

Anterior Tibial Tubercle Avulsion Fracture in Pediatric Patients. Case Report

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ABSTRACT

Epiphysiolysis of the anterior tibial tubercle in adolescents accounts for 1% of physeal injuries and 3% of proximal tibial fractures, and it may involve the physis; therefore, they require a proper diagnosis and treatment to avoid complications. **Objective:** To report a clinical case, compare it with similar published cases, examine the differences, and, based on our experience, arrive at a resolution. We present a 13-year-old male who consulted after suffering direct trauma to his right knee while running in sports practice one month earlier. Radiography revealed epiphysiolysis due to avulsion of the anterior tibial tubercle (Odgen IIIA and Jones III), thus the patient underwent open reduction and internal fixation with two partially-threaded cannulated screws and washers. A plaster cast was placed and removed after six weeks to begin rehabilitation. Because healing and return to regular activity were quick, AP and lateral radiographs were obtained for diagnosis and a CT scan for surgery planning. Then, open reduction and internal fixation with two cannulated screws surrounding the physis was performed, although the patellar tendon was explored first since it had a higher risk of invagination within the fracture line. **Conclusion:** Although there is no consensus on diagnosis and treatment due to the small number of reported cases of this injury, which is increasing due to the growing popularity of sports among young people, it is advisable to suspect it in young patients who sustain knee injuries with extension limitation.

Keywords: Pediatric patient; knee; tibial tubercle avulsion; osteosynthesis; patellar tendon.

Level of Evidence: IV

Fractura por avulsión de la tuberosidad anterior de la tibia en pacientes pediátricos. Reporte de caso

RESUMEN

Introducción: Las epifisiólisis de la tuberosidad anterior de la tibia en adolescentes representan el 1% de las lesiones fisarias y el 3% de las fracturas de la tibia proximal, y pueden comprometer la fisis; por lo tanto, ameritan un diagnóstico y un tratamiento correctos para evitar complicaciones. El objetivo de este artículo es comunicar un caso clínico, compararlo con casos similares publicados, analizar las diferencias y, sobre la base de la experiencia, llegar a una conclusión para su resolución. Presentamos a un varón de 13 años que consultó tras sufrir un traumatismo directo en la rodilla derecha, durante la carrera en la práctica deportiva, un mes atrás. La radiografía mostró epifisiólisis por avulsión de la tuberosidad anterior de la tibia (Odgen IIIA y Jones III), por lo que fue sometido a reducción abierta y fijación. Como la recuperación y el retorno a la actividad habitual fueron rápidos, se tomaron un par radiográfico para el diagnóstico y una tomografía para la planificación quirúrgica. **Conclusión:** Si bien no hay un consenso sobre el diagnóstico y el tratamiento por la baja cantidad de casos publicados, es conveniente sospechar este cuadro en pacientes jóvenes que sufren traumatismo en la rodilla con limitación de la extensión.

Palabra clave: Paciente pediátrico; rodilla; avulsión; tuberosidad anterior de la tibia; osteosíntesis; tendón rotuliano.

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INTRODUCTION

Epiphysiolysis of the anterior tibial tuberosity (ATT) in adolescents accounts for 1% of physeal injuries and 3% of proximal tibial fractures.¹ The pathophysiology of this type of fracture is directly related to the ossification pattern of the knee. The physis of the ATT that connects to the tibial plateau is most susceptible to fracture between the ages of 13 and 16, as the cartilage closes from posterior to anterior. The proximal tibia has two ossification centers. The main one is located in the physis of the proximal tibia, and the secondary one is located at the level of the anterior tubercle. The closure of these centers starts from posterior to anterior and from proximal to distal; the ossification center of the anterior tuberosity is the last to close.² It is critical to be familiar with the differential diagnoses and potential treatment options for ATT avulsion in adolescents since, according to recent publications, it is a rare injury that is becoming more common as young people participate in more sports. ATT fractures in adolescents are typical childhood injuries that directly involve the physis and require prompt diagnosis and treatment to avoid growth complications such as genu recurvatum, loss of flexion-extension, patella alta, and osteonecrosis (rare).

Trauma mechanism

1. Jumping take-off. The fracture occurs in the final phase, with the knee extension, and only the tuberosity is fractured.

2. While landing from a jump. The knee is in flexion, thus fracturing both.

3. Forced extension against resistance. It causes avulsion of the tuberosity.

4. Forced flexion. It causes avulsion of the tuberosity.³

The most commonly used classifications are:

Odgen classification (Figure 1):

- Type IA: Fracture line leads through the ossification center of the tuberosity.
- Type IB: Same as type IA, but with displacement.
- Type IIA: Fracture-separation of the entire tuberosity.
- Type IIB: Same as type IIA, but with comminution of the ossification center.
- Type IIIA: Fracture line extends to the femorotibial joint with some displacement.
- Type IIIB: Same as type IIIA, but with comminution.⁴ (types IA, IB and IIA: conservative treatment), (types IIB, IIIA and IIIB: surgical treatment)

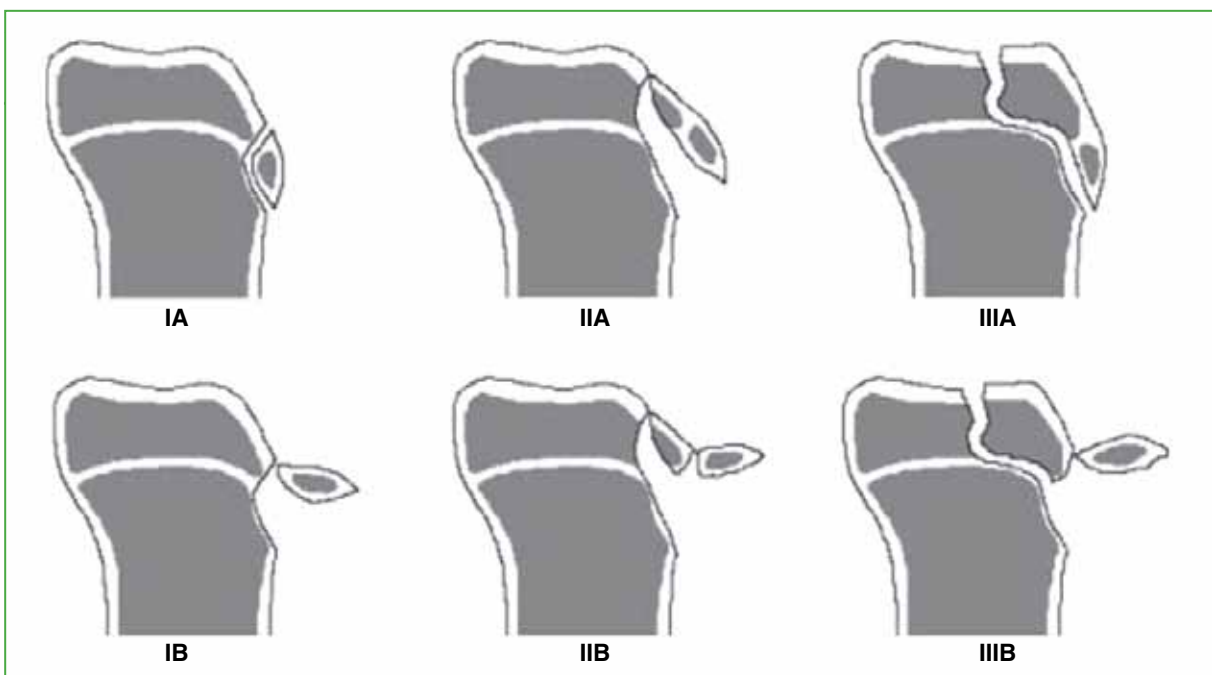


Figure 1. Odgen's classification of avulsion fractures of the anterior tuberosity of the tibia.

Watson-Jones classification (Figure 2):

- Type I: Fracture-separation of the secondary ossification center of the tubercle near the posterior border of the insertion of the patellar tendon.
- Type II: Fracture-separation between the primary and secondary ossification centers of the proximal tibial epiphysis.
- Type III: Same as Salter and Harris Type III. The line of separation follows an ascending path through the primary ossification center of the proximal tibial epiphysis, affecting the joint.
- Types A and B are modifiers according to the degree of displacement and fragmentation.

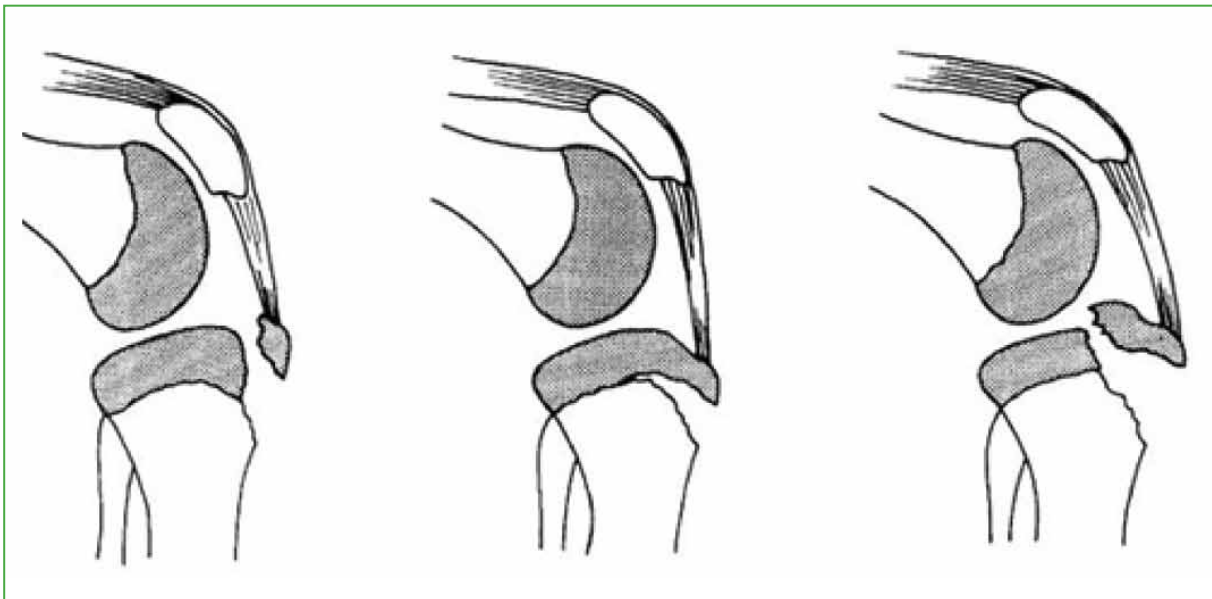


Figure 2. Watson-Jones classification for avulsion fractures of the anterior tuberosity of the tibia.

OBJECTIVE

The purpose of this article is to report the presentation, diagnosis, and treatment of a clinical case, compare it to similar published cases, analyze the differences, and draw a conclusion based on the experience gained in its resolution.

CLINICAL CASE

A 13-year-old male reported having suffered direct trauma to the right knee during running in sports practice (soccer) one month earlier. Physical examination found an antalgic gait that required crutches and a knee immobilizer, edema in the ATT region, patella alta, and pain on palpation and flexion-extension. AP and lateral radiographs (Figure 3) and a comparative radiograph of the contralateral limb revealed ATT avulsion, type IIIA of the Ogden classification. Computed tomography showed ATT avulsion with a fracture line extending to the articular surface of the tibia, with displacement.



Figure 3. AP and lateral radiographs of the knee.

The surgery involved an open reduction and osteosynthesis, as well as the insertion of two parallel screws that did not impact the physis (one in the metaphysis region and the other in the epiphysis region). During the operation, a patellar tendon injury was discovered along with invagination of the distal fibers in the fracture site. The tendon was released and a suture was made at the level of the periosteum, in the anterior region of the proximal tibia (Figures 4 and 5). Reduction and osteosynthesis were performed with two 3.5-mm parallel screws and a washer in the epiphysis and metaphysis (Figures 6-8). A long leg cast was placed in extension without weight bearing for six weeks, after which rehabilitation treatment started. (Figure 9).

Three months after surgery, the patient walked and ran with full weight bearing; radiographs revealed no changes and no complications; and the arc of motion ranged from 0° to 120° of flexion-extension. Six months after surgery, the patient resumed his sports practice with a flexion-extension of 0° to 135°, which showed a good arc of motion, without pain or discomfort.



Figure 4. Approach over the anterior tuberosity of the tibia showing the patellar injury and avulsion.



Figure 5. Fracture line of the anterior tibial tuberosity plus exploration of the invaginated tendon.



Figure 6. Lateral knee radiograph. Osteosynthesis with cannulated screws.



Figure 7. Placement of cannulated screws on the anterior tibial tuberosity.



Figure 8. AP knee radiograph. The cannulated screws are visualized.



Figure 9. AP and lateral radiographs of the knee. The osteosynthesis material in the anterior tibial tuberosity and the immobilization with long leg cast are shown.

DISCUSSION

Different types of surgery have been proposed for injuries affecting the joint (Ogden type III). Agrelo et al. suggest that open reduction and internal fixation with two parallel screws is an adequate treatment that does not cause complications, after a six-month follow-up.³ Pesi and Havranek recommend closed reduction and internal fixation using percutaneous cannulated screws as the first line of treatment for Ogden type III injuries; if the physis is still open, they suggest pinning (success rate >80%),⁵ but not exploring the patellar tendon. Bauer et al. advise extreme caution with this type of injury and recommend looking for associated injuries. These authors use cerclage to protect the patellar ligament repair and avoid the use of washers for osteosynthesis.⁶ Nikiforidis et al. also recommend cerclage, because fixation allows for earlier and easier rehabilitation, but requires a second surgical procedure to remove the material.⁷ Medus and Maestu also opted for cerclage and immobilization until the third week, then progressed to partial weight bearing in the fourth week, reaching 90° of flexion in the eighth week, followed by cerclage removal and a new intervention in the twelfth week.⁸

Casas-Lopez et al. always recommend exploring the extensor mechanism and ruling out the interposition of soft tissues or other structures that may be involved in type II and III injuries. Additionally, they state that the use of pins or screws does not depend on the patient's age, but rather on the type of injury and the dimensions of the fragments, thereby avoiding displacements. Correct fixation and placement of the material will be crucial in case of potential growth in the proximal tibial physis.⁹

As other authors (Balmat et al.),¹⁰ we use two partially-threaded cannulated screws plus a washer, placed in parallel, one in the epiphysis and the other in the metaphysis, avoiding the physis. Previously, we explore the fracture line for the interposition of the patellar tendon and, unlike Nikiforidis et al., we do not use cerclage. These authors use cerclage and implement early rehabilitation without immobilization and walking without weight-bearing, assisted with crutches until the sixth week, followed by cerclage removal in the eighth week, and require a second surgical procedure for the removal of the material, which delays the return to sport and may cause quadriceps atrophy. We also differ from Pesi and Havranek, who perform internal fixation with percutaneous screws as a first attempt without tendon exploration; in this case, the immobilization time, full weight bearing, and time until return to sports activity were shorter, as described by Agrelo et al. and Casas-López et al. In our case, it was not possible to perform an MRI as suggested by Tuca and Pineda¹¹ because we did not have a scanner and the patient did not have meniscus symptoms in the clinical controls.

This author conducted a 5-year follow-up, and found a fully recovered range of motion between week 4 and 8; the patients under evaluation returned to their activities at the third month, but all had quadriceps atrophy. Medus and Maestu also opted for cerclage and cast immobilization until week 3, then removed the cast and allowed partial weight bearing at week 4, reaching 90° of flexion at week 8, followed by cerclage removal and a new procedure at week 12.

CONCLUSIONS

Soccer is one of the most popular sports in Argentina, thus the low prevalence of these cases, both reported and observed in everyday practice, is noteworthy. However, it is possible that this is the main cause in our country. Other countries, where the main sport is basketball or athletics, which entail high and long jumping, account for the majority of cases. Although there is no consensus on the diagnosis and treatment due to the low number of published cases, increasing sports participation among young people increases the number of cases; thus, it is prudent to suspect this condition in young people who suffer a knee traumatism with extension limitation.

Conflict of interests: The authors declare no conflicts of interest.

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