# Anterior Tibial Tuberosity Refracture in an Adolescent After Surgical Treatment. Case Report and Literature Review

**Cristina Jiménez Nava, Araceli Mena Roson, Miguel Ángel Plasencia Arriba**
*Department of Traumatology and Orthopedic Surgery. Hospital Universitario Príncipe de Asturias, Alcalá de Henares, Madrid, Spain.*

**ABSTRACT**
Refracture of the anterior tibial tuberosity in adolescents is a rare complication, particularly following surgical treatment, and has been scarcely reported in the literature. We present the case of an adolescent who sustained an anterior tibial tuberosity fracture, underwent surgical treatment at our center, and experienced a refracture four months later while playing sports. The patient underwent a second surgical procedure, which yielded favorable results. Although refracture is an uncommon complication, it is essential to recognize its possibility and to be prepared to manage it effectively. Further studies are required to identify the risk factors that may contribute to its occurrence.
**Keywords:** Refracture; anterior tibial tuberosity; surgery; adolescent.
**Level of Evidence:** IV

**Refractura de la tuberosidad tibial anterior en un adolescente luego del tratamiento quirúrgico. Presentación de un caso y revisión bibliográfica**

**RESUMEN**
La refractura de la tuberosidad tibial anterior en adolescentes es una complicación infrecuente y poco descrita en la bibliografía, más aún tras un tratamiento quirúrgico. Presentamos el caso de un adolescente que sufrió una fractura de la tuberosidad tibial anterior y fue operado en nuestro centro. A los 4 meses, tuvo una recidiva después de practicar deportes. Fue sometido a una nueva intervención y los resultados han sido buenos. Aunque la refractura es una complicación rara, es importante tenerla en cuenta y saber abordarla de forma adecuada. Es necesario llevar a cabo más estudios para dilucidar los factores de riesgo que puedan influir en esta complicación.
**Palabras clave:** Refractura; tuberosidad tibial anterior; cirugía; adolescente.
**Nivel de Evidencia:** IV

## INTRODUCTION

Fractures of the anterior tibial tuberosity (ATT) are rare injuries, accounting for less than 1% of physeal fractures and less than 3% of pediatric fractures, although their incidence is rising.[1,2] They are ten times more frequent in males and typically occur during adolescence (ages 12–14), close to skeletal maturity.[3,4]

The most commonly used classification system is Ogden's, and treatment varies depending on the fracture pattern. Generally, Ogden types IA, IB, and IIA are managed conservatively, while the others require surgical intervention.[4,5]

Complications such as compartment syndrome have been widely reported in the literature. However, refractures, particularly following surgical treatment, are less commonly discussed.

The aim of this article is to present a case of a recurrent ATT fracture after surgical treatment and to review the relevant literature.

Received on March 25th, 2024. Accepted after evaluation on May 19th, 2024 • Dr. CRISTINA JIMÉNEZ NAVA • crisjnava@gmail.com https://orcid.org/0009-0000-3487-1689
**How to cite this article:** Jiménez Nava C, Mena Roson A, Plasencia Arriba MÁ. Anterior Tibial Tuberosity Refracture in an Adolescent After Surgical Treatment. Case Report and Literature Review. *Rev Asoc Argent Ortop Traumatol* 2024;89(6):637-646. https://doi.org/10.15417/issn.1852-7434.2024.89.6.1938

This Journal is licensed under Attribution-NonCommercial-ShareAlike 4.0 International Creative Commons (CC-BY-NC-SA 4.0).

## CLINICAL CASE

A 14-year-old male presented after sustaining a fall while playing soccer, with his knee in flexion. Clinical examination revealed joint effusion, knee flexion, and varus deformity. Radiographs demonstrated a complex Ogden type IVB ATT fracture (Figure 1).

**Figure 1.** Anteroposterior and lateral radiographs of the proximal tibia. The initial fracture of the anterior tibial tuberosity is observed.

The patient underwent emergency surgery involving closed reduction and osteosynthesis with two 3.5 mm cannulated percutaneous partial-thread screws (Figure 2). The immediate postoperative period was uneventful. Partial weight-bearing was initiated early, and a gradual extension-flexion orthosis (0°–90°) was introduced from the third week, along with progressive quadriceps strengthening exercises under physiotherapeutic guidance. At 12 weeks, he was cleared to return to sporting activities.

**Figure 2.** Anteroposterior and lateral radiographs of the knee. Postoperative control.

At four months postoperatively, the patient presented with pain and functional impairment in the left knee following hyperextension. Clinical examination revealed joint effusion, an ascending patella, and tenderness over the ATT. Radiographs showed an Ogden type IIB ATT fracture-avulsion. A CT scan ruled out intra-articular involvement and confirmed consolidation of the posterior line of the initial fracture (Figures 3 and 4).

A second surgery was performed using an anterior approach. The previous osteosynthesis material was removed, and the ATT bone fragment was osteosutured with a braided non-absorbable polyester suture (Orthocord®, Johnson & Johnson, Madrid, Spain). Two perpendicular tunnels were created in the tibia to pass the sutures. The fracture was reduced and fixed with two 4.5 mm bicortical cannulated partial-thread screws. The sutures were then tied securely. Finally, the patellar tendon was reanchored using a Krackow-type suture with No. 5 Ethibond® (Johnson & Johnson, Madrid, Spain) through two tibial tunnels, tied at 30° of knee flexion (Figures 5 and 6).

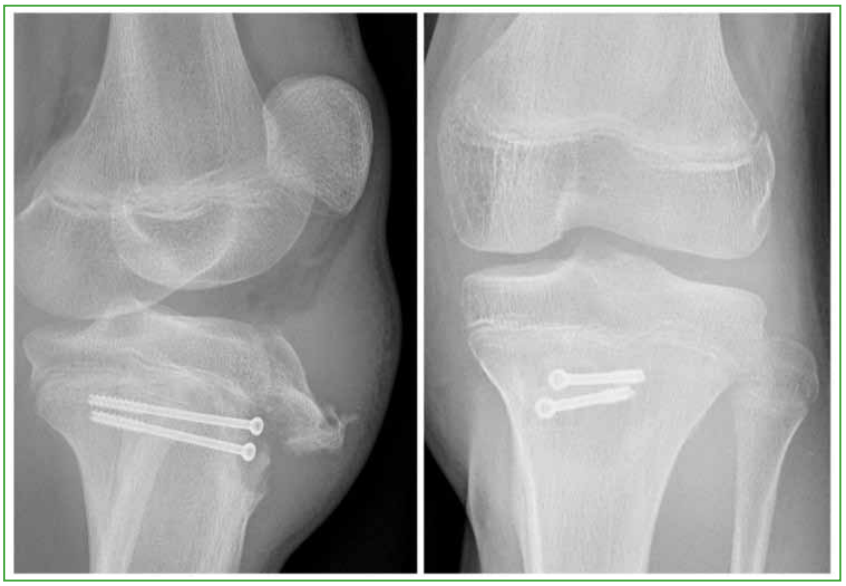

**Figure 3.** Anteroposterior and lateral radiographs of the knee. The refracture is observed.

**Figure 4.** Computed tomography of the knee. The refracture with previous consolidated line is observed.

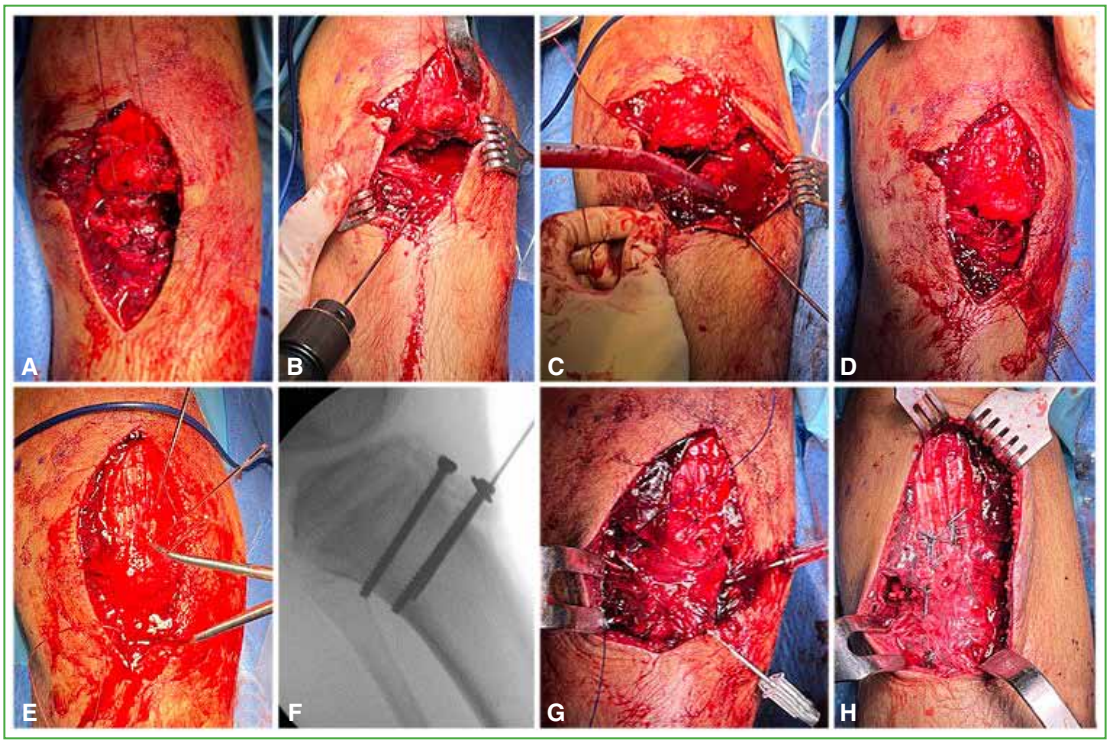


**Figure 5.** **A.** After removal of the osteosynthesis material, a suture with Orthocord® is passed through the bone fragment. **B and C.** Creation of two crossed tunnels with drill. **D.** Passage of the suture through the tunnels. **E.** Fracture reduction and temporary fixation with K-wires. **F.** Definitive fixation with 2 cannulated screws. **G.** Creation of two tunnels in the tibia for passage of the Ethibond® suture. **H.** Krackow type suture in the patellar tendon with 2 Ethibond® and knotting through tunnels with 30º of flexion.

**Figure 6.** Anteroposterior and lateral radiographs of the knee. Control after the second operation.

The immediate postoperative period was uneventful. The knee was immobilized at 15° of flexion for three weeks, with non-weight bearing. Gradual weight-bearing and flexion using an articulated orthosis were introduced, reaching 90° over the following three weeks.

Four months postoperatively, the patient had regained full range of motion, was pain-free, and achieved full weight-bearing (Figure 7). At six months, he returned to his usual physical activities without any limitations.

**Figure 7.** Clinical control at 4 months.

## DISCUSSION

The secondary ossification center of the proximal tibial epiphysis develops during the first days of life. The anterior tibial tuberosity (ATT) has a separate ossification center that typically appears between the ages of 7 and 12 years.[6] These ossification centers serve distinct functions: the primary center contributes to growth and shaping, while the secondary center serves as the insertion site for the patellar tendon. Fusion of these centers follows a specific sequence, with the ATT being the last to close—around 14 years of age in girls and 16 years in boys.[3]

ATT fractures most commonly occur in athletic settings, particularly during jumping. The two primary injury mechanisms are quadriceps contraction with the knee extended (at the jump's apex) or rapid passive flexion with the quadriceps contracted (upon landing).[5] The proximal tibial physis fuses from posterior to anterior, and the fracture pattern depends on the degree of skeletal maturity and knee flexion at the time of trauma. Generally, ATT fractures involving the proximal epiphysis occur at more than 30º of knee flexion (Figures 8 and 9).[7,8]

Although rare, ATT fractures are becoming increasingly frequent. They are particularly notable in fractures with posterior physeal or metaphyseal involvement. Types IV and V fractures were not described until 1985 by Ryu and Debenham and in 2003 by McKoy and Stanitski, respectively.[9] Previously, these injuries were classified as proximal tibial fractures using the Salter-Harris classification.[10]

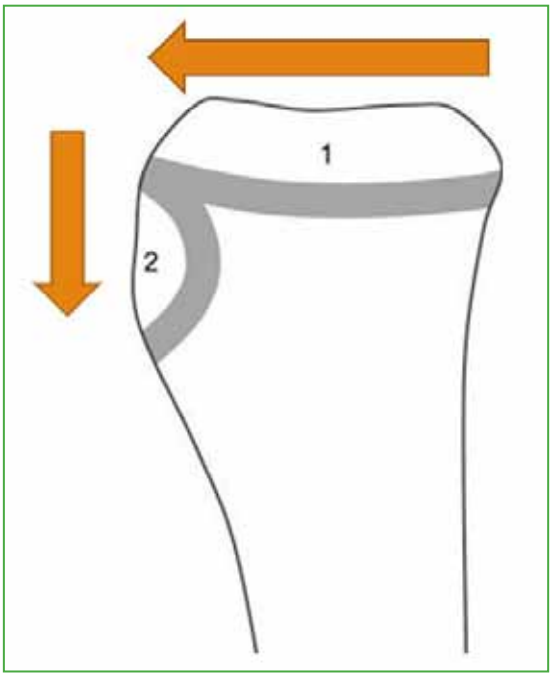


**Figure 8.** Direction of physeal closure.


**Figure 9.** Mechanisms of injury.

The first classification system for ATT fractures was proposed by Watson-Jones in 1976.[11] However, the most widely used system is the one published by Ogden in 1980,[12] with subsequent additions by Ryu and Debenham (type IV) and McKoy and Stanitski (type V) (Figure 10).[9,13] .

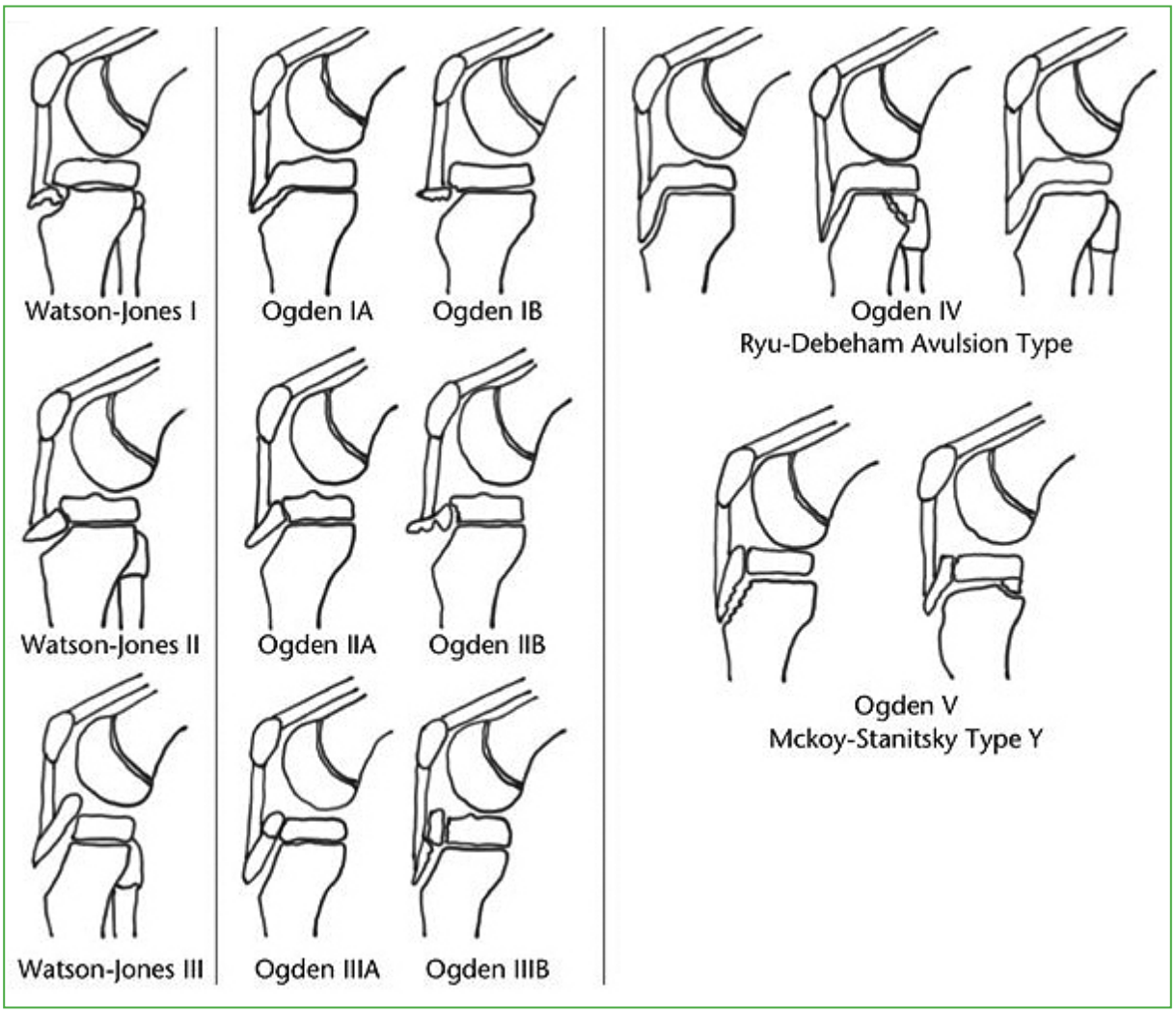


**Figure 10.** Classifications of anterior tibial tuberosity fractures. Image taken from Rodriguez I, Sepúlveda M, Birrer E, Tuca MJ. Fracture of the anterior tibial tuberosity in children. *EFORT Open Rev* 2020;5(5):260-7. https://doi.org/10.1302/2058-5241.5.190026

Numerous associated injuries have been reported, including anterior cruciate ligament (ACL) involvement, quadriceps and patellar tendon avulsions (2%), and meniscal injuries (2%).[2,10,14,15] The most critical associated injury is compartment syndrome, due to the proximity of the anterior tibial recurrent artery. Its reported incidence ranges from 4% (Pretell-Mazzini et al.[16]) to 20% (Frey et al. and Polakoff et al.).[15] .

For diagnosis, routine anteroposterior and lateral radiographs are essential. If intra-articular fractures or recurrences are suspected, as in our patient, a CT scan is recommended. MRI is indicated when ligament or meniscal injuries are suspected.

The therapeutic goal is to restore the knee's extensor mechanism and articular surface while repairing any intra-articular structures. Conservative treatment is typically reserved for Ogden type I or II fractures with <2 mm displacement or for skeletally immature patients.[9,17]

Various surgical techniques have been described, but none has been proven superior. The most common approach is open or closed reduction with fixation using partial-thread screws (average diameter: 4–4.5 mm) to achieve compression. Arthroscopy can assist in reducing joint fragments, avoiding arthrotomy. Extensive periosteal involvement requires repair to enhance stability. Reattachment of the patellar tendon is necessary in cases of concomitant involvement. Other options include needle fixation (suitable for younger patients to reduce the risk of physeal injury),[2] tension bands, or combinations thereof. Plate osteosynthesis is primarily used for Ogden type IV fractures.[4]

Osteosynthesis material often needs removal due to discomfort caused by screw head irritation. Removal is recommended after physeal closure.[16,18]

The overall complication rate for ATT fractures is approximately 28%, with up to 56% of cases involving anterior pain or implant bursitis. The second most common complication is refracture (5%), mainly in Ogden types III, IV, and V fractures. Less frequent complications include infection, recurvatum deformity, and pseudoarthrosis (<1%).[3]

Refracture of an ATT initially treated with surgery is a rare complication and is scarcely addressed in the literature. This complication poses challenges in reconstructing the knee's extensor mechanism.[19] Stable fixation is crucial for restoring normal activities while respecting the physis to prevent complications like premature physeal closure. [18]

Several authors have described an association between a higher rate of complications and posterior metaphyseal involvement, including compartment syndrome and refracture.[3,10,20] In the study by Brey et al., a statistically significant association between posterior metaphyseal involvement and refracture was demonstrated. However, the initial treatment in that study was conservative, making the results not directly comparable to cases treated surgically.[10]

In 2018, Valenzuela et al. published a case of refracture following surgery, although with different characteristics from our case. In their report, the refracture occurred in the context of a complicated postoperative course, which resulted in tendon retraction and chronic ATT avulsion.[19] By contrast, in our patient, the refracture occurred after an initially satisfactory postoperative recovery.

According to the literature, the average recommended period before resuming sports activities is at least 3 months.[3] Therefore, it would not be reasonable to attribute the failure of osteosynthesis in our patient to premature return to sports or poor compliance. Alternatively, one could speculate that osteosynthesis using two 3.5 mm screws may have provided insufficient stability. However, there are currently no robust studies to support this hypothesis. Thus, further research is needed to identify potential causes of osteosynthesis failure in these cases.

## CONCLUSIONS

ATT refracture is a rare complication in the evolution of this condition but should be carefully considered in these patients. It is essential to perform definitive surgical treatment that allows the patient to resume physical activity safely, incorporating measures to increase stability and relieve tension on the patellar tendon when necessary.

Additional studies are warranted, as many variables remain undefined. Identifying the risk factors associated with such complications will be critical to improving outcomes and guiding clinical decision-making.

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

A. Mena Roson ORCID ID: https://orcid.org/0000-0002-8128-2649
M. Á. Plasencia Arriba ORCID ID: https://orcid.org/0009-0004-3226-7428

## REFERENCES


1. Koivisto ST, Laaksonen T, Ahola JA, Helenius I, Stenroos A. Epidemiology and management of proximal tibia fractures in children and adolescents: a population-based study based on the Kids' Fracture Tool. *Acta Orthop* 2022;93:826-30. https://doi.org/10.2340/17453674.2022.4879
2. Formiconi F, D'Amato RD, Voto A, Panuccio E, Memeo A. Outcomes of surgical treatment of the tibial tuberosity fractures in skeletally immature patients: an update. *Eur J Orthop Surg Traumatol* 2020;30(5):789-98. https://doi.org/10.1007/s00590-020-02629-y
3. Rodriguez I, Sepúlveda M, Birrer E, Tuca MJ. Fracture of the anterior tibial tuberosity in children. *EFORT Open Rev* 2020;5(5):260-7. https://doi.org/10.1302/2058-5241.5.190026
4. Pedrazzini A, Maserati I, Cesaro G, Visigalli A, Casalini D, Bertoni N, et al. Tibial tubercle avulsion fracture during sport activities in adolescent: a case report. *Acta Biomed* 2022;92(S3):e2021571. https://doi.org/10.23750/abm.v92iS3.12580
5. Ares O, Seijas R, Casas-Duhrkop, Catala J. Fractura de la tuberosidad anterior de la tibia en el adolescente. *Acta Ortop Mex* 2012;26(2):121-4. PMID: 23323303
6. Beaty JH, Kumar A. Fractures about the knee in children. *J Bone Joint Surg Am* 1994;76:1870-80. https://doi.org/10.2106/00004623-199412000-00016
7. Jakoi A, Freidl M, Old A, Javandel M, Tom J, Realyvasquez J. Tibial tubercle avulsion fractures in adolescent basketball players. *Orthopedics* 2012;35(8):692-6. https://doi.org/10.3928/01477447-20120725-07
8. Borch-Madsen P. On symmetrical bilateral fracture of the tuberositas tibiae and eminentia intercondyloidea. *Acta Orthop Scand* 1954;24(1-4):44-9. https://doi.org/10.3109/17453675408988551
9. McKoy BE, Stanitski CL. Acute tibial tubercle avulsion fractures. *Orthop Clin North Am* 2003;34(3):397-403. https://doi.org/10.1016/s0030-5898(02)00061-5
10. Brey JM, Conoley J, Canale ST, Beaty JH, Warner WC Jr, Kelly DM, et al. Tibial tuberosity fractures in adolescents: is a posterior metaphyseal fracture component a predictor of complications? *J Pediatr Orthop* 2012;32(6):561-6. https://doi.org/10.1097/BPO.0b013e318263a370
11. Mostofi SB. *Fracture classifications in clinical practice*. London: Springer-Verlag London; 2006.
12. Ogden JA, Tross RB, Murphy MJ. Fractures of the tibial tuberosity in adolescents. *J Bone Joint Surg Am* 1980;62(2):205-15. PMID: 7358751
13. Ryu RK, Debenham JO. An unusual avulsion fracture of the proximal tibial epiphysis. Case report and proposed addition to the Watson-Jones classification. *Clin Orthop Relat Res* 1985;(194):181-4. PMID: 3978913
14. Frey S, Hosalkar H, Cameron DB, Heath A, David Horn B, Ganley TJ. Tibial tuberosity fractures in adolescents. *J Child Orthop* 2008;2(6):469-74. https://doi.org/10.1007/s11832-008-0131-z
15. Polakoff DR, Bucholz RW, Ogden JA. Tension band wiring of displaced tibial tuberosity fractures in adolescents. *Clin Orthop Relat Res* 1986;209(209):161-5. PMID: 3731588
16. Pretell-Mazzini J, Kelly DM, Sawyer JR, Esteban EMA, Spence DD, Warner WC, et al. Outcomes and complications of tibial tubercle fractures in pediatric patients: A systematic review of the literature: A systematic review of the literature. *J Pediatr Orthop* 2016;36(5):440-6. https://doi.org/10.1097/BPO.0000000000000488
17. Abalo A, Akakpo-numado KG, Dossim A, Walla A, Gnassingbe K, Tekou AH. Avulsion fractures of the tibial tubercle. *J Orthop Surg (Hong Kong)* 2008;16(3):308-11. https://doi.org/10.1177/230949900801600308
18. Little RM, Milewski MD. Physeal fractures about the knee. *Curr Rev Musculoskelet Med* 2016;9(4):478-86. https://doi.org/10.1007/s12178-016-9370-7
19. Valenzuela ML, López Soto V, Molina IL. Cirugía de rescate en casos de desplazamiento secundario crónico de la tuberosidad tibial anterior en la adolescencia: a propósito de un caso. *Rev Soc Andal Traumatol Ortop* 2018;35(1):49-53. Available at: http://www.revista.portalsato.es/index.php/Revista_SATO/article/view/61/pdf
20. Andrews KA, Gillette M, Shah RV, Mckean LA, Sanford CG. Type IV tibial tubercle fracture-Salter-Harris type II variant. *J Surg Case Rep* 2019;2019(7):rjz209. https://doi.org/10.1093/jscr/rjz209