

Simultaneous Avulsion Fractures of the Tibial Tuberosity of Both Knees in a 14-Year-Old Boy: A Case Report

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ABSTRACT

Fractures of the tibial tuberosity are uncommon injuries in adolescents, representing an estimated 0.4% to 2.7% of all pediatric fractures. Most of these injuries occur in young, active males commonly between the ages of 12 to 17 years. Sports, particularly those involving jumping or sudden starts and stops, are most often implicated. Injuries of the tibial tuberosity of both knees are especially rare, with little more than 30 cases reported in the past 60 years. We present a 14-year-old male football player with simultaneous avulsion fractures of the tibial tuberosity of both knees. We reviewed the anatomy, mechanisms of injury, classification systems, treatment strategies, and complications regarding this rare injury.

Keywords: Bone Fractures, Tibia, Avulsion Fracture, Adolescent, Football

INTRODUCTION

In 1954, Borsch-Maden¹ first described fractures of the tibial tuberosity of both knees. About 30 additional cases have since been described.²⁻⁶ The proximal tibia has two ossification centers: the primary proximal tibia epiphysis that comprises the tibial plateau, and the tibial tubercle (a smaller, anterior ossification center). The proximal tibial physis closure progresses in a posterior to anterior direction, whereas the tibial tubercle physis proceeds proximally to distally, finally closing in patients between the ages of 13 and 15 years in adolescent girls and 15 to 19 years in adolescent boys.

Furthermore, as observed by Ogden,⁷ the histological features of the physis underlying the tibial tubercle are unique. The features are composed almost entirely

of fibrocartilage as opposed to the normal columnar physeal cartilage usually seen in growth plates. The tensile strength of fibrocartilage is greater than that of the columnar physeal cartilage and can better resist the force exerted on the tibial tubercle by the knee extensor mechanism from the patellar tendon. However, the tibial tubercle physis begins to close with age, and the fibrocartilage is replaced with columnar physeal cartilage, which weakens the area and increases the risk of fracture. Given this, the most common injury is caused by active extension of the knee (eg, jumping) or forced passive flexion of the knee (eg, falling on knees) against a contracted quadriceps muscle.

Owing to the involvement of two ossification centers and physes, new classification systems have been developed to categorize tibial tuberosity fractures, as opposed to the traditional Salter-Harris classification system. Watson-Jones⁸ first categorized tibial tubercle fractures into three types: type I, distal portion of the tibial tubercle is avulsed; type II, entire tibial tubercle is avulsed along with a distal fragment of proximal tibia epiphysis at the level of the physis; and type III, fracture extends through tibial tubercle and proximal tibia epiphysis to the joint. Ogden et al⁹ further modified this system to include subtypes A (non-comminuted) and B (comminuted).

Since then, several additions have been proposed including type IC, avulsion of tibial tubercle with accompanying patellar tendon avulsion¹⁰; type IV, separation of the tibial tubercle physis extends posteriorly, involving entire proximal tibial physis¹¹; and type V that combines types III and IV to create a Y-shaped fracture line as shown in Figure 1.¹² Most recently, Pandya et al¹³ proposed a new classification

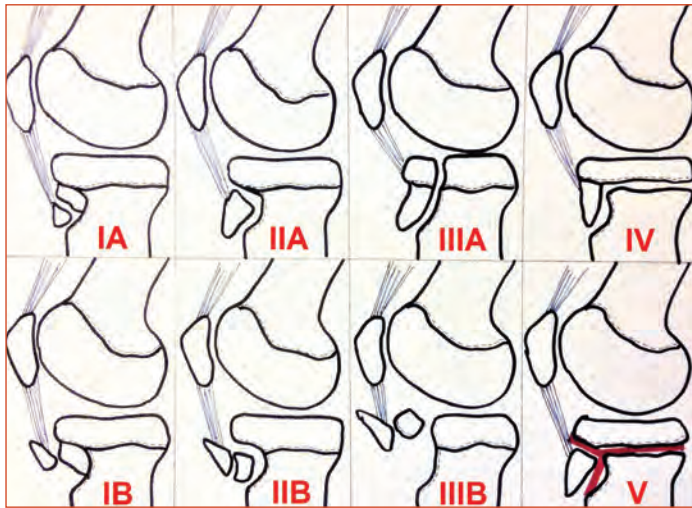


Figure 1. Classification system of tibial tuberosity fractures, showing types IA, IIA, IIIA, IV, IB, IIB, IIIB, and V.

system that placed additional emphasis on intraarticular extension. We describe a 14-year-old adolescent male football player who presented with simultaneous avulsion fractures of the tibial tuberosity of both knees.

CASE REPORT

A 14-year-old male football player presented to an outside emergency department with acute pain in both knees. The patient was running sprints during football practice when he felt a “pop” in both knees and immediate pain. He fell to the ground and was unable to walk. He reported no history of knee injuries. Findings of radiographs revealed tibial tuberosity avulsion fractures of both knees. The patient was transferred to our facility for further care.

On physical examination, the patient had moderate edema of both knees without ecchymosis or erythema. He had tenderness to palpation over the tibial tuberosity of both knees. He was unable to extend either knee and had pain with limited range of motion. His distal neurovascular status was intact, including dorsalis pedis and posterior tibial pulses, capillary refill, sensation, and ankle and toe plantar and dorsiflexion. He was notably obese with a calculated body mass index of 39.1 kg/m². Radiograph findings showed tibial tuberosity avulsion fractures of both knees, consistent with Ogden type IIIA fractures with the right knee (Figure 2A) more displaced than the left (Figure 2B).

The patient was admitted to the orthopaedic service about 24 hours after the injury. He underwent open reduction and internal fixation. After the incision, the tibial tubercle was reduced under direct visualization and placement was confirmed using a Steinmann pin and fluoroscopy. Two fully threaded cortical screws (4.5 mm) were used to secure each tibial tubercle, directed anteriorly and posteriorly. Intraoperatively, the right tibial tubercle was fractured in a single, large

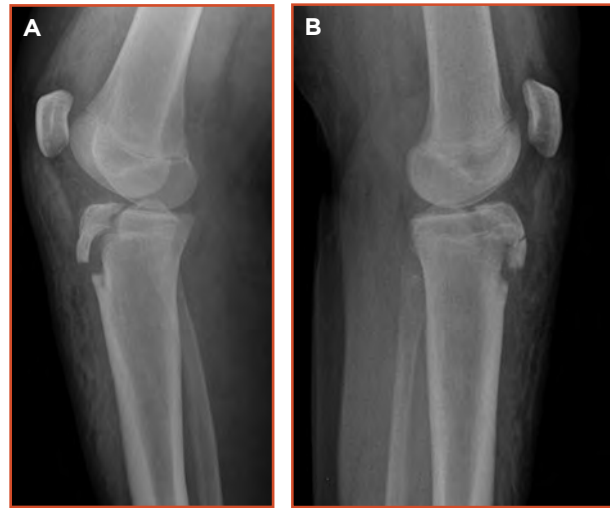


Figure 2. Radiographs of the A) right and B) left knees, showing avulsion fractures of the tibial tuberosity in both knees.

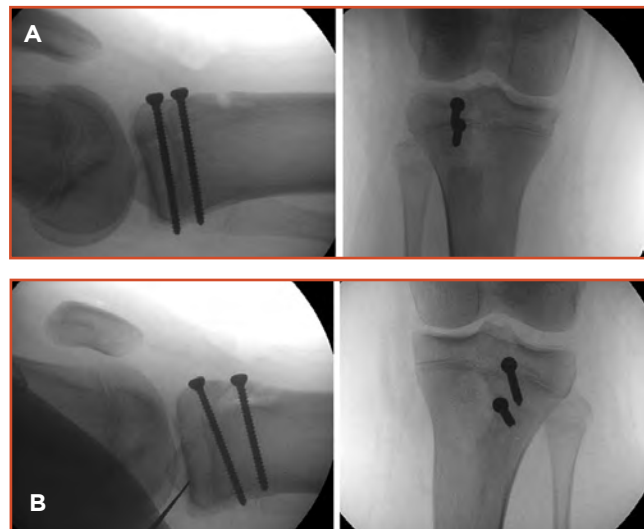


Figure 3. Intraoperative fluoroscopic images of the A) right and B) left knee after open reduction and internal fixation.

piece through which two screws were placed (Figure 3A). The left tibial tubercle was in two pieces, and one screw was placed through each fragment (Figure 3B). Postoperatively, all lower-extremity compartments were notably soft with brisk capillary refill distally. The patient’s knees were placed in hinged Bledsoe knee braces, locked in full extension at 0°. He was able to bear weight as tolerated with the assistance of a walker.

At 4-weeks postoperatively, the patient’s braces were opened to 0° to 30° of extension when not bearing weight but remained locked while bearing weight. At 8-weeks postoperatively, he had full range of motion while non-weight bearing; however, he was instructed to continue using the braces while walking. At 14-weeks postoperatively, the patient no longer required the braces and a new radiograph revealed complete healing

of the fractures (Figure 4). Although the extensor mechanism was intact on both knees, considerable quadriceps weakness was noted; subsequently, the patient was referred to a physical therapist. At 7-month follow-up, he had returned to playing football. Hardware removal will be considered at about 1 year postoperatively.

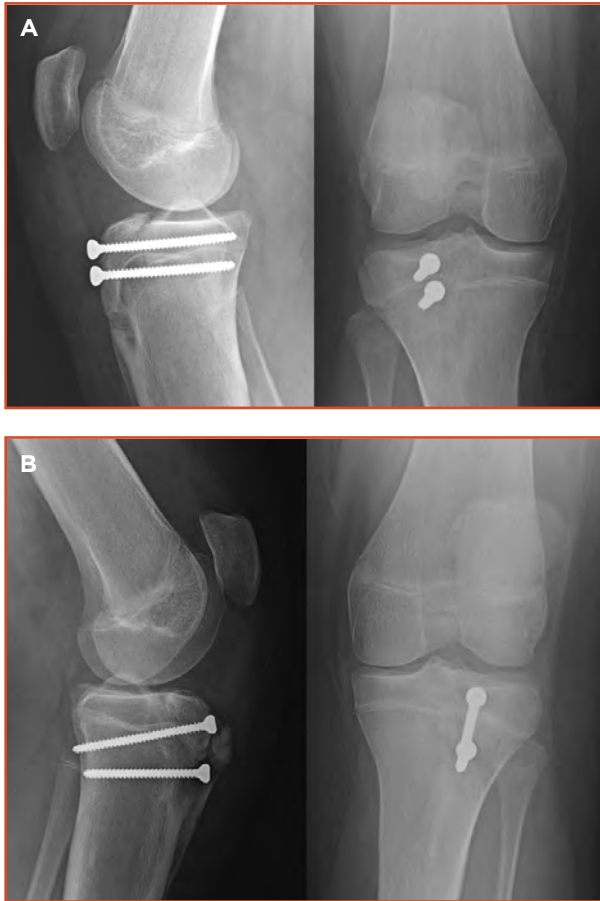


Figure 4. Radiographs of A) right and B) left knees at 14-weeks postoperatively, showing healed fractures.

DISCUSSION

The current case is a typical example of avulsion fractures of the tibial tuberosity of both knees. Roy et al² described the average patient age in the reported cases as 14 years, with adolescent boys most commonly affected (20 of 21), fitting our patient's profile. This may be because of the age difference between the closure of tibial tubercle physis with girls (ages 13 and 15 years) and boys (notably later at 15 to 19 years). Our patient was injured by a common mechanism of injury, involving active extension against a contracted quadriceps muscle while sprinting.

A reported complication of tibial tubercle fractures includes compartment syndrome, possibly caused by damage to the nearby anterior tibial recurrent artery. Higher degree, comminuted fractures are at greater risk, and a prophylactic anterior compartment fasciotomy can be considered at the time of surgical treatment.

Brey et al¹⁴ found a higher incidence of complications in patients with tibial tubercle fractures that extended through the posterior metaphysis. The study also noted three cases of re-fracture after initial nonoperative treatment. Considerable growth deformities are not usually observed after tibial tubercle fractures because the physes are naturally nearing to closure. Genu recurvatum, leg-length discrepancy, malunion, nonunion, and patella alta and infera have been reported as rare complications. Postoperative bursitis due to prominent hardware has been described, for which the use of smaller screws has been suggested as a preventative measure.¹⁵

Treatment choices depend on the degree of displacement, comminution, and intraarticular involvement of injury. Type IA injuries can be managed nonoperatively, with a 4- to 6-week course of immobilization and the knee in full extension (by using a brace or long leg cast), followed by rehabilitation. Nearly all type IB, II, III, IV, and V fractures require surgical repair, with either use of pins or cancellous screws to obtain fixation. Short-term outcomes of tibial tubercle fractures are generally promising, but few studies have reported long-term outcomes.¹⁵

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