Case Report

Tibial tubercle avulsion fractures

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Abstract

Tibial tubercle avulsion fractures are uncommon injuries seen in the paediatric age group which are due to an indirect force caused by the sudden contraction of the quadriceps muscles against the patellar tendon insertion on the tibia tubercle. The injury is most commonly associated with jumping and landing sports, such as basketball, long jump, high jump and football. The average age at presentation is 14.6 years and boys are predominantly affected. The child typically presents with pain in the anterior knee, joint effusion, haemarthrosis and inability to bear weight. Standard radiographs of the joint will reveal the avulsed tibia tubercle and also aid in classification of the injury. The major task in the treatment of this fracture is in maintaining a satisfactory reduction against the proximal pull of the quadriceps muscles. Satisfactory results are usually achieved, however, by operative reduction and fixation with cancellous screws, though some authors have reported good results with conservative treatment. We present a 15-year-old male adolescent who presented with tibia tubercle avulsion fracture of the right knee and was managed by open reduction and internal fixation using two cancellous screws.

Keywords: Avulsion fractures, paediatric fractures, tibia tubercle avulsion, tibia tuberosity avulsion

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INTRODUCTION

Tibial tubercle avulsion (TTA) fractures are uncommon pediatric fractures and account for <1% of epiphyseal injuries. Of all proximal tibia fractures, approximately 3% are TTA fractures.[1] There are four stages of tibial tubercle development: Cartilaginous, apophyseal, epiphyseal and bony union.[2] The cartilaginous stage exists before the development of a secondary ossification centre. The apophyseal stage occurs when a secondary ossification centre appears, at approximately 8–14 years of age. The apophysis coalesces with the proximal tibia epiphysis during the epiphyseal phase. In the final stage or transitional phase, bony union and closure of the physis occur. The fracture occurs during the transitional phase of development when the tibial tubercle is most vulnerable to injury. This takes place between ages 10–15 years in girls and 11–17 years in boys.[2,3] The average age of the patients sustaining a TTA fractures is 14.6 years.[4]

The injury results due to an indirect force caused by the sudden contraction of the quadriceps muscles. The quadriceps mechanism then forcefully contracts against the patellar tendon insertion on the tibia tubercle. The patellar ligament inserts on the secondary ossification centre, which places the tibial tubercle at risk for an avulsion injury.[1] The injury is most commonly associated with jumping and landing sports, such as basketball, long jump, high jump and football. Some predisposing factors to this condition include tight hamstrings, patella baja and disorders involving physeal abnormalities.[5] Osgood-Schlatter's disease has also

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been suggested as a predisposing factor to TTA fractures, though more recent reports show that there is an unclear relationship between the two conditions.[6,7] TTA fractures occur almost exclusively in boys and are postulated to occur due to increased quadriceps strength.[8] Other factors that are thought to contribute to the higher incidence in adolescent males are the increased sports participation among male adolescents and the later age at bony fusion.[3] We present the case of an adolescent male who was managed for TTA fracture in our Centre.

CASE REPORT

A 15-year-old boy presented with 24 hours' history of left knee pain and swelling, with associated inability to bear weight on the affected lower limb. He sustained the injury during a football game when he landed awkwardly on the left lower limb. He initially presented in another hospital from where he was referred to us.

On examination the left knee was markedly swollen and bruised with tenderness on palpation. There were absence of knee extension and inability to bear weight. Radiological examination of the affected knee revealed Type IIIB TTA fracture. Figure 1 – The knee was subsequently immobilised with a high above knee slab and elevated with a triangular bolster. He was then worked up for surgery.

Surgical procedure

Under spinal anaesthesia and routine prepping, an upper thigh tourniquet was applied with the knee in 90° of flexion. The image intensifier was positioned and the initial films taken. The proximal tibia was exposed through an anterior approach and a medial parapatellar arthrotomy performed. Haematoma was evacuated and knee exploration performed. Intra-operative findings include a torn meniscus and comminution of the distal fragment of the separated tibia tubercle. The meniscal tear was repaired and the fracture site irrigated and reduced. A pair of reductions clamps was used to temporarily maintain the reduction. Two lag screws were then inserted under image control and the clamps removed. A 6 mm cancellous screw was used in the upper fragment. Fixation of the lower fragment was however difficult due to the comminution of the fragment. We used a smaller [4.5 mm] cancellous screw to achieve some stability in the lower fragment [Figures 2 and 3]. The fixation was then assessed for stability by passive flexion and extension of the knee joint. Wound was irrigated and closed in layers.

Post-operatively the knee was immobilised with a hinged brace. Non-weight bearing mobilisation on crutches was commenced on the 3rd post-operative day. Quadriceps strengthening physiotherapy and knee range of motion exercises were commenced at 3 weeks post-operative period, together with partial weight bearing mobilisation. The brace was removed at 6 weeks post-operative period.

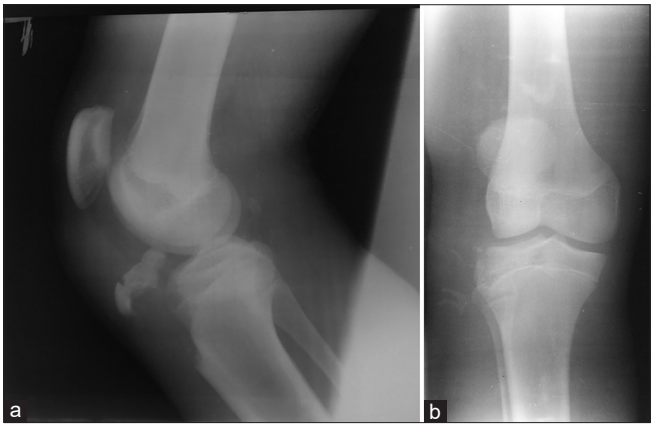

Figure 1: (a and b) Pre-operative anteroposterior and lateral X-ray films

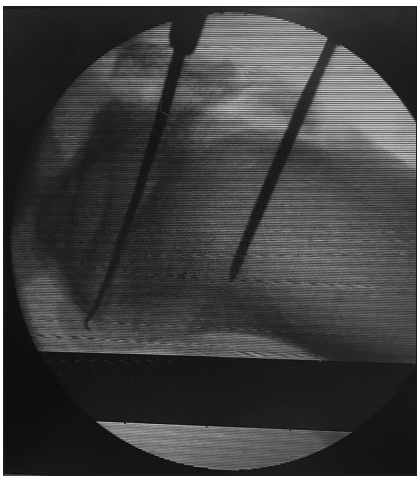

Figure 2: Intra-operative C-arm image

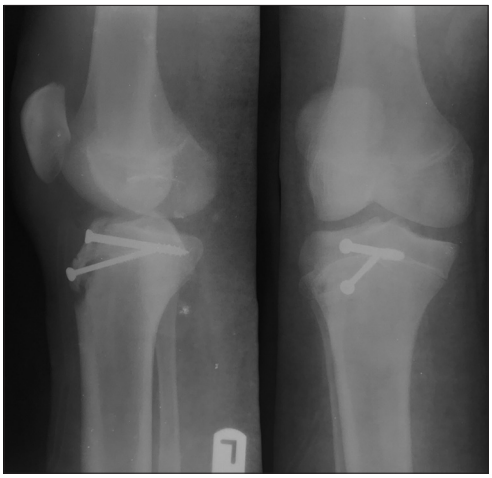

Figure 3: Immediate post-operative anteroposterior and lateral X-ray films

Full weight bearing was commenced at 3 months when radiological examination showed bony union [Figure 4]. The patient regained full range of motion of the knee joint by 3 months [Figures 5 and 6]. He was able to resume sporting activity at 6 months.

DISCUSSION

Patients with TTA fractures often present with pain in the anterior knee, joint effusion, haemarthrosis and inability to bear weight.[3] Patients with a small TTA avulsion fracture may still have an intact extensor mechanism due to intact retinacula structures. However, with more extensive TTA fractures patients may have impaired extensor function.[9] A comprehensive physical examination is crucial in the paediatric patient as the history may not be as reliable as in the adult. A detailed neurovascular examination is also a requirement as there is the risk of developing compartment syndrome with TTA fractures.[9] Standard radiographs including anteroposterior, lateral and oblique views are required for the diagnosis of TTA fractures. Additional investigations may be required depending on associated injuries. Three-dimensional imaging (computed tomography and magnetic resonance imaging) may be utilised to better characterise these fractures and provide the treating surgeon with information that may alter the surgical approach, including the need for concomitant arthroscopy or open arthrotomy.[10]

Tibial tubercle avulsion fractures are classified based on an extended classification system which was originally developed by Watson-Jones. The classification includes Types I, II, III, IV and V [Figure 7]. Types I, II and III were described by Watson-Jones. In Type I fractures, there is avulsion of the apophysis without injury to the tibia epiphysis. In Type II fractures on the other hand, the fracture line extends into the tibia epiphysis which is lifted superiorly while in Type III, the fracture line extends into the joint. Types I, II and III may be further divided into

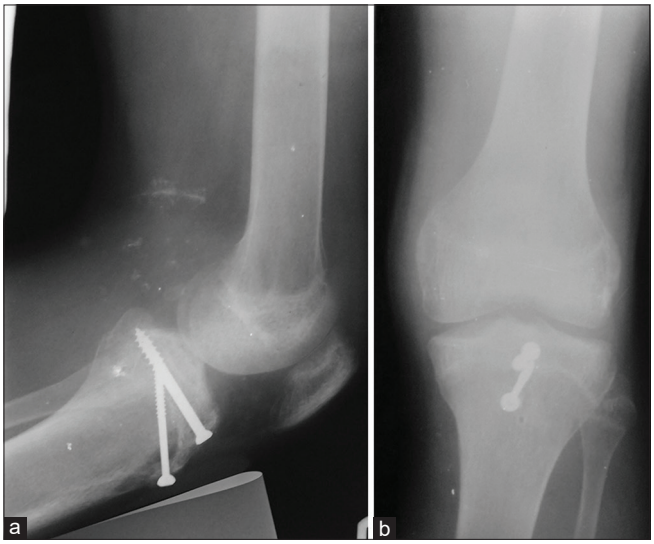

Figure 4: (a and b) Three months post-operative anteroposterior and lateral X-ray films

Figure 5: Image showing extent of knee flexion at 3 months

Figure 6: Image showing extent of knee extension at 3 months

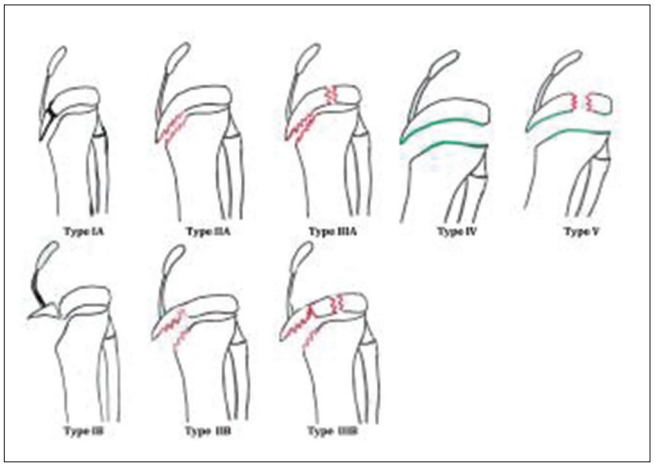

Figure 7: Classification of tibial tubercle avulsion fractures[11]

A, B and C subtypes, with A indicating displacement, B indicating comminution and C indicating associated patellar ligament avulsion. The A and B sub-divisions were added by Ogden while C was added by Frankel. For classification of more extensive injury, Type IV was introduced by Ryu and Type V by Mckoy.[11] In Type IV injuries the fracture involves the whole tibial epiphysis while in Type V injuries there is intra-articular involvement as well. Type V can also be described as a combination of Type IIIA and Type IV.

Initial treatment in all cases of TTA fractures involves ice therapy, immobilisation in a splint and elevation to significantly reduce swelling.[8,12] The major task in the treatment of this fracture is in maintaining a satisfactory reduction against the proximal pull of the quadriceps muscles. Type 1 fractures can be managed conservatively in extension with a brace, cylinder cast or a long leg cast for 4–6 weeks. Close observation is, however, maintained in the first 2–3 weeks for any sign of loss of stability which will require percutaneous or open reduction and internal fixation. In Type II to V fractures, open reduction and internal fixation with lag screws is recommended and as the patient is very close to the end of growth, fixation of the fragment should not affect remaining growth.[13,14] However, in the rare case in which the fracture occurs in a younger individual, the periosteum can be sutured to the retinaculum and supported with smooth Kirschner wires.[14] Some authors have, however, reported good result with conservative treatment irrespective of the severity of injury.[7] Surgery should be performed under image control to avoid overpenetration of the posterior tibia cortex. In Type IIIB fractures where comminution and meniscal disruption may be present, an arthrotomy is recommended for visualisation and exploration of the knee joint. Meniscal tears are repaired and articular continuity re-established. Arthroscopic repair can be performed in selected cases.

Post-operatively, a cast or knee immobiliser is applied to the limb for 4–6 weeks and restricted weight bearing activity commenced. If the fixation is stable, progressive knee flexion activity is commenced soon after surgery. Lower limb strengthening and hamstring stretching exercises are also commenced. Progressive full weight bearing is commenced at 6 weeks.

There is an overall complication rate of 28% following TTA fractures, with the most devastating complication being compartment syndrome.[6,15] Compartment syndrome occurs in about 3.5% of cases and necessitates frequent evaluations of compartment pressure in the affected limb.[6] Thus, an emergency fasciotomy may be required as a separate procedure or at the time of surgery. The commonest complication, however is bursitis, which accounts for 56% of the complications. Bursitis occurs due to prominent implants and requires implant removal. As most of the patients are close to the end of skeletal maturity, the incidence of growth disturbances is low. Genu recurvatum accounts for 4% and limb length discrepancy, 5% of complications.[6] Thus, it is imperative to follow the patients up until skeletal maturity as additional procedures may be required in the event of the development of growth anomaly. Other complications include persistent pain (18%), re-fracture (6%) and knee stiffness (2%).[6,15] We however did not record any complication in our case.

CONCLUSION

The management of tibia tubercle avulsion fractures can be challenging in the sense that it is difficult to maintain a satisfactory reduction against the proximal pull of the quadriceps muscles. However complications are fortunately rare and most cases result in satisfactory treatment outcome. The management of Type IIIB TTA fracture in the index case by open reduction and lag screw fixation resulted in good functional outcome with early return to pre-morbid activity level.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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