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Case Report

Avulsion Fracture of the Tibial Tuberosity in Adolescents: A Rare Case and Surgical Fixation Technique

Farzad Amouzadeh Omrani[1], Kourosh Kharkan Ghamsari[2], Mojtaba Baroutkoub[3], Sina Afzal[4], Saeed Kokly[5,*]

[1] Associate Professor, Department of Orthopedic and Trauma Surgery, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2] Orthopedic Surgeon, Joint, Bone, Connective tissue, and Rheumatology Research Center (JBCRC), Department of Orthopedics, 5th Azar Hospital, Golestan University of Medical Sciences, Gorgan, Iran
[3] Assistant Professor, Department of Orthopedic and Trauma Surgery, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[4] Orthopedic Surgeon, Department of Orthopedic and Trauma Surgery, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[5] Assistant Professor, Joint, Bone, Connective tissue, and Rheumatology Research Center (JBCRC), Department of Orthopedics, 5th Azar Hospital, Golestan University of Medical Sciences, Gorgan, Iran

[*]Corresponding author: Saeed Kokly; Joint, Bone, Connective tissue, and Rheumatology Research Center (JBCRC), Department of Orthopedics, 5th Azar Hospital, Golestan University of Medical Sciences, Gorgan, Iran. Tel: +98-1731153396, Email: skokly@gmail.com

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Abstract

Background: Only 3% of all proximal tibial fractures result in an avulsion fracture of the tibial tuberosity. It is often seen in youngsters between the ages of 3 and 6 and is less frequent after puberty.
Case Report: A 15-year-old boy was presented with severe left knee pain following a high jump. X-ray and computed tomography (CT) scan showed a tibial tuberosity fracture with joint surface involvement. The damaged part was fixed with a 4.5mm cannulated screw and washer, reinforced with 2 SwiveLock anchors. In the sixth week, full weight bearing and full range of motion (ROM) were obtained.
Conclusion: The primary objective in managing tibial tubercle fractures is the restoration of both the extensor mechanism and the integrity of the joint surface in cases where they have been compromised.

Keywords: Knee Fractures; Avulsion Fracture; Knee; Internal Fixation; Sports

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Background

Engaging in sports activities carries inherent risks, with approximately 22% of teenagers susceptible to injuries. Among these injuries, tibial tuberosity avulsion fractures (TTAFs) are infrequent, constituting less than one percent of all epiphyseal injuries and roughly 3% of all proximal tibial fractures (1, 2). Basketball and other sports like football, gymnastics, and spring boarding are frequently associated with TTAF.

TTAFs often result from activities that involve jumping, with the most commonly reported mechanisms being: 1) a forceful contraction of the quadriceps during knee extension while jumping and 2) happening as a quick passive knee flexion counteracting the contracting quadriceps upon landing (3-6).

Pretell-Mazzini et al. performed a study surrounding TTAFs and summarized the Ogden classification into five groups, where within each group, the fracture can be displaced, nondisplaced, or comminuted (7).

We experienced a rare case of TTAF in an adolescent during simple falling down, and we aimed to report a new surgical technique for this condition.

Case Report

The patient presented as a 15-year-old adolescent boy with severe left knee pain following a high jump and inability to walk and bear weight on the lower left limb. Left straight leg raise (SLR) was negative, and there was swelling and direct tenderness on the tibial tuberosity of the leg. Organ pulse and sensation and distal movements were normal. X-ray (Figure 1) and computed tomography (CT) scan (Figure 2) of the knee showed a torn tibial tuberosity fracture with joint surface involvement (Ogden type 3B).

Figure 1. Preoperative anteroposterior and lateral X-rays of the left knee

There was no compartment syndrome. The patient underwent surgery and the damaged part was fixed with a 4.5mm cannulated screw and washer, and the fixation was reinforced with 2 SwiveLock anchors (Figure 3).

After the operation, he was immobilized with a splint for up to 3 weeks, during which time isometric quadriceps exercise was performed, followed by SLR and ankle pump. Then, between the third and sixth weeks, weight-bearing was obtained with a crutch and gentle range of motion (ROM), and at the end of the sixth week, full weight-bearing and full ROM were obtained.

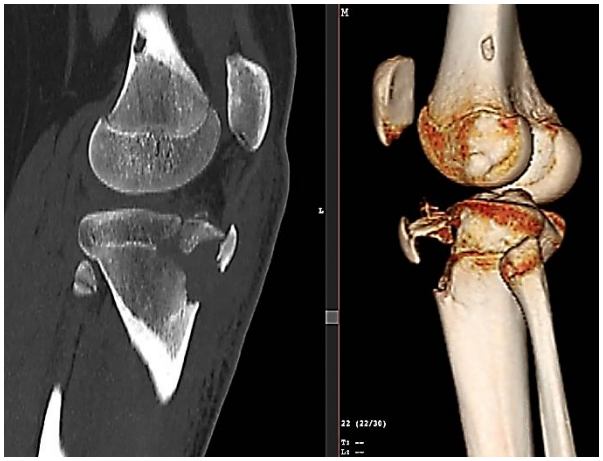

Figure 2. Preoperative computed tomography (CT) scan of the left knee

The School of Medicine, Golestan University of Medical Sciences, Gorgan, Iran, and the Department of Orthopedic Surgery both gave their approval for this study, which was carried out in accordance with the Declaration of Helsinki. Before deciding to publish the results, the patient's parents were told about the study and gave their informed consent.

The patient's parents gave their written informed consent for the publishing of this case report and any related pictures.

The Editor-in-Chief of this journal has a copy of the written consent for review.

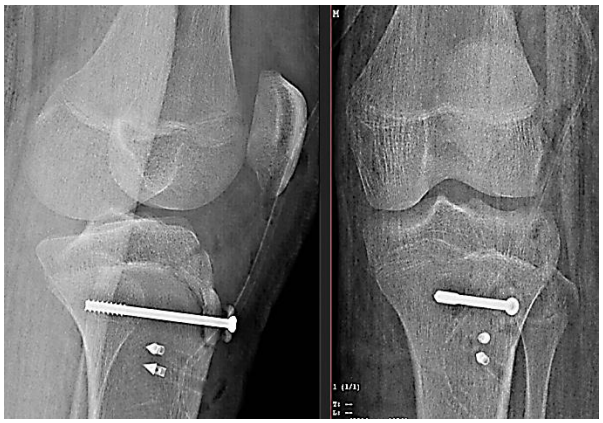

Figure 3. Post-operative anteroposterior and lateral X-rays of the left knee

Discussion

Ehrenborg has outlined the process of tibial tubercle formation (8). The cartilaginous stage lasts from birth to the ages of nine for girls and ten for boys, and it occurs before the secondary ossification center develops. The ossification center arises in the tongue of the cartilage that drapes over the anterior tibial metaphysis during the apophyseal stage, which comes after. The tubercle and epiphyseal bony union indicate the epiphyseal stage. The proximal tibia complete osseous formation occurs during the final bony stage. Evidence suggests that the physis closes in a regular manner (9-12).

The tibial tuberosity develops in traction as opposed to the proximal tibial epiphysis, which occurs in compression. The tuberosity is susceptible to fracture because the proximal tibial epiphysis shuts first in a manner distally to the tubercle apophysis and then posterior to the anterior direction.

The majority of TTAF cases are found in young males with a male-to-female ratio greater than 10:1 (13). The reason for the significant male preponderance with this injury is thought to be that males develop natural epiphysiodesis of the proximal tibia at a later age (6). Due to their greater stature and stronger quadriceps, guys have more traction loads on the tibial tubercle (13). Furthermore, the tibial apophysis is more susceptible because of the histological change that takes place in this age range of 13 to 16 years (13).

Greenstick or complete fractures of the proximal tibial metaphysis often affect youngsters between the ages of three and six. In contrast, teenagers are more likely to have a tibial tubercle fracture (14).

When the injury occurs with the knee in either a full extension or up to 30 degrees of flexion, TTAF without epiphysial fracture will result; with greater than 30 degrees of flexion, avulsion of both the tibial tuberosity and proximal tibial epiphysis will occur (15).

Tibial tubercle fractures have been linked to concomitant injuries such as meniscal tears, cruciate ligament laxity, patellar or quadriceps tendon avulsions, and compartment syndrome (16-18). However, in a recent systematic review of tibial tubercle fractures, low rates of tendon avulsion (2%), meniscal tears (2%), and cruciate ligament laxity (1%) were reported (7).

By using a lateral plain radiograph, tibial tubercle fractures are often identified. The tibia should be turned slightly internally during the lateral projection view to put the somewhat lateral tubercle perpendicular to the X-ray cassette, improving the diagnostic plain film's usefulness.

While patella alta may be more trustworthy in that comparison, contralateral films may be useful in differentiating between marginally displaced pieces and normal ossification.

A plexus of arteries located behind the patellar ligament at the point of attachment to the tibial tubercle provides the majority of the blood supply for the tubercle (19). With this fracture, the vascular anastomosis that originates from the anterior tibial recurrent artery may tear (20, 21). Although vascular compromise in isolated tubercle injuries is rare, it may be disastrous in cases of proximal tibial physeal fractures.

In terms of vascular injuries, bleeding into the anterior compartment from the anterior tibial recurrent artery, which crosses the base of the tubercle, is a possibility for TTAF. Through the onset of compartment syndrome, this vascular impairment is linked to indirect ischemia rather than direct ischemia (20).

With a 4% incidence, preoperative compartment syndrome is linked to this damage. Our patient, however, did not feel this. One explanation could be that we decompressed the compartment pressure by doing open reduction and fixation two days after the injury.

Patella baja, tense hamstrings, a history of Osgood-Schlatter disease (OSD), and conditions such as physeal abnormalities are among the risk factors (22).

Nineteen individuals with tibial tubercle fractures were studied by Riccio et al. The body mass index (BMI) at the time of follow-up averaged 28.8 (18.5-43.8) (23). According to Shin et al., there was insufficient data to conclusively demonstrate that having a high BMI would increase the risk of fractures. In their dataset, the average BMI was 24.3 (16.0-31.1) (24). The BMI in our case was 28 (19.2-34.3), which means overweight.

Genu recurvatum is suggested as a possible complication of tibial tuberosity fracture; however, there is just one case record describing this issue. Due to the timing of the fracture in relation to physiologic physiodesis, genu recurvatum is often not seen as a complication frequently linked with this fracture (6, 25).

When the extensor mechanism and joint surface are damaged, the therapy for tibial tubercle fractures is to repair them (26).

The literature-related treatments for TTAF differ according to the pattern of avulsion fractures: IIB and III AB categories are always addressed surgically, and IB categories are often treated orthopedically, with the exception of periosteum interposition instances. IA and IIA categories are operated inside closed reduction and cast immobilization, and a knee is held in extension for six weeks (22).

Avulsed fragments are first explored and reduced using anterior midline approach. After that, fixation with screws or pins may be accomplished, and the repair of torn periosteum can enhance the fix.

Despite the fact that a number of complications - including compartment syndrome, malunion, non-union, patella baja, fracture through internal fixation, and genu recurvatum - have been documented and may arise in the first year after surgery (7), considering the near-skeletal maturity of these individuals, these consequences are uncommon.

Conclusion

TTAF is a rare injury that should be considered in individuals approximately 15 years of age who experience sudden knee pain. In some cases, X-rays may not provide a complete assessment of the damage extent. Surgical fixation is a favorable choice for displaced fractures due to its lower complication rate and the achievement of excellent functional and clinical outcomes.

Conflict of Interest

The authors declare no conflict of interest in this study.

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