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Avulsion Fracture of the Tibial Tubercle in Adolescents: 3 Cases and Review of the Literature

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Abstract | **Case Report**

Tibial tubercle avulsion fractures are an uncommon injury occurring due to strong contraction of the quadriceps femoris muscle. Of all proximal tibial fractures, approximately 3% are tibial tubercle avulsion fractures. We report 3 cases of anterior tibial tubercle fractures in 3 adolescents treated at the pediatric surgical emergency department in Rabat. Standard radiographs of the knee will reveal the avulsed tibia tubercle and also allow fracture classification. There are multiple classification systems with multiple modifiers. The most commonly used is the modified Ogden classification. Tibial tubercle avulsion fractures can be associated with concomitant soft tissue damage, periosteal damage, and compartment syndrome leading to extensor mechanism disruption, joint laxity, or vascular compromise. Treatment can be nonsurgical or surgical, and indications depend on fracture type. Most fractures are surgical candidates and can be repaired with open reduction and internal fixation (ORIF) or arthroscopy. Satisfactory results are usually achieved.

Keywords: Tibial tubercle fracture, ORIF, Avulsion of tibiale tubercule.

INTRODUCTION

Avulsion fracture of the tibial tuberosity is considered as a relatively uncommon adolescent injury. Typically caused by injuries from sporting activities involving jumping, they are the result of two possible mechanisms: abrupt knee flexion with quadriceps contraction, typical of jump landing; violent quadriceps contraction with a fixed foot, as in jumping. The child typically presents with pain in the anterior knee, joint effusion, haemarthrosis and inability to bear weight.

The major task in the treatment of this fracture is in maintaining a satisfactory reduction in order to have perfect functional result and avoid sequelae.

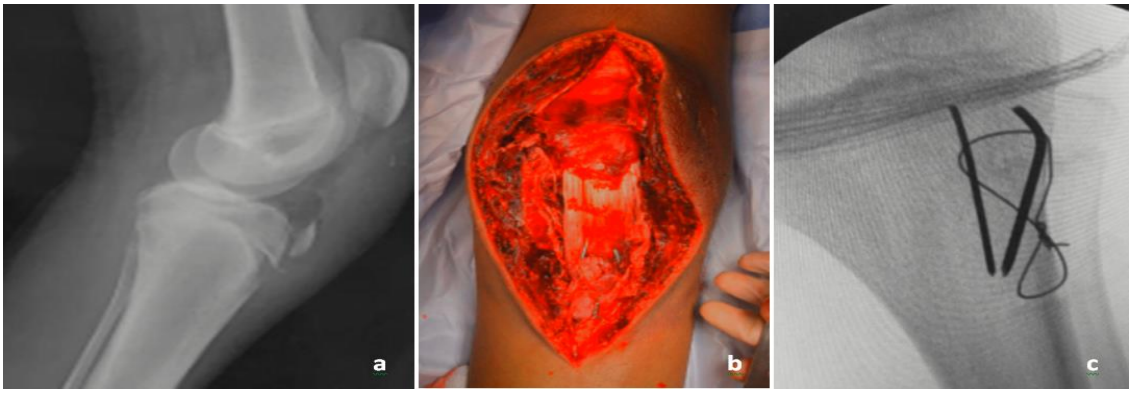

Fig-1: Open reduction and internal fixation of tibial tubercule avulsion fracture with Kirschner wires

CASE REPORTS

During a foot-ball game, a 14-year-old male experienced sharp pain in his knee while jumping and colliding with another player. He was diagnosed with a displaced tibial tubercle avulsion fracture with proximal extension into the knee joint (Ogden type IIIB) **(figure 1a)**. The fracture was managed with an open reduction internal fixation (ORIF) **(figure 1b)** of the tibial tubercle with two kirshner wires **(figure 1c)**.

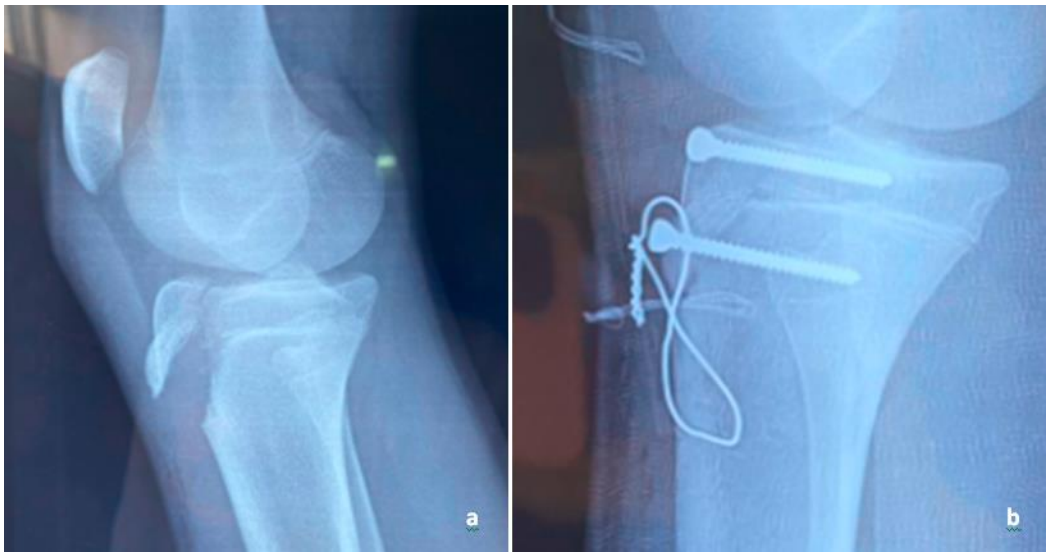

Fig-2: Open reduction and internal fixation of a IIIb type tibial tubercule avulsion fracture with cortical screws

The second patient was a 14-year-old male boy. He was dribbling with the ball while playing football when a fall occurred. He was unable to weight bear and extend his knees. On examination there was swelling and bruising around proximal tibia with palpable displacement of the tibial tubercle.

Radiological examination of the affected knee revealed Type IIIB **(figure 2a)** TTA and a patellar avulsion were suspected.

The tubercle fragment was reduced via bicortical fixation with a 50 mm fully threaded 3.5 mm cortical screw **(figure 2b).** The anatomic repair of the patellar tendon was completed with two mattress sutures and tied.

Finally, a 15-year-old boy presented with right knee pain and swelling, with associated inability to bear weight. He sustained the injury during a football game.

An avulsion fracture a type lll diagnosis was confirmed by radiography of knee. The patient benifited from an open reduction and internal fixation using two cancellous screws.

Postoperative Radiographic imaging revealed well-positioned screws. After five months follow-up, the patient reported no pain and had regain 95% of his normal function. All patients received plaster cast immobilisation for 4-6 weeks. Rest with a walking ban is also prescribed.

After consolidation, passive flexion-extension activities were started in combination with progressive strengthening of the lower limb and hamstring stretching exercises. A progressive resumption of walking is also started after 6 weeks.

Regular monitoring of patients until they reach skeletal maturity is recommended to ensure normal growth without any resultant osseous deformities such as genu recurvatum or lower limb inequality.

DISCUSSION

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 fracture.

The injury results 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.

Osgood schlatter has also been suggested as a predisposing factor to TTA fractures, though more recent reports show that there is an unclear relationship between the two conditions.

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.

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 used to better characterize these fractures and provide the treating surgeon with information that may alter the surgical approach, including the need for concomitant arthroscopy or open arthrotomy.

Tibial tubercle avulsion fractures can be associated with concomitant soft tissue damage, periosteal damage, and compartment syndrome leading to extensor mechanism disruption, joint laxity, or vascular compromise [6]. In a series of 336 tibial avulsion fractures in adolescent patients, there were 8 (2%) patellar or quadriceps tendon avulsions, 6 (2%) meniscal tears, 3 (1%) increased ligamentous laxity, and 12 (4%) compartment syndromes [8].

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. 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 Kirschnerwires. Some authors have, however, reported good result with conservative treatment irrespective of the severity of injury. 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.

Surgeon comfort with the fixation technique mostly drives the nature of fixation and at this point literature does not recommend any evidence-based preference for a certain technique over the others.

Among the possible complications of this injury are: limb discrepancy, genorecurvatum, patella baja, nonunion, calcification of the patellar tendon and anterior cruciate ligament instability. However, compartment syndrome is a potentially severe complication that should be considered immediately after injury.

CONCLUSION

Most of the fractures require open reduction and internal fixation and usually heal well without any significant complications.

Isolated, non-comminuted tibial tubercle fractures (types IA, IB, and IIA) can be treated with closed reduction for 4–6 weeks, whereas tibial tubercle fractures that are comminuted or extend intra-articularly should be repaired via open reduction internal fixation.

Rehabilitation after avulsion fracture of the tibial tuberosity is an important consideration for this relatively uncommon adolescent injury.

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