

# Avulsion fractures of tibial tuberosity in adolescents

## *Treatment with closed reduction and percutaneous screwing, using MRI to identify combined intraarticular lesions*

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### ABSTRACT

Avulsion fracture of the tibial tuberosity is an uncommon lesion generally seen in adolescents. Intra-articular lesions combined with a tibial tuberosity fracture reported in the literature are; 3 patellar tendon ruptures, 2 anterior cruciate ligament tears, 2 medial collateral ligament tears, 2 medial meniscus tears, one arcuate ligament tear, and one lateral meniscus tear. In our study, both cases sustained an avulsion fracture of the tibial tuberosity. Preoperative MRI in one case revealed posterior cruciate ligament rupture. Under the image intensifier, we treated both patients by closed reduction and percutaneous screwing with 2 cancellous screws. Radiographic assessment showed complete healing of the avulsion fractures in both cases. Both of our patients gained previous levels of daily and sporting activity prior to the injury, and were completely asymptomatic. Our objective in reporting this case study is to point to the fact that there is no previous reporting of the avulsion fracture of the tibial tuberosity accompanied by posterior cruciate ligament rupture in the literature and to evaluate the findings of the minimal invasive treatment method we applied to both cases.

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An avulsion fracture of the tibial tuberosity is an uncommon lesion generally seen in adolescents as a result of injuries sustained during sportive activities.<sup>1,2</sup> The incidence forms of 0.4-2.7% of overall epiphyseal injuries, mostly in boys.<sup>2,3</sup> The fracture has been reported to occur upon the sudden contraction of the quadriceps muscle while the knee is being forcibly flexed.<sup>2,4</sup> Ogden et al,<sup>2</sup> described 3 types of avulsion fractures of the tibial tubercle: type I fracture across the secondary ossification center level with the posterior border of the patellar ligament insertion, type II fracture at the junction of

the primary and secondary ossification centers of the proximal tibial epiphysis, and type III fracture propagating upward across the primary ossification center of the proximal tibial epiphysis into the knee joint. Each type divides into 2 subtypes A and B, depending on the severity of displacement and comminution. In our study, both cases sustained an avulsion fracture of the tibial tuberosity. Preoperative MRI in one case revealed posterior cruciate ligament rupture, and discoid meniscus in the other, the latter being identified by coincidence. Under the image intensifier, we treated both patients

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**Case Reports. Patient 1.** A 15-year-old boy, licensed basketball player, took place in a basketball game when he slipped as he jumped for a rebound, and fell heavily landing with his entire weight on his left foot. A simultaneous maximum contraction of the quadriceps muscle associated the event, which was apparently a hyperflexion injury of the left knee joint. Immediately after the fall, he became unable to extend his knee. During examination, his left knee was in 40° of flexion and it was impossible for him to bring his knee in extension. The radiograph revealed type IIIA avulsion fracture of the tibial tuberosity (**Figure 1a**). In the MRI assessment of intra-articular structures, discoid lateral meniscus was identified by coincidence, and other intra-articular structures were found to be intact (**Figure 1b**). The fracture line extended into the knee joint. Examination under anesthesia showed negative valgus-stress instability; negative anterior drawer sign and a negative pivot-shift test. Treatment was provided under image intensifier control by closed reduction and percutaneous fixation with 2 cancellous screws. Postoperatively,

the knee was held in a knee immobilizer and the patient walked with partial weight bearing for 6 weeks. During this period, passive motion of the knee was permitted. After 6 weeks, the patient began weight bearing and started on an exercise program to regain full range of motion and muscle strength. Follow-up was 31 months and when the patient was admitted for implant removal at 16 months after the injury, radiographic assessment revealed complete healing of the fracture of the tibial tuberosity (**Figure 1c**). The patient gained full mobility and returned to his previous level of sporting activity.

**Patient 2.** A 16-year-old boy, not involved in any sporting activity neither at amateur nor at professional level, was injured in a traffic accident, when he crushed into a car driving from the opposite side as he was riding a motorbike. As he crushed into the car bumper, his left knee in flexion sustained a direct posterior blow such as the one in a dashboard injury. He had immediate, severe pain in the left knee and was unable to bear weight on that limb. Rapid swelling of the knee ensued. During physical examination, the patient held his left knee in 40° of flexion and it was impossible for him to extend his knee. A large hematoma was present, which diffused from the knee site to the proximal cruris and had the risk of developing compartment syndrome. In the radiograph taken, we diagnosed type IIA fracture of the tibial tuberosity. Preoperative MRI revealed posterior cruciate ligament tear and other intra-articular structures were intact (**Figures 2a, 2b & 2c**). Regarding the risk

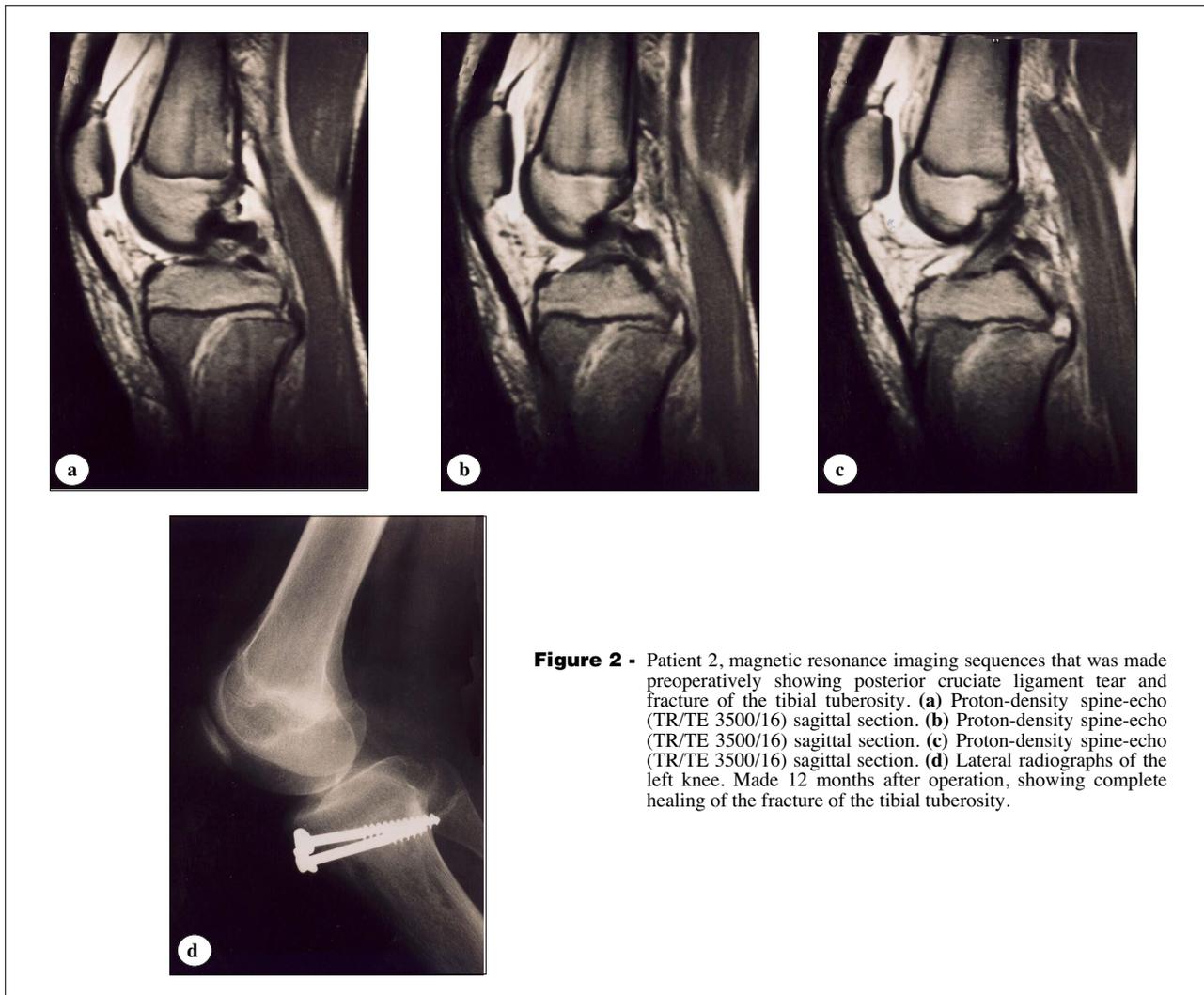


**Figure 1** - Patient 1, (a) Lateral radiographs of the left knee, showing a type IIIA fracture of the tibial tuberosity. (b) Magnetic resonance imaging sequences that were made preoperatively showing discoid lateral meniscus, which was identified by coincidence and fracture of the tibial tuberosity extended to the knee. Proton-density turbo spine-echo (TR/TE 3000/10/Ef) coronal section. (c) Made 16 months after operation, showing complete healing of the fracture of the tibial tuberosity.

of compartment syndrome, anterior compartment pressure was followed by intra-compartmental pressure monitoring system (Ref 295-1; Stryker®, Kalamazoo, Michigan). During observation, except from swelling and pain, no other compartment syndrome findings were identified. Additionally, the maximum compartment pressure measured was 21 mm Hg. Therefore, no fasciotomy was required. Examination under anesthesia resulted in a 3+ posterior drawer sign, a negative anterior drawer sign, and a negative valgus instability. When the activity level and the preference of the patient were taken into consideration, it was planned to ensue a conservative treatment for the posterior cruciate ligament tear whereas closed reduction and percutaneous screwing were performed for the treatment of the tibial tuberosity avulsion fracture under image intensifier. The knee was immobilized postoperatively in a cylinder cast for 8 weeks without weight bearing. After removal of the cast,

the patient began weight bearing and started on an exercise program to regain full range of motion. The patient also adopted vigorous quadriceps strengthening exercise as it might often compensate for the loss of the posterior cruciate ligament. Follow-up was 27 months. Twelve months after the injury the patient was admitted for removal of the screws. Radiographs revealed complete healing of the tibial tuberosity fracture (**Figure 2d**). A loss of approximately 10° of flexion was determined. Under anesthesia, the anterior drawer sign and valgus stress test were negative, and there was no instability on posterior drawer sign.

**Discussion.** A few series of this lesion have been found in the literature. The average number of cases reported on the most important series of this subject is 15.<sup>2,5</sup> Games and sporting activity, particularly gymnastics and basketball stand as the most frequent cause in etiology.<sup>2,6,7,8</sup> One of our



**Figure 2 -** Patient 2, magnetic resonance imaging sequences that was made preoperatively showing posterior cruciate ligament tear and fracture of the tibial tuberosity. (a) Proton-density spine-echo (TR/TE 3500/16) sagittal section. (b) Proton-density spine-echo (TR/TE 3500/16) sagittal section. (c) Proton-density spine-echo (TR/TE 3500/16) sagittal section. (d) Lateral radiographs of the left knee. Made 12 months after operation, showing complete healing of the fracture of the tibial tuberosity.

cases was a patient injured in a basketball game and the other in a motor vehicle-related accident. Osgood-Schlatter disease has been reported to be frequently present in the history of patients.<sup>2</sup> However, in our cases, we identified no correlation with Osgood-Schlatter disease. Reported intra-articular lesions combined with the fracture of the tibial tuberosity in the literature are: 3 patellar tendon ruptures, 2 anterior cruciate ligament tears, 2 medial collateral ligament tears, 2 medial meniscus tears, one arcuate ligament tear, and one lateral meniscus tear.<sup>2,4,8,9</sup> In the preoperative MRI assessment, one of our cases showed posterior cruciate ligament lesion, and the other discoid meniscus, the latter being found by coincidence. Many authors have emphasized the significance of ruling out any intra-articular lesions by clinical examination when faced with the avulsion fracture of the tibial tuberosity. In case of any suspicion; however, they proposed performing arthrotomy at the time of open reduction or arthroscopy.<sup>1,4</sup> By contrast, in our acute traumatic cases we preferred to use MRI for the purpose of operative treatment planning and ruling out any intra-articular lesion, since we consider clinical examination alone as diagnostically insufficient.

In the treatment of type II and III avulsion fractures of the tibial tuberosity, many authors have advocated an aggressive approach including open reduction and internal fixation. They have also performed primary repair of any ligamentous and meniscal injuries, if present.<sup>2,4,5</sup> In our cases however, considering the characteristics of the associating intra-articular lesions determined by preoperative MRI as well as the physical activity level and the individual preferences of the patients, we planned a conservative treatment for the intra-articular lesions. As a result of this, we treated the avulsion fracture of the tibial tuberosity in both patients with a less aggressive method including, closed reduction and percutaneous screwing under image intensifier. Both of our patients returned to normal function, including sports and they were completely asymptomatic, with no disability. Pappas et al<sup>10</sup> noted that genu recurvatum deformity was caused by premature closure of the anterior portion of the physis in skeletally immature children. As our cases were 14-year-old and older, we did not encounter with such a problem. In literature, compartment syndrome has been found to accompany avulsion fracture of the tibial

tuberosity.<sup>7</sup> With respect to compartment syndrome, our cases were closely followed with intra-compartmental pressure monitoring system, and we identified no related complication. Christie and Dvonch<sup>6</sup> reported a patient with persistent loss of 25° of knee flexion 19 months after a type III injury. Ogden et al<sup>2</sup> reported leg length discrepancy, Levi and Coleman<sup>5</sup> reported a patient with a persistent prominence after open reduction and internal fixation. We determined a loss of 10° of flexion in the patient with posterior cruciate ligament lesion, and identified however, no persistent prominence and no leg length discrepancy. Complete anatomic reduction of intra-articular fracture fragment within a closed reduction and stabilized the fixation through a minimal invasive method have been the determining factors in our cases.

We believe that closed reduction and minimal invasive percutaneous screwing under image intensifier control will be successful in the treatment of avulsion fractures of the tibial tuberosity in those cases provided that, by preoperative MRI either the possibility of any intra-articular lesion is ruled out or no surgical treatment is planned despite its presence.

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