Adolescent Proximal Tibia Physeal Injury

Hasan Ceylan, Cem Yıldırım, Musa Korkmaz, Doğan Atlıhan, Mahmut Ercan Çetinus

Clinic of Orthopedics and Traumatology, Haseki Training and Research Hospital,İstanbul, Turkey

ABSTRACT

Proximal tibial growth plate injuries are one of the rare cases seen in adolescents. Acute complications, such as arterial damage and compartment syndrome, and also chronic complications, such as genu recurvatum, can be seen in these patients. In this review, we present the treatment and complications of 2 14-year-old patients, who were admitted to our emergency service as a result of acute trauma.

Keywords: Proximal tibia physeal injury, acute compartment syndrome, genu recurvatum

INTRODUCTION

Although knee traumas in children are commonly observed, cases of proximal tibial epiphyseal injuries are exceedingly rare (1). Proximal tibial physis is anatomically stable. It is laterally buttressed by the upper end of the fibula. On the front end, it spans downward from the tibial tubercle epiphysis to the adjacent metaphysis (2). Collateral ligaments attach to the metaphysis, and the epiphysis is protected from varus–valgus stresses. The cruciate ligament does not cause epiphyseal injury despite being attached to the epiphysis (3). Due to this protection, detachment of the proximal tibial epiphysis is rare and it requires significant force. In this review, we present two cases of proximal tibial epiphysis due to an extravehicular traffic accident and fall.

CASE REPORTS

Case 1

A 14-year-old male patient was admitted to our emergency polyclinic due to an extravehicular traffic accident. Swelling and widespread tenderness were present around the left knee. Ankle and first toe dorsiflexion were present. Tibialis posterior and dorsalis pedis arteries could be palpated. Capillary filing was normal. Bilateral radiograph showed that the tibial shaft was displaced posteriorly, and Salter Harris type II proximal tibial epiphyseal injury was detected (Figure 1). Initially, closed reduction and long leg bracing were performed for the patient under the conditions of the polyclinic. Closed reduction was unsuccessful; therefore, open reduction was performed under general anesthesia. The fracture gap was accessed via a longitudinal incision through the anteromedial left knee with the presence of a pneumatic tourniquet while the patient was lying in a supine position. The hip and knee were brought to 45° flexion, the proximal metaphysis was pulled toward the anterior side, and the fracture was reduced and stabilized via percutaneous Kirschner wires (two laterally and two medially) (Figure 2). Because the cruris anterior compartment was too stretched, clinically compartment syndrome was considered and long leg bracing was performed in extension via anterolateral fasciotomy. The patient underwent a 10-day negative pressure wound care treatment, and then, his wound was primarily closed. His braces remained for 6 weeks, following which knee exercises were started. Kirschner wires were removed on the 12th week, and full weight support was allowed. There were no problems in the patient's 15th-month examination, except a for 15° recurvation in the knee. Leg lengths were equal, and findings of the neurological examination were normal (Figure 3, 4). Written informed consent was obtained from the father of the patient.

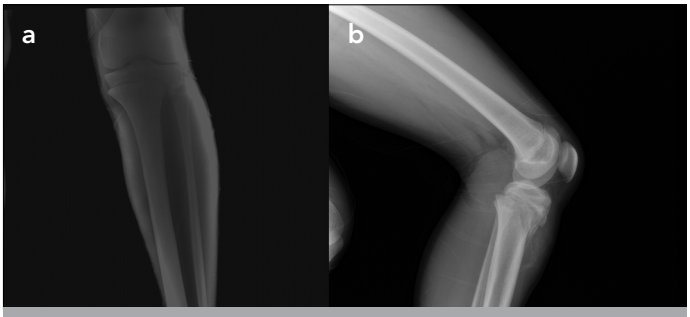

Figure 1. a, b. Direct radiography of the first case after trauma

Case 2

A 14-year-old male patient was brought to our emergency service by his relatives due to a fall. He had severe pain and sensitivity in his right knee. His bilateral radiograph revealed right tibial proximal end type II epiphysiolysis and fibula proximal diaphysis fracture (Figure 5). Findings of his neurovascular examination were normal. The patient underwent closed reduction and long leg bracing under sedation. Control radiography revealed that the reduction was unsuccessful, and detection via a percutaneous K-wire was planned. Close reduction was achieved under general anesthesia via two diagonal K-wires sent from the medial right knee to the fracture gap while the patient was lying in a supine position. The cruris anterior compartment was observed to be

Address for Correspondence: Hasan Ceylan
E-mail: drhasanceylan@gmail.com

Received Date: 01.08.2015 **Accepted Date:** 24.08.2015

DOI: 10.5152/jarem.2015.889

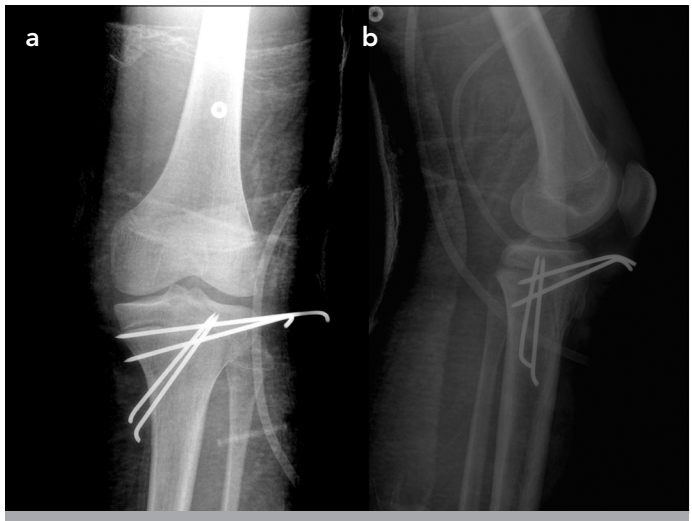

Figure 2. a, b. Radiography of the first case after early surgery

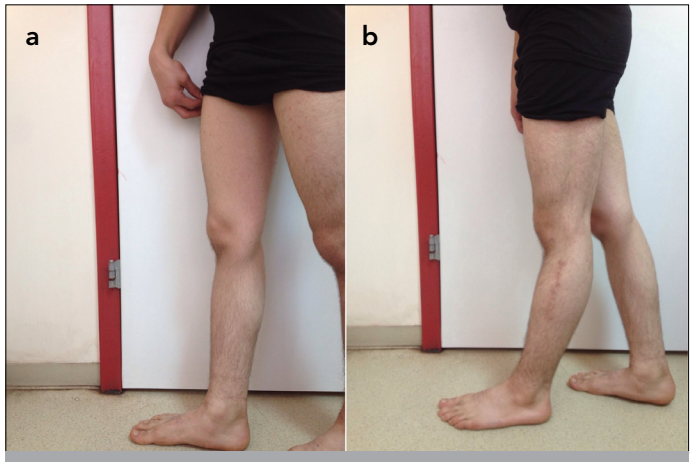

Figure 3. a, b. Clinical presentation at the 15th month, recurvatum

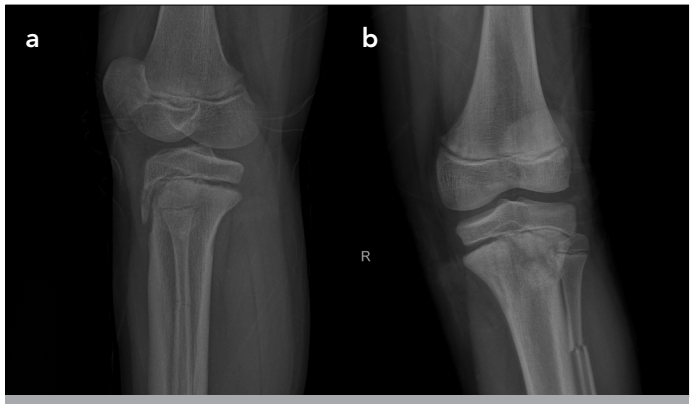

Figure 4. a, b. Direct radiography of the second case after trauma

stretched; therefore, inner anterior compartment pressure was measured via a digital monitoring system. Inner compartment pressure was measured to be 65 mm, and fasciotomy was decided. Fasciotomy was performed via an approximate anterolateral incision of 15 cm, and long leg bracing was performed for the patient. The patient received a 10-day negative pressure wound care treatment, and his fasciotomy area was closed with a split

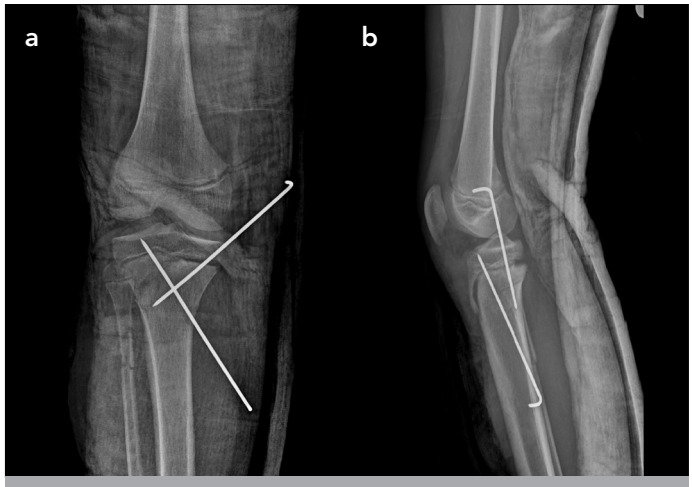

Figure 5. a, b. Radiography of the second case after early surgery

thickness skin graft obtained from the right anterior femur (Figure 6). The patient's braces remained for 6 weeks, and his wires were removed after 12 weeks. The patient had no complaints is his 6th-month examination. Range of motion of the joint was full, and findings of his neurological examination were normal. The patient is still under observation. Written informed consent was obtained from the father of the patient.

DISCUSSION

Proximal tibial epiphyseal injury cases are rare (4). They are usually encountered in adolescents in indirect traumas and during sports activities (5). The mechanism and type of injury vary depending on age. The most common injury mechanism is abduction–adduction trauma during childhood, and the most common injury mechanisms are hyperextension trauma and, despite being rare in late adolescence, flexion trauma of the knee between the ages of 10 and 12 years (5). Our first case involved hyperextension, while the second involved abduction–adduction trauma.

Proximal tibial epiphyseal injuries cause important complications. The most serious complication is arterial damage. The vascular injury rate is approximately 10% (6). The popliteal artery is close to the proximal tibia and the fibrous arch of the popliteal muscle. Therefore, injuries of the popliteal artery and its major branches can occur in proximal tibial epiphyseal injuries, in which the shaft is displaced posteriorly. Required vascular examinations and inspections must definitely be performed before and after the reduction. If an artery injury is detected and if it is treated within 6 hours, the extremity can be saved at a rate of 90%. If 8 hours or more time is elapsed, this rate decreases (7). Our patients' initial arterial pulse rate could be palpated, their emergency Doppler ultrasonographies were normal, and arterial pathologies were not observed in their follow-ups.

Another important complication is compartment syndrome. Compartment syndrome results in the disruption of the microcirculation of tissues following the pressure increase in closed osseofacial tissues (8). Tibial fractures are the most common causes of compartment syndrome in children, as is the case in adults (9). In the physical examination of compartment syndrome, findings such as tightness in the relevant compartment, severe pain in the passive movements of muscles passing along the compartment,

Figure 6. a, b. Scar tissue of the first case after fasciotomy and grafting

hyperesthesia, paresthesia, and pain disproportionate to injury are observed. However, classical findings of compartment syndrome may not be observed in children. A physician should keep three A's in mind: "anxiety", "agitation", and "increased analgesic need" (10). Devices that measure compartment pressure can be utilized in patients with limited cooperation, who are exposed to anesthetics, and who have neurological injuries (10). We performed fasciotomy because of severe tightness of the anterior compartment during the operation in the first case and because of the inner compartment pressure being 65 mmHg in the second case. Shelton et al. (3) encountered compartment syndrome in only one patient in their study consisting of 26 patients. Both our patients underwent emergency fasciotomy. Emergency fasciotomy ensures the decrease in inner compartment pressure, increase in venous flow, and tissue perfusion. Timely and sufficiently performed fasciotomies in children can yield perfect results (11).

In the 15-month follow-up of the first case, genu recurvatum was detected. Genu recurvatum deformity can be caused by Osgood–Schlatter disease (12), tibial tubercle avulsion (13), prolonged immobilization (14), skeletal traction (15), and femoral and tibial fractures (16). Histological structure of the proximal tibial growth plate is not uniform. The growth plate beneath the tibial tubercle is made of fibrocartilage tissue in order to decrease the stress caused by the patellar tendon (17). Similar to other regions, rest of the growth plate is made of hypertrophic columnar cells. The anterior fibrocartilage tissue is replaced with columnar cells during skeletal maturation, and this is the most vulnerable period to traumas. Physiologically, closing of the physis begins centrally and continues centrifugally, and the tibial tubercle physis closes the last. This maturation period is when physis is the most vulnerable to traumas, and proximal tibial traumas are reported the most during adolescence (18).

Similarly, in our case, an injury occurred during this maturation period, and anterior surgical open reduction and detection were performed. Genu recurvatum occurred as a result of damage incurred to the growth plate during the trauma or surgical treatment. Corrective osteotomy is being planned going forward.

CONCLUSION

With this case report, we wanted to emphasize on the necessity of considering these types of complications when treating proximal tibial epiphyseal injuries in adolescents.

Informed Consent: Written informed consent was obtained from the parents of the patients who participated in this case.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – H.C., M.K., D.A., C.Y., M.E.Ç.; Design – H.C., M.E.Ç.; Supervision – H.C., D.A.; Resources – C.Y., M.K.; Materials – M.K.; Data Collection and/or Processing – H.C., C.Y.; Analysis and/or Interpretation – H.C., M.E.Ç.; Literature Search – H.C., M.K.; Writing Manuscript – H.C.; Critical Review – M.E.Ç.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Burkhart SS, Peterson HA. Fractures of the proximal tibial epiphysis. J Bone Joint Surg Am 1979; 61: 996-1002. [CrossRef]
2. Aitken AP, Ingersoll RE. Fractures of the proximal tibial epiphseal cartilage. J Bone Joint Surg Am 1956; 38-A: 787-96. [CrossRef]
3. Shelton WR, Canale ST. Fractures of the tibia through the proximal tibial epiphyseal cartilage. J Bone Joint Surg Am 1979; 61: 167-73. [CrossRef]
4. Peterson HA. Proximal tibia. In: Epiphyseal growth plate fractures, Chap. 20. Springer, Berlin, 2007. p. 659.
5. Mubarak SJ, Kim JR, Edmonds EW, Pring ME, Bastrom TP. Classification of proximal tibial fractures in children. J Child Orthop 2009; 3: 191-7. [CrossRef]
6. Beaty JH, Kasser JR. Rockwood and Wilkins' fractures in children. 5th ed. Philadelphia: Lippincott; 2001. p. 1011-9.
7. Green NE, Swiontkowski MF. Skeletal trauma in children. 3rd ed.Philadephia: Saunders; 2003. p. 124-7.
8. Willis RB, Rorabeck CH. Treatment of compartment syndrome in children. Orthop Clin North Am 1990; 21: 401-12.
9. Flynn JM, Bashyal RK, Yeger-McKeever M, Garner MR, Launay F, Sponseller PD. Acute traumatic compartment syndrome in children: diagnosis and outcome. JBJS Am 2011; 93: 937-41. [CrossRef]
10. Bae DS, Kadiyala RK, Waters PM. Acute compartment syndrome in children: contemporary diagnosis, treatment and outcome. JPO 2001; 21: 680-8. [CrossRef]
11. Gorczyga JT, Roberts CS, Prigh KJ, Ring D. Review of treatment and diagnosis of acute compartment syndrome of the calf: current evidence and best practices. Instr Course Lect 2011; 60: 35-42.
12. Jeffreys TE. Genu recurvatum after Osgood–Schlatter's disease, a case report. J Bone Joint Surg [Br] 1965; 47B: 298-9.
13. Ogden JA, Tross RB, Murphy MJ. Fractures of the tibial tuberosity in adolescents. J Bone Joint Surg [Am] 1980; 62A: 205-15. [CrossRef]
14. Botting T, Scrase WH. Premature epiphyseal fusion at the knee complicating prolonged immobilization for congenital dislocation of the hip. J Bone Joint Surg [Br] 1965; 47B: 280-2.
15. Van Meter JW, Branick RI. Bilateral genu recurvatum after skeletal traction. A case report. J Bone Joint Surg [Am] 1980; 62A: 837-9. [CrossRef]
16. Bowler JR, Mubarak SJ, Wenger DR. Tibial physeal closure and genu recurvatum after femoral fracture: occurrence without a tibial traction pin. J Pediatr Orthop 1990; 10: 653-7. [CrossRef]
17. Ogden JA, Southwick WO. Osgood–Schlatter's disease and tibial tuberosity development. Clin Orthop 1976; 116: 180-9.
18. Mizuta T, Benson WM, Foster BK, Paterson DC, Morris LL. Statistical analysis of the incidence of physeal injuries. J Pediatr Orthop 1987; 7: 518-23. [CrossRef]