European Journal of Orthopaedic Surgery & Traumatology (2019) 29:1359–1363
https://doi.org/10.1007/s00590-019-02441-3



# Combined avulsion fracture of the tibial tubercle and patellar tendon rupture in adolescents: a case report

**Víctor Manuel Bárcena Tricio**[1] · **Rodrigo Hidalgo Bilbao**[1]

Received: 4 December 2018 / Accepted: 12 April 2019 / Published online: 19 April 2019


**Abstract**
Simultaneous occurrence of tibial tubercle fracture and patellar tendon avulsion is an extremely rare condition. However, they have become more frequent due to increased participation in sports at a younger age. Diagnosis is not always straightforward, and treatment consists of open reduction and internal fixation. Only a few case reports of such injuries were reported in the literature with limited information according to diagnoses, treatment, and outcome in adolescents.

**Keywords** Knee injuries · Tibial tubercle fracture · Patellar tendon avulsion

## Introduction

Avulsion fractures of the tibial tubercle are rare injuries in adolescents and represent less than 1% of all physeal fractures [1–3], while patellar tendon ruptures are also uncommon with no clearly reported incidence. Only a few cases have been reported in the literature with the combination of a tibial tubercle fracture and patellar tendon rupture [1–13]. It occurs from violent eccentric contraction of the quadricep muscle. The tubercle is avulsed during aggressive knee flexion during quadricep contraction or aggressive quadricep contraction when the ipsilateral foot is fixed, both of which can occur during jumping activities [14]. This injury is more common in males than in females and has an association with Osgood–Schlatter disease [15].

In the pediatric population, the physis is the weakest link between the muscle–tendon–bone complex. For this reason, an avulsion fracture of the tibial tubercle is much more frequently occurring than a tendon rupture. Unlikely injuries having been reported in the literature with limited information according to diagnoses, treatment, and outcome in children [3]. The aim of this study was to report one extremely rare case of avulsion fracture of the anterior tibial tuberosity associated with patellar tendon avulsion. We describe a case and a repair technique and try to increase the awareness of this combined injury.

## Case report

The patient is a 14-year-old boy who felt severe pain in his left knee while jumping during a soccer match. The patient's height and weight were 1.85 m and 70 kg (BMI 20.45), respectively. Before this injury, he had been training 8 h per week and felt a dull anterior pain in both knees for a few months.

He experienced an immediate knee pain with swelling and was unable to ambulate.

The first examination showed a restriction of motion and an inability to perform a straight-leg raise. He had pain over the tubercle and patellar tendon area with a limited range of motion. Skin over the knee was without abrasions or open wounds.

X-rays (Fig. 1) demonstrated a displaced type IIB avulsion fracture of the tubercle apophysis and a high-riding patella.

After induction of general anesthesia, prophylactic antibiotics were administrated, and the limb was exsanguinated with an Esmark wrap, and the tourniquet was inflated.

The anterior approach was made to the tibial tubercle using a parapatellar incision. While exposing the tendon and the fragment, it became apparent that the tendon was completely avulsed from the tubercle fragment (Fig. 2). The patient underwent open reduction and internal fixation of

✉ Víctor Manuel Bárcena Tricio
vibartri@hotmail.com

[1] Hospital Universitario de Burgos, Avenida Islas Baleares s/n, Burgos, Spain

**Fig. 1** Preoperative X-ray of the knee showed displaced tibial tubercle. The distance between the distal pole of the patella and the avulsed fragment was increased

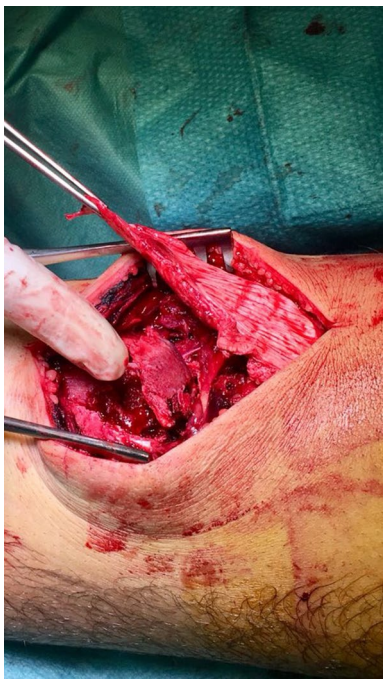

**Fig. 2** After arthrotomy incisión, the patellar tendon avulsion and the tibial tubercle avulsión were identified

the apophyseal fracture and repair of the patellar tendon. The apophyseal fracture fragment was rotated approximately 180°. The fragment was secured with two 5-mm partially threaded screws across the apophysis (Fig. 3). Fiberware sutures were placed in krackow fashion and passed through a transverse drill hole made in the tibia, just distal to the tubercle (Fig. 4).

Postoperation, the leg was immobilized for 6 weeks in a long leg cast. After 2 weeks, X-ray of the knee with lateral view and AP view demonstrated fixation of the tibial tubercle fracture with the use of two fully threaded cortical screws (Fig. 5). Weight bearing was allowed after removal of the

**Fig. 3** Tibial tubercle was fixed with two partially threaded screws and the patellar tendon was placed with a Krackow suture using a transosseous suture. Before the skin was closed, stable fixation was achieved with the knee being flexed 90°

cast. The patient regained full ROM by 12 weeks postoperation (Fig. 6) and returned to full sports participation within 6 months.

## Discussion

Tibial tubercle avulsion fractures are relatively uncommon in children and adolescents [16]. It happens with an immature skeleton, in which the muscles, ligaments, and tendons are stronger than the growth plates. The weakest aspect of the extensor mechanism in the adolescent is the changing growth plate in the tibial tubercle, where the injury occurs. These injuries usually occur in adolescents aged between 13 and 17, which is consistent with the time of the secondary ossification and fusion of tibial tubercle apophysis with the epiphysis [7, 15]. The mechanism of the injury is a forceful contraction of the quadricep in a flexed knee or with a fixed foot. Pandya et al. [14] have described, in their retrospective review, that these injuries are associated with jumping activities (basketball 27%, soccer 22%, and running 22%).

The occurrence of such injury patterns had increased nowadays because of the participation in sports activities during the adolescence.

The combination of tibial tubercle avulsion fracture and patellar tendon avulsion is extremely infrequent. The

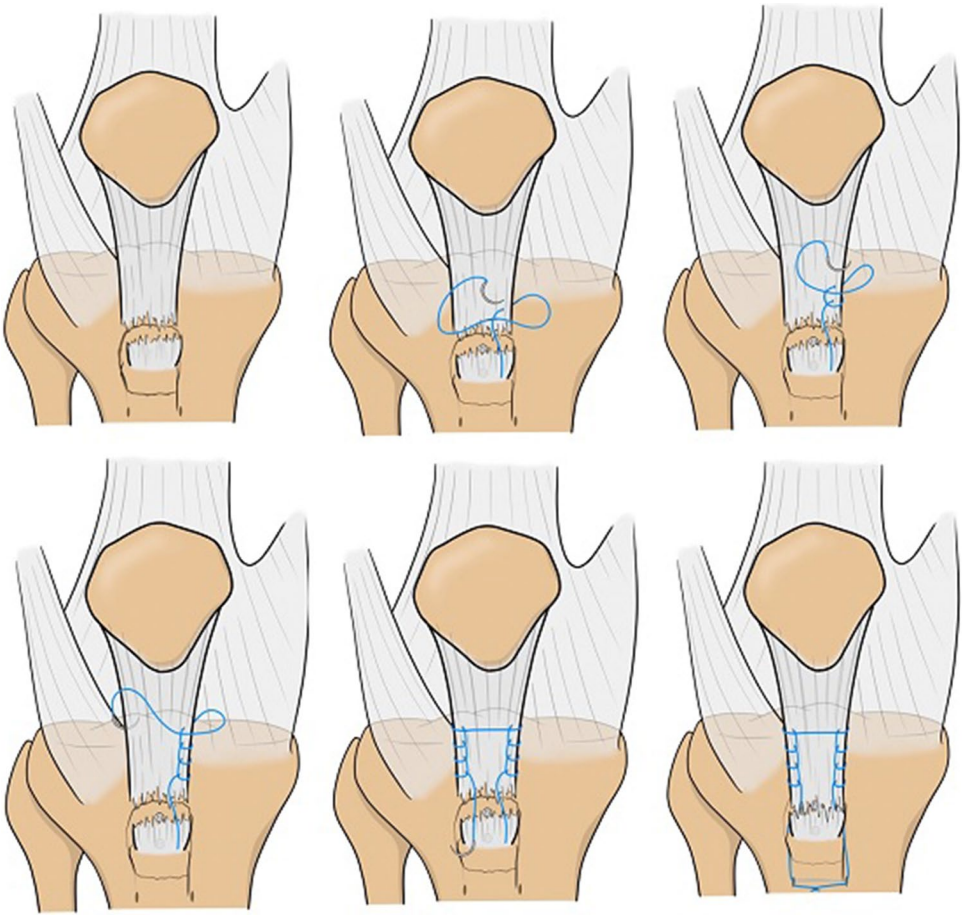

**Fig. 4** Scheme/figure depicting the technique to fix the tibial tubercle the Krackow technique used and the reparation of the patellar tendon rupture


**(a)** **(b)**

**Fig. 5** Postoperative X-rays of the knee with a lateral view (**b**) and an AP (**a**) view demonstrating fixation of the tibial tubercle fracture with the use of two fully threaded cortical screws. The distance between patella and tibial tubercle was restored on the lateral view. This figure was compared with lateral view Fig. 1

reported incidence of patellar tendon rupture ranges from 2 to 15.7% [17]. Maybe who was the first to report such injury in 1982, had proposed that violent continued contraction of the quadricep muscle even after the fracture occurred,

(a) (b)

**Fig. 6** After 3 months, the left knee AROM is the same as of right knee

was responsible for such injury pattern [6]. The failure of the extensor mechanism at two distinct locations, like our patient, has not been clearly defined.

The possibility of associated injuries is well documented in the literature [4, 9, 10, 16, 18, 19]. These include injury to the meniscus, cruciate, and colateral ligament or injury to the patella ligament as seen in our case.

The presence of a patellar tendon avulsion has significant management implications, and the clinical detection may prove challenging. There are some clues that may suspect as a palpable patella ligament gap and the patients inability to actively extend the knee against gravity. Anteroposterior and lateral radiographs are critical in the diagnosis. The use of advanced imaging would surely increase diagnostic accuracy, but it should be individualized depending on the type of the fracture. Tibial tubercle fractures with articular involvement might need additional studies, such as MRI, arthroscopy, or mini-arthrotomy to better identify and evaluate associated injuries [20]. Intra-articular involvement is often missed with the use of X-ray and underestimates injury severity. Therefore, it would seem interesting to use a CT scan or MRI. In the current case, we suspected the association and performed an arthrotomy. The main disadvantage of a CT scan is radiation in young patients and the limitation with soft tissue. The main disadvantage of an MRI is the lack of bony detail compared with the CT scan. Both can be useful when the clinician is concerned that a significant intra-articular soft tissue or ligament injury exists [14].

In our patient, we use the tourniquet, but there is not much information about their utility in the literature. Alburquerque et al. [21] and Behery et al. [1] have reported their use. Considering the surgical approach, many authors recommend a midline vertical incision to facilitate any possible knee surgery in the future [22]. Open reduction and internal fixation are the standard treatment for avulsion fracture of the tibial tubercle. Management focuses on restoration of the extensor mechanism. Several types of treatments have been reported in the literature, such as splint immobilization, Kirschner wires, tension bands, and cannulated screws. Nondisplaced tibial tubercle avulsion fracture Ogden types I and II can be treated conservatively with cast or percutaneous fixation without open surgery. However, the simultaneous occurrence of tibial tubercle fracture and patellar tendon avulsion obliges to perform an open fixation. In our case, the treatment consists of open reduction and internal fixation of the tibial tubercle fracture with compression screws in addition to surgical repair of the avulsed patellar ligament with transosseous suture. Although open reduction and internal fixation with screws are recommended for tibial tubercle avulsion, whether to use unicortical or bicortical fixation is debatable. Arkade et al. [16] have not found differences in outcome for unicortical or bicortical fixation. The decision to use unicortical or bicortical fixation is not clear, but with adequate stability, the unicortical screws could avoid the potential neurovascular risks associated with bicortical drilling.

In addition, reattachment of the patellar ligament is necessary. The reinsertion of the patellar ligament has been described using staples, tension band, or transosseous suture. In our patient, the patellar tendon was repaired using the Krackow technique with fiber wire through proximal tibia transosseous tunnels.

Postoperative management consists of a long leg cast for 4–6 weeks and then active range motion exercises. After some weeks of immobilization with a cast, a Bled Soe hinged knee brace is a good option. The time required to regain full range of motion and return to sports is between 3 and 5 months. Similarly, the full range of motion was achieved at 3 months and our patient returned to sports at 6 months. Complications are rare, and they include compartment syndrome, loss of flexion, malunion, nonunion patella ínfera, and fracture through the fixation device [9].

## Conclusion

Simultaneous occurrence of tibial tubercle fracture and patellar tendon rupture represents a very low range of patients who suffered a traumatic injury of the knee extensor mechanism. Although uncommon, the possibility of simultaneous occurrence of the tibial tubercle fracture and patellar tendon avulsion should be considered increasing in sports activities at a younger age.

### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no competing interest.

**Ethical approval** The study was approved by the institutional review board.

## References


1. Behery OA, Feder OI, Beutel BG, Godfried DH (2018) Combined tibial tubercle fracture and patellar tendon avulsion: surgical technique and case report. J Orthop Case Rep 8(3):18–22
2. Pereira AL, Faria ARV, Campos TVO, Andrade MAP, Silva GMAE (2018) Tibial tubercle fracture associated with distal rupture of the patellar tendon: case report. Rev Bras Ortop 53(4):510–513
3. Yousef MAA (2018) Combined avulsion fracture of the tibial tubercle and patellar tendon rupture in pediatric population: case series and review of literature. Eur J Orthop Surg Trumatol 28:317–323
4. Swan K Jr, Rizio L (2007) Combined avulsion fracture of the tibial tubercle and avulsion of the patellar ligament. Orthopedics 30:571–572
5. Sullivan L, Lee CB, Simonian PT (2000) Simultaneous avulsion fracture of the tibial tubercle with avulsion of the patellar ligament. Am J Knee Surg 13(3):156–158
6. Mayba II (1982) Avulsion fracture of the tibial tubercle apophysis with avulsion of patellar ligament. J Pediatr Orthop 2:303–305
7. Kaneko K, Miyazaki H, Yamaguchi T (2000) Avulsion fracture of the tibial tubercle with avulsion of the patellar ligament in an adolescent female athlete. Clin J Sport Med 10(2):144–145
8. Frankl U, Wasilewski SA, Healy WL (1990) Avulsion fracture of the tibial tubercle with avulsión of the patellar ligament Report of two cases. J Bone Joint Surg Am 72(9):1411–1413
9. Uppal R, Lyne D (2007) Tibial tubercle fracture with avulsion of the Patellar ligament: a case report. Am J Orthop 36:273–274
10. Clarke DO, Franklin SA, Wright DE (2016) Avulsion fracture of the tibial tubercle associated with patellar tendon avulsion. Orthopedics 39:561–564
11. Perez Carro L (1996) Avulsion of the patellar ligament with combined fracture luxation of the proximal tibial epiphysis: a case report and review of the literature. J Orthop Trauma 10:355–358
12. Sie EJ, Kacou AD, Sery BL, Lambin Y (2011) Avulsion fracture of the tibial tubercle associated with patellar ligament avulsion treated by staples. Afr J Paediatr Surg 8(1):105–108
13. Schiedts D, Mukisi M, Bastaraud H (1995) Fractures of the tibial tuberosity associated with avulsion of the patellar ligament in adolescents. Rev Chir Orthop 81:635–638
14. Pandya NK, Edmonds EW, Roocroft JH, Mubarak J (2012) Tibial tubercle fractures: complications, classification, and the need for intra-articular assessment. J Pediatr Orthop 32(8):749–759
15. Ogden JA, Tross RB, Murphy MJ (1980) Fractures of the tibial tuberosity in adolescents. J Bone Joint Surg Am 62:205–215
16. Arkade A, Schur M, Refakis C, Capraro A, Woon R, Choi P (2019) Unicortical fixation is sufficient for surgical treatment of tibial tubercle avulsion fractures in children. J Pediatr Orthop 39(1):18–22
17. Pretell-Mazzini J, Kelly DM, Sawyer JR (2016) Outcomes and complications of tibial tubercle fractures in pediatric patients: a systematic review of the literatura. J Pediatr Orthop 36(5):440–446
18. Agarwalla A, Puzzitiello R, Stone AV, Forsythe B (2018) Tibial tubercle avulsion fracture with multiple concomitant injuries in a adolescent male athlete. Case Rep Orthop 2018:1070628
19. Nicolini AP, Carvalho RT, Ferretti M, Cohen M (2018) Simultaneous bilateral tibial tubercle avulsion fracture in a male teenager: a case report and literature review. J Pediatr Orthop B 27(1):40–46
20. Pretell-Mazzini J, Kelly DM, Sawyer J, Esteban EMA, Spence D, Warner WC, Beaty JH (2016) Outcomes and complications of tibial tubercle fractures in pediatric patients: a systematic review of the literature. J Pediatr Orthop 36:440–446
21. Alburquerque RP et al (2012) Simultaneous bilateral avulsión fracture of the tibial tuberosity in a teenager: case report and therapy used. Rev Bras Ortop 47:381–383
22. Nikiforidis PA, Babis GC, Triantafillopoulos IK, Themistocleous GS, Nikolopoulos K (2004) Avulsion fractures of the tibial tuberosity in adolescent athletes treated by internal fixation and tension band wiring. Knee Surg Sports Traumatol Arthrosc 12(4):271–276