalid. Furthermore the article is written on a review of the present English and German literatures concerning the patellar sleeve fracture.

CASE REPORT

We present an 11-year-old Caucasian boy, who arrived at the accident and emergency department unable to bare any weight on his left leg. He explained that the same day he had been jumping on a trampoline when a sudden onset of pain and swelling occurred to his left knee, after landing on fully extended legs. The patient's mother described the injury as a 'dislocation of the femur close to the tibia' immediately after the trauma.

The boy was of moderate adiposity, (70 kilograms), but otherwise healthy with no medical history and no recognized hypermobility, (Beighton scale 0), or use of steroids. Initial examination revealed diffuse swelling and extreme pain when trying to bear weight or when passive or active mobilization of the knee was attempted. Plain radiographs of the knee in accident and emergency department showed a high riding patella and calcifications according to the patella tendon. No fracture was seen (Figure 1).

A three-day ambulatory control revealed persistent swelling and global tenderness around the anterior aspect of the knee. The patient's mobility decreased from 0 to 30 degrees and he was unable to perform a straight-leg raise. An ultrasound (US) examination revealed a likely avulsion and a small partial tearing of the ligamentum patella. There was no rupture of the quadriceps ligament (Figure 2).

For comparison, the right knee was also US-scanned and changes compatible with Sinding Larsen-Johansson syndrome were detected. Based on the US-verified avulsions, the patient was diagnosed with minor avulsions of the patella, and therefore, treated conservatively with a hinged knee brace for six weeks with gradual unlocking from 0 to 90 degrees, and allowance of full (weight) support.

Following the removal of the knee brace and six weeks of intensive physiotherapy, the patient still had pain-complaints and a 20 degree extension defect. Clinically, the patella was still high riding and a subsequent MRI scan revealed osseous avulsion of the inferior pole of the patella with division of ligamentum patella, an infrapatellar sleeve fracture. Subsequently, a subacute open surgical reduction and fixation of the patella as done, using a cerclage and fiberwire sutures.

Our case was coincidentally examined in the emergency department three years following the sleeve fracture. The patient had been lifting weights and suddenly felt a similar onset of pain to the left knee as three years beforehand. A normal plain radiograph of the affected knee (Figure 3) and a normal examination,

apart from a little distinct soreness of the patella ligament, ruled out a re-rupture or fracture.

A five-year follow-up examination revealed that the patient was still complaining of soreness and swelling around the distal part of the patellar ligament. Based on an objective examination and normal radiologic imaging, the patient was treated with a methylprednisolone and bupivacaine blockade on suspicion of chronic irritation of the patellar ligament. At a six-year follow-up, the patient had no complaint.

Method of review of literature

The following databases were searched PubMed, EMBASE, and Cochrane.

Moreover, articles ranging from 1990 and onwards were firstly prioritized with focus on etiology, clinical presentation, diagnosis, treatment and prognosis. At the final selection, only articles in English, German and Danish were chosen.

This review is based on articles concerning patellar sleeve fractures published in international, scientific journals. The emphasis is on infrapatellar fractures, being the most frequent subtype of sleeve fractures.

Search words

Patellar sleeve fracture, pediatric patella fractures, fractures of the patella, pediatric fractures, pediatric trauma, knee trauma, inferior patellar sleeve fracture, superior patellar sleeve fracture, avulsion fracture, imaging of a patellar sleeve fracture, MRI scan of a patellar sleeve fracture, ultrasound of a patellar sleeve fracture.

DISCUSSION

Incidence

In spite of its rarity, the patellar sleeve fracture is the most common type of patellar fractures in children under 16 years of age, with a frequency of 57% among reported cases [1, 2, 7]. The average age for children with this type of fracture is 12, years, and is strongly linked to the fact that most youngsters in this age group are active in various types of sports [2]. More boys than girls suffer this type of injury in the majority of published case-reports [8–10].

Categorization of the patellar sleeve fracture

To this day, there is still no specific classification of the patellar sleeve fracture, nor is there a main standard of treatment [3, 10–12]. Grogan et al. classified the patellar sleeve fracture from a review of 47 cases. He divided it into a superior, which is the least common. An inferior, which often occurs with an

acute injury. A medial, occurring with a simultaneously lateral dislocation of the patella; and a lateral type representing a chronic stress lesion due to repetitive tensile pulling of the vastus lateralis muscle. All four avulsion fractures emanating from respectively the superior pole, inferior pole, medial margin and lateral margin of the patella. These terms are mainly used today, with the Inferior type being the most dominant when reviewing the published cases [5, 9].

Pathogenesis

The patella is the largest sesamoid bone in the body. It initiates its ossification around the age of three to six years. It has several different ossification centers and ossifies from the inside out until the whole bone, with exception of the articular surface, is completely ossified. In this way, an osteochondral transformation zone is created around a bonecore during ossification. This zone is particular vulnerable at the age of 12 years.

Therefore, a minor piece of bone avulsed from the patella in a young child, represents a comprehensive cartilaginous and soft-tissue damage [8, 10, 13, 14]. The patellar sleeve fracture is thus classified as an avulsion fracture. A large piece of articular surface is pulled off the patella with varying sizes of fragmented bone, hence the term “sleeve fracture”. This largely occurs at the proximal or distal end of the patella alias a superior or inferior patellar sleeve fracture (Figure 4 and Figure) 5 [6, 15, 16].

The fracture typically occurs when the child is playing and contracts the quadriceps muscle against a partially flexed knee. The knee suddenly buckles and gives way. It is foremost a non-contact mechanism injury and is often seen in activities such as trampoline jumping, skateboarding or ball sports [7, 13, 16, 17].

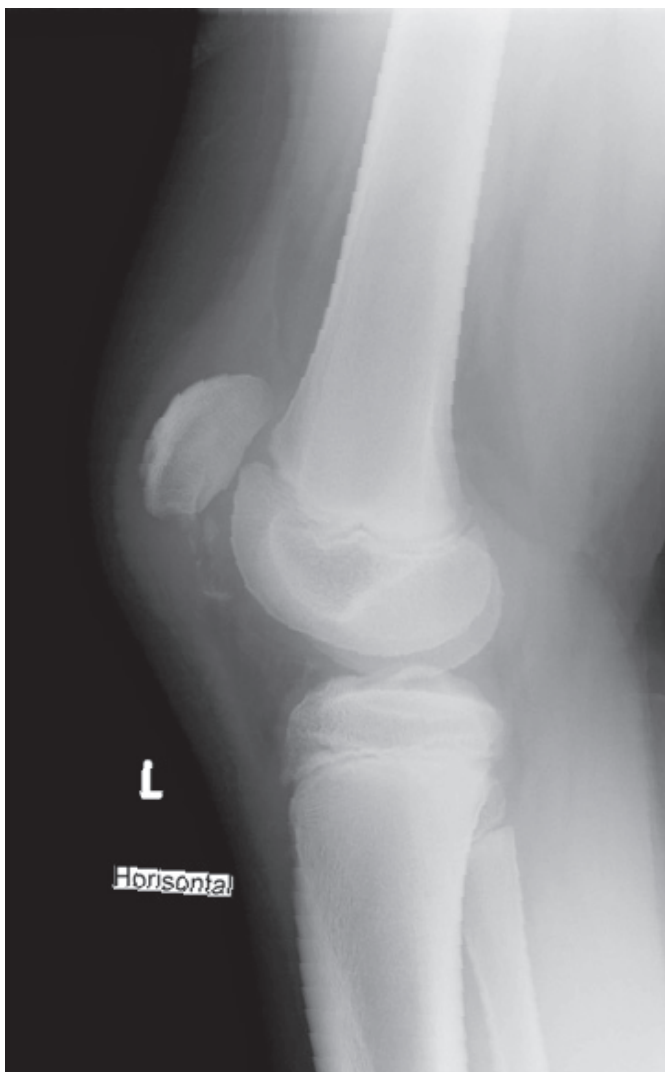


Figure 1: Horizontal plain radiograph from our case showing a high-riding patella, small intra-articular edema, calcifications according to the infrapatellar fat pad and the patella tendon. A following MR revealed an inferior patellar sleeve fracture.

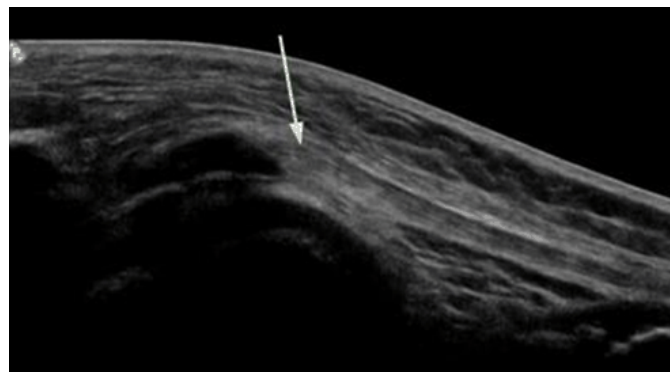


Figure 2: Lateral ultrasound-projection of our case representing partial tearing of the superior part of ligamentum patella (white arrow).



Figure 3: Horizontal plain radiograph of the left knee ‘from our case’ illustrating normal conditions.

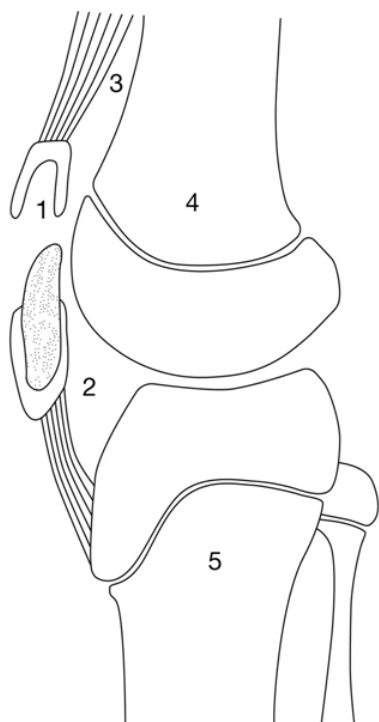


Figure 4: Illustration of an superior patellar sleeve fracture. 1: Patella; 2: osteochondral avulsion fragment; 3: Quadriceps tendon; 4: Femur; 5: Tibia by Johan Kirkegaard and Emre Senoglu.

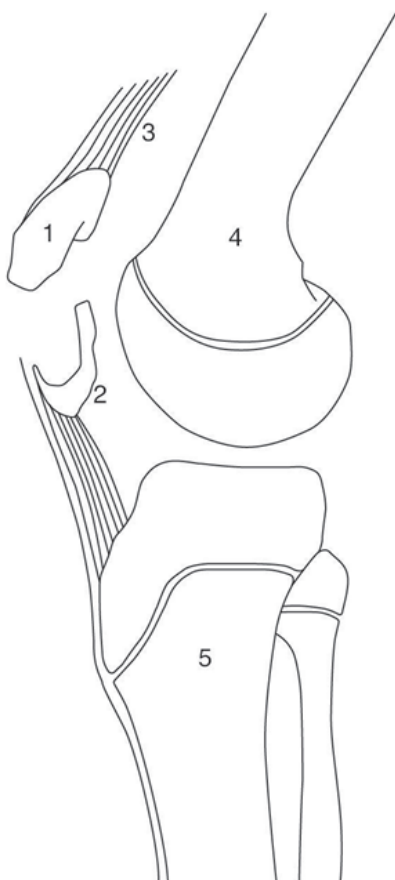


Figure 5: Illustration of an inferior patellar sleeve fracture. 1: Patella; 2: osteochondral avulsion fragment; 3: Quadriceps tendon; 4: Femur; 5: Tibia by Johan Kirkegaard and Emre Senoglu.

Clinic

Anamnestically, the patient often explains a sudden feeling of pain to the knee during a powerful jump or an explosive acceleration. On examination, one will often find a sore and swollen knee and an inability to perform straight-leg raise, or to support weight on the inflicted leg [8, 18, 19]. Apart from the effusion, there are two essential clues. Firstly, there is a palpable gap at the lower or upper part of the patella, and secondly, there is a patella alta, in that the patella on the affected side will be felt lying more proximally than the contralateral patella [8, 20, 21].

The fracture may not be easy to detect on plain radiographs. The diagnosis is obvious though when the fractured bone fragment is observed at the distal part of the patella - illustrated in Figure 4. However, this is not so when the fragment is exclusively composed of periosteum and cartilage. In this case, a good hint can be a patella alta [8]. A radiologic alternative is a ultrasound examination, which can detect the fracture with or without a bony fragment [14, 22]. Another alternative is a MRI scan [8, 23, 24]. If the imaging possibilities do not indicate a typical patellar sleeve fracture, one should bear in mind the pain seen in repetitive stress conditions such as Osgood–Schlatter disease, Sinding–Larsen–Johansson disease or the avulsed fragments seen in children with fixed flexion deformities such as in cerebral palsy or arthrogryposis [2].

Treatment

The main purpose of treatment is to re-establish the length of the patellar ligament and reduce the more proximal situated patella. This is only possible through an open surgery. Conservative treatment in form of a locked hinge knee brace with gradual unlocking is recommended if the diastasis is 2 mm or less. [10, 20, 22]. According to Arbeitsgemeinschaft für Osteosynthesefragen (AO) foundation, the performed surgery is recommended to be a reduction and internal fixation of the avulsed fragment.

If a patellar sleeve fracture is not diagnosed within one to two months after the trauma, an ectopic bone formation will occur. This is due to the exposure of potent bone-forming tissue at the lower pole of the patella and will result in an enlargement or even duplication of the patella [18, 25]. Surgery is necessary to remove any ectopic bone formation in order to achieve the correct reduction and fixation. This underlines the importance of a rapid diagnosis.

Prognosis and follow-up

A rapid diagnosis and treatment of the patellar sleeve fracture is essential for the best possible outcome. Failure to detect the fracture, or conservatively treating a sleeve fracture with a diastase exceeding

2 mm, will result in a permanent disability with a patella alta or/and ectopic bone formation. This will cause instability of the knee, reduced extension and weakness, quadriceps wasting, knee pain inflicted by the osteochondral damage and even ossification of the patellar tendon causing patella magna or duplication of the patella [2, 18, 25].

When a patellar sleeve fracture is promptly diagnosed and correctly treated, the prognosis is very good in the vast majority of cases. Dai and Zhang reviewed 14 cases of patellar fractures among children between 9–15 years of age. All cases underwent open reduction. Eight of these cases were patellar sleeve fractures. Follow-up reports of a 2–20 year period revealed excellent results. Thirteen patients had a functional score of 100 points and an activity level of 7–10 [7]. Concerning conservative treatment, Gao et al. reported 11 cases of patellar sleeve fractures among children with a mean age of 12 years, where six were treated conservatively and five surgically. With the exception of a 10 degree extension lag for a single patient, all cases achieved good/excellent results [13].

The patellar sleeve fracture is most commonly seen among boys under the age of 16 years. It is a rare subtype among patellar fractures, but is nevertheless, the most frequent among adolescents with fractured patellas. It is important to consider this type of fracture, when treating a child with sudden knee pain. Plain radiographs are helpful if illustrating an obvious fracture or a patella alta.

Ultrasound and magnetic resonance imaging are good alternatives, which our case also accentuates, and are also important in the absence of improvement and essential when in doubt as to whether or not surgery should be performed [8, 24].

A rapid diagnosis is of utmost importance and the treatment is often open surgery. With early treatment the prognosis is good, and within a year the patient usually regains full function of his/her knee [13, 20, 22, 25].

CONCLUSION

Apart from being a rare fracture, this case illustrates the importance of continuing follow-up and examinations. A faster MRI would have shorten the patient's period of illness. This case underlines the lack of a standard diagnosis method when suspecting a patellar sleeve fracture. In our opinion, an MRI scan should always be indicated when finding avulsions of the patella.

Author Contributions

Johan Kirkegaard – Substantial contributions to conception and design, Acquisition of data, Analysis

and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published

Manuel Bieder – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Susanne Kristensen Mallet – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Jesper Fabrin – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Guarantor

The corresponding author is the guarantor of submission.

Conflict of Interest

Authors declare no conflict of interest.

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