

TIBIAL TUBERCLE AVULSION FRACTURE IN A MALE ADOLESCENT

Damir Matoković^{1,2}, Andrea Šimić-Klarić^{1,3}, Marijana Tomić Rajić³, Helena Tesari Crnković³, Mislav Jurinić⁴ and Savo Jovanović¹

¹School of Medicine, Josip Juraj Strossmayer University, Osijek; ²Department of Orthopedics, ³Department of Pediatrics, Požega General County Hospital, Požega; ⁴medical student, School of Medicine, University of Zagreb, Zagreb, Croatia

SUMMARY – Tibial tuberosity fractures are rare in childhood, most frequently due to excessive quadriceps muscle contraction. On performing long jump, a 15-year-old boy sustained tibial tuberosity avulsion fracture type II according to Watson-Jones. The patient was treated operatively with fragment repositioning and screw fixation. Ten months after the injury and rehabilitation, he resumed his sports activities with full range knee motion.

Key words: *Tibial fractures; Adolescent; Treatment outcome; Fracture fixation; Case reports*

Introduction

Tibial tuberosity fractures are rare in childhood, mostly occurring consequentially to direct or indirect strain in the area of tibial tuberosity. The lesion is generally caused by indirect traction force due to abrupt and excessive quadriceps muscle contraction during sports activities. Strong traction force acts in the area of distal patellar ligament attachment to tibia on abrupt, strong, passive knee bending with tense quadriceps muscle, as on stopping the body at landing in long jump or on quadriceps strain with the knee extended on taking off in volleyball, basketball, high jump, etc.¹. As tibial tubercle has not yet fused during the period of growth, forceful quadriceps contraction may tear it off. Fractures mostly occur just before completion of growth, when the area of proximal tibia growth has not yet fully closed, generally at the age of 14-17 years^{2,3}.

Fracture classification into three types according to Watson-Jones, subsequently modified by many authors, e.g., Ogden *et al.*, Ryu and Debenham, and Inoue *et al.* into five types, is most commonly found in the literature³⁻⁷. Type I is avulsion of a small part of tibial tubercle and displaced upward. Type II extends across the physis but does not enter the joint. In type III, the line of fracture passes upward and backward, and enters the joint across the proximal articular surface of the tibia. Type IV is a fracture through the entire proximal tibial epiphysis (fracture of tibial tuberosity extends posteriorly along the proximal tibial physis). Like type IV, type V involves complete tibial epiphysis creating an “Y” fracture configuration^{5,8}. Some authors use a unique fracture classification in the zone of growth in children according to Salter-Harris. Salter-Harris type 1 fracture (without dislocation) or type 1 according to Watson-Jones (avulsion of a small part of tibial tuberosity) is treated conservatively by immobilization for 6-8 weeks, while type 2 and 3 fractures are managed operatively to restore the function of the knee extension apparatus.

Predisposing factors that favor the occurrence of fractures include previous complaints associated with

Correspondence to: *Assist. Prof. Damir Matoković, MD, PhD*, Požega General County Hospital, Osječka 107, HR-34000 Požega, Croatia

E-mail: damirmatokovic@gmail.com

Received March 25, 2014, accepted January 8, 2015



Fig. 1. Knee x-ray in lateral projection shows elevated patella and detachment of tibial tuberosity apophysis.

Osgood-Schlatter disease, patella baja, and patients with osteogenesis imperfecta^{9,10}. Fractures can be isolated (extra-articular), involving the joint (intra-articular), or associated with injuries of other knee structures or proximal tibial epiphysis. Because tibial tuberosity fractures are very rare in childhood, such fractures are frequently unrecognized and untreated. A failure to recognize and manage lesions of the supporting structures of the knee can result in instability and functional loss of the knee, including consequential premature osteoarthritis, malunion, non union, patella alta or genu recurvatum deformity, and disorders involving physeal abnormalities.

Case Report

On performing long jump at physical training, a 15-year-old boy experienced severe pain in the anterior knee segment, which prevented his further sports activities. On examination, he reported severe pain and presented swelling in his anterior knee, in the area of tibial tuberosity, with clinically elevated patella. He held his knee in 30 degree flexion. He could not bear weight on this leg, with difficult and painful passive and active knee extension. The neurocirculatory status of the leg was normal, free from signs of compartment syndrome. Prior to this injury, the patient had no discomforts such as pain in the area of tibial tuberosity. Standard knee x-rays in lateral projection revealed elevated position of the patella and tear of tibial tuberosity with cranially shifted fractures (Fig. 1). We did not use magnetic resonance imaging (MRI) technique preoperatively because of technical error. Clinical examination showed no lesions of other ligaments or other knee structures. Upon preoperative preparation and work-up in general endotracheal anesthesia and pneumatic tourniquet, open repositioning and fixation of the tibial tuberosity fragments with two cortical screws of 4.5 mm in diameter was performed (Fig. 2). Washers with cortical screws were not used because of local skin condition, although some authors do not use washers. Using washers with cortical screws

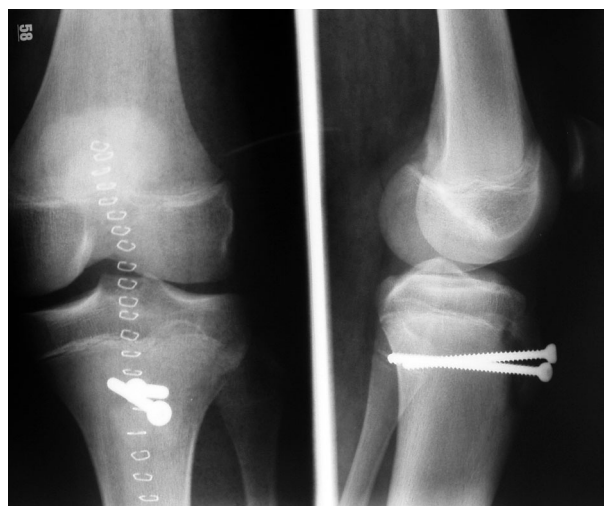


Fig. 2. Follow up knee x-ray in anteroposterior and lateral projection after osteosynthesis with two cortical screws.



Fig. 3. Follow up knee x-ray in anteroposterior and lateral projection after removing two cortical screws.

allows stronger fragment fixation and earlier gradual leg weight-bearing.

The fracture fissure did not involve intra-articular structures of the anterior knee and the patellar ligaments were intact. Postoperatively, the patient was immobilized with knee orthosis for 4 weeks and used crutches to prevent full weight-bearing of the leg because of strong traction forces of femoral quadriceps muscle contraction. Physical therapy procedures were initiated during his hospital stay and continued on outpatient basis. Postoperative follow up and nine months post surgery final x-ray showed normal position of the patella and fragments without growth disturbance (Fig. 3). The osteosynthetic material was removed on second procedure performed 9 months later. Upon completion of treatment, the patient's knee was painless, stable, with full range motion and strong, without atrophy and weakness of the femoral quadriceps muscle and the boy resumed his sports activities.

Discussion

Tibial tubercle avulsion fractures usually occur consequentially to the action of excessive traction due to forceful strain of the femoral quadriceps muscle. Our patient had type 2 fracture according to Watson-Jones (the fracture involving the area of tibial tuberosity and the proximal tibia zone of growth without articular involvement). Fractures mostly occur toward completion of the growth^{3,7}. The proximal tibia zone of growth undergoes closure from the posterior toward

the anterior segment. Therefore, the type of fracture depends on the force intensity and age, i.e. degree of the zone of growth ossification. Fractures should be differentiated from Osgood-Schlatter disease, where there is no apophysis detachment.

As our patient was aged 15, osteosynthesis had no major impact on the growth of the upper part of the tibia. Prior to this injury, the patient reported no pain in the area of tibial tuberosity or deviation from the anatomic physiologic position of the patella. These fractures are rare, accounting for 3% of all fractures in the region of proximal tibia, less than 1% of fractures in the zone of growth, and 0.4%-2.7% of all epiphysis fractures^{3,11}. Tibial tuberosity fractures most often occur in the young male population at a more than 10:1 male to female ratio. Avulsion of tibial tuberosity apophysis in childhood may be associated with numerous complications such as patella baja, knee contraction, compartment syndrome, associated lesions of the meniscus or ligament, and knee recurvatum due to fractures involving the proximal tibia zone of growth. The fracture is usually unilateral, however, bilateral and concurrent fractures may also occur; in addition, re-fracture following osteosynthesis is also possible¹².

In the orthopedic literature, most authors recommend and consider preoperative MRI as an important diagnostic tool for intra-articular structures of the anterior knee and patellar ligament.

Avulsion fractures of tibial tuberosity are rare, mostly due to the action of forceful traction consequential to excessive strain of the femoral quadriceps muscle. The treatment of tibial tubercle fractures is primarily based on the injury severity, displacement, associated complication injuries and fracture pattern. Most authors agree that primary indications for surgery are anterosuperior displacement of one or more fragments of the tuberosity and extension of the fracture through the proximal tibial ossification center into the knee joint, with disruption of the joint surface. Non-displaced fractures can be treated conservatively by cast immobilization with a 6-week course of non weight-bearing. The mean goal of surgical treatment is restoring the extensor mechanism and the joint surface with all its associated components. Early recognition and treatment usually produce good results⁵.

References

1. Jakoi A, Freidl M, Old A, Javandel M, Tom J, Realyvasquez J. Tibial tubercle avulsion fractures in adolescent basketball players. *Orthopedics*. 2012;35:692-6.
2. Huang YC, Chao YH, Lien FC. Sequential avulsions of the tibial tubercle in an adolescent basketball player. *J Pediatr Orthop B*. 2010;19:231-3.
3. Frey S, Hosalkar H, Cameron DB, Heath A, Horn DB, Gantley TJ. Tibial tuberosity fractures in adolescents. *J Child Orthop*. 2008;2:469-74.
4. Watson-Jones R. *Fractures and joint injuries*, 4th edn. Baltimore: Williams & Wilkins, 1955.
5. Ogden JA, Tross RB, Murphy MJ. Fractures of the tibial tuberosity in adolescents. *J Bone Joint Surg Am*. 1980;62:205-15.
6. Ryu JO, Debenham RK. 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.
7. Inoue G, Kuboyama K, Shido T. Avulsion fractures of the proximal tibial epiphysis. *Br J Sports Med*. 1991;25:52-6.
8. Howarth WR, Gottschalk HP, Hosalkar HS. Tibial tubercle fractures in children with intra-articular involvement: surgical tips for technical ease. *J Child Orthop*. 2011;5:465-70.
9. Tamborlane JW, Lin DY, Denton JR. Osteogenesis imperfecta presenting as simultaneous bilateral tibial tubercle avulsion fractures in a child. *J Pediatr Orthop*. 2004;24:620-2.
10. Khodadadyan-Klostermann C, Morren R, Raschke M, Haas N. Simultaneous bilateral tibial tubercle avulsion fractures in a boy with osteogenesis imperfecta. *Eur J Trauma*. 2003;3:164-7.
11. Hand WL, Hand CR, Dunn AW. Avulsion fractures of the tibial tubercle. *J Bone Joint Surg Am*. 1971;53:1579-83.
12. McKoy BE, Stanitski CL, Hartsock LA. Bilateral tibial tubercle avulsion fractures with unilateral recurrence. *Orthopedics*. 2006;29:731-3.

Sažetak

AVULZIJSKI PRIJELOM *TUBEROSITAS TIBIAE* U ADOLESCENTA

D. Matoković, A. Šimić-Klarić, M. Tomić Rajić, H. Tesari Crnković, M. Jurinić i S. Jovanović

Prijelomi apofize *tuberositas tibiae* u dječjoj dobi su rijetki. Najčešće su posljedica snažne kontrakcije mišića kvadricepsa. Dječak u dobi od 15 godina zadobio je tijekom skoka udalj avulzijski prijelom *tuberositas tibiae* tip II. prema Watson-Jonesu. Liječen je operativno te je učinjena repozicija i fiksacija ulomaka vijcima. Deset mjeseci nakon ozljede i provedene rehabilitacije vratio se sportskim aktivnostima uz pun opseg pokreta koljena.

Ključne riječi: *Tibijalne frakture; Adolescent; Ishod liječenja; Frakture, fiksacija; Prikazi slučaja*