

Popliteal artery thrombosis resulting from a fracture of the proximal tibial epiphysis in a 12-year-old boy

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ABSTRACT

Proximal tibial epiphyseal fractures in children are very rare but the association to vascular complications in these types of injuries is notoriously known. However, the insidious presentation of popliteal vascular trauma especially in children can often be overlooked leading to limb-threatening ischemia. We describe a rare case of a 12-year-old boy, involved in a car accident, with popliteal artery thrombosis caused by intimal disruption, complicating a Shalder-Harris type I fracture of the proximal tibial epiphysis. Although capillary refill was less than 2sec in both feet, ipsilateral distal leg pulses were absent. The patient was treated with closed reduction and stabilization of the fracture. A reverse great saphenous vein graft was successfully used to replace the injured popliteal artery segment. In such injuries, a high index of suspicion for vascular trauma should be maintained even in a warm foot. Asymmetry of distal pulses necessitates further investigation of the arterial network. Prompt diagnosis and treatment of the fracture and vascular injury will allow limb salvage.

KEY WORDS: proximal tibial epiphysis fracture; popliteal artery thrombosis; compartment syndrome

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1. Introduction

Usually what we call epiphyseal fractures are fractures through the epiphyseal growth plate, also known as physis. The fracture line usually passes through the hypertrophic zone of the physis which is the weakest from a bio-mechanical point of view. Physeal injuries are commonly classified according to Shalder-Harris classification [1]. Physeal injuries represent 15-30% of all fractures in children [2]. However, the incidence of proximal tibial epiphyseal fractures accounts for only 0.5-3% of all epiphyseal fractures [2, 3]. A possible explanation is that the proximal tibia epiphysis does not receive any ligamentous or tendinous attachments and any stresses are transmitted directly to the metaphysis [4]. Thus, these types of fracture should be considered as the result of high energy trauma potentially associated with neurovascular complications [5]. Shelton et al. in 1979 reported on 39 fractures of the tibia involving the proximal tibial epiphyseal cartilage, treated over a twenty-five-year period [6]. Two patients had disruption of the popliteal artery. In 1991 Wozasek et al., reported on 30 injuries involving the proximal tibial epiphysis, treated during a period of 28 years [5]. In their series, 3 patients presented with peripheral ischemia on admission. In sharp contrast, proximal tibia metaphyseal fractures in children are considered as low energy injuries [7]. Although blunt traumatic vascular injuries in children are relatively rare they carry a high risk of surgical intervention and contribute to significant morbidity if not diagnosed and managed early [8,9,10]. We present the case of a twelve year old boy who suffered a popliteal artery thrombosis resulting from a proximal tibial epiphyseal fracture. The patient's parents were informed that data concerning the case would be submitted for publication and they provided consent.

2. Case Report

A 12-year old boy was involved in a car accident and sustained an anterior shear injury to his left knee. Plain x-rays revealed a trans-epiphyseal fracture of the proximal tibia with anterior and medial displacement of the distal segment. Closed reduction was performed under general anesthesia and the knee was

immobilized in a plaster. Twenty hours after injury, the patient complained for paresthesias and pain of his right leg and foot and transferred to our institution for further evaluation and treatment. At presentation (24 hours after accident) the patient complained for increasing pain of his right leg. On clinical examination he had hypoesthesia of the foot in the distribution of the peroneal and the tibial nerve, and absence of foot pronation and active dorsiflexion of the ankle and toes. The foot was warm and pink colored, however popliteal artery, posterior tibial and dorsalis pedis artery pulses were not palpable. Monophasic Doppler signal could be detected in the posterior tibial artery. Capillary refill of both feet was less than 2 seconds. The angiography revealed above knee popliteal artery occlusion (**Fig.1A**). Delayed images showed reconstitution of the anterior, posterior tibial and the peroneal artery distal to the trifurcation, *via* poor genicular collateral branches (**Fig.1B**). The extension of the arterial lesion could not be identified because of an apparent prograde and retrograde thrombosis. X-ray evaluation revealed a Salter Harris Type I proximal tibial epiphysis fracture. On the lateral and anterior-posterior knee X-rays, a 5 mm posterior-lateral displacement of tibial metaphysis at the fracture site was noticed.

Under general anesthesia and supine position of the patient, the fracture was anatomically re-reduced, under fluoroscopy control, with the knee placed in full flexion. The fracture was stabilized with two 2.4mm crossing Kirschner wires (KW) (**Fig. 2**). No significant ligamentous instability was detected under manipulation. An external fixator was applied at the anterior-lateral side spanning the knee in order to temporarily stabilize the knee joint and fracture and provide a stable joint for vascular dissection and repair. With the patient in prone position and through a posterior S-shaped incision the popliteal space was explored. The gastrocnemius heads for 2-3 cm proximal and distal to the level of the fracture were severely traumatized, with muscle mass loss. The posterior tibial nerve was contused with epineural hematoma infiltration. The popliteal artery was thrombosed at the level of the knee joint line for a 7 cm length distally. An intimal disruption was extended for 3 cm. Thrombectomy

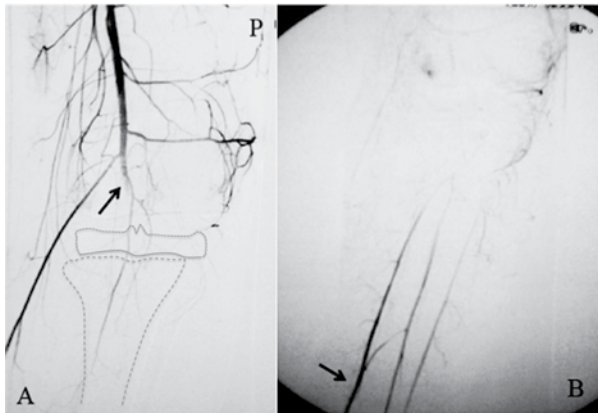


Fig 1. Occlusion of the popliteal artery above the knee joint line (arrow). The collateral circulation is sustained by genicular branches. P: proximal B: Peripheral refilling of the tibial arteries by collateral circulation. Posterior tibialis artery (arrow)

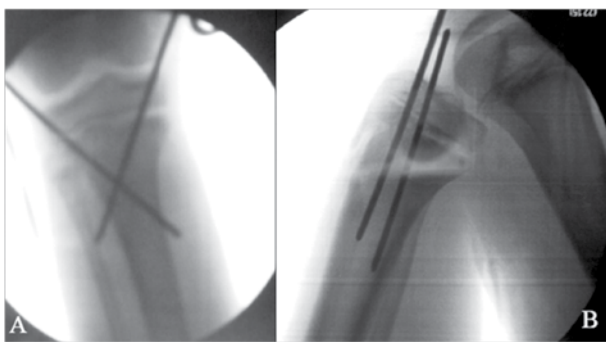


Fig 2. A: Anteroposterior intraoperative x-ray. A: Two crossing KWs stabilize the fracture. B: lateral intraoperative x-ray. The fracture is anatomically reduced with full knee flexion

of the posterior tibial artery was performed and slow blood back flow was noticed. Vascular repair was performed with interposition of a 5 cm reversed great saphenous vein graft, bypassing the injured part of the artery. Both proximally and distally, an end-to-end anastomosis was performed, with 6-0 polypropylene interrupted suture. Fasciotomy of the four compartments of the tibia was also performed. However the muscles of the anterior compartment were not responding to electrical stimulation. Immediately post-operatively a dorsal pedal and posterior tibial artery biphasic flow was detected by Doppler and in the second post-operative

day there were palpable pulses. The 3rd post-operative day the patient developed necrosis of the muscles of the anterior and lateral compartment complicated by infection and high fever. Multiple surgical debridement procedures were undertaken resulting in complete resection of soft tissues of the anterior and lateral compartment including peroneal nerve and tibialis anterior artery. Thirty days post op the patient had well healed incisions and the external fixator was removed. Ten days later the epiphyseal fracture was considered healed and KWs were removed too.

The ultrasound color Doppler performed 3 and 12 months later, showed a patent graft without stenosis. At 12 months follow up there was a 30 mm leg length discrepancy, resulting from premature closure of the femoral and tibial physis around the knee. The patient had 110° knee flexion and full extension. Equinus – varus deformity of the foot resulted from the unopposed action of the tibialis posterior tendon, despite the use of foot-ankle orthoses. The patient underwent Achilles tendon lengthening and anterior transfer of the posterior tibialis tendon at the age of 14 years and is currently walking with a shoe lift to compensate for the 3.5 cm leg length discrepancy.

3. Discussion


The Salter-Harris type I fracture epiphysiolsis of this case represents an equivalent to antero-lateral knee dislocation injury, stretching the popliteal artery, the tibial and the peroneal nerves and can severely threaten the leg's viability. The popliteal vessels are tethered by fibrous attachments around the knee joint at the exit of the Hunter's canal and at the upper tibial metaphysis by the soleus tendinous arch [2]. Depending on the mechanism of injury, an epiphyseal fracture even with small displacement of the distal fragment can compress the popliteal artery and jeopardize arterial flow. The severe antero-lateral translation, as in this case, stretched the artery to a degree where the intima was ruptured, the peroneal nerve sustained severe intraneural damage and the gastrocnemius heads severely contused with muscles mass loss. The collateral genicular vessels around the knee joint, if not damaged, can provide adequate blood supply for the leg and foot skin, but inadequate for the deep tissues.

Pediatric vascular injuries differ from adult injuries in several aspects. Pediatric injuries are more difficult to detect due to insidious presentation of blunt vascular trauma [12]. In the setting of acute popliteal artery occlusion, the important clinical question is if this collateral circulation can provide adequate blood supply and oxygen for all bone and soft tissue, thus permitting limb salvage. However children's nerves and muscles are considered more susceptible to ischemia than adult's tissues [13]. In the presence of other significant bone or nerve injuries a thorough vascular evaluation, in a seemingly perfused leg, might be neglected [12]. Aitkin et al. underlined the critical importance of earliest possible reduction [11].

Minimal injuries, as endothelial disruption could be asymptomatic and heal spontaneously, but larger intimal flaps could later result in thrombus formation and ischemia. Any delay in diagnosis of arterial insufficiency and treatment after 6 hours could irreversibly affect limb viability, therefore close monitoring with repeated examination of the patient and its leg is mandatory [12,14,15,16]. Arterial spasm of the small size vessels is common feature in childhood, and this can further complicate the diagnosis of a vascular injury [12,14,17].

The described patient had a seemingly well perfused leg with pink skin and less than 2 sec capillary refill at the pulp of the toes. The posterior tibial artery at the ankle level and dorsalis pedis was not palpable but monophasic blood flow was detected. Clinically, the collateral circulation provided enough blood supply to the skin of the leg, the foot and the toes but not to the deeper musculature.

The hallmark of an ischemic anterior and lateral compartment syndrome is pain that becomes intolerable with plantar flexion, not relieved by analgesic medication [18]. Additionally, revascularization after prolonged ischemia triggers the development of reperfusion injury to the ischemic tissues of the compartment [16]. Nerve dysfunction is also an early symptom of compartment syndrome [18]. In our case, the sensory deficit expressed with paresthesias and hypesthesia in the distribution of peroneal and tibial nerve, could be the result of direct nerve trauma during the initial injury. However the progressive nature of neural symptoms in association to increasing leg pain supported the clinical diagnosis of compartment syndrome. The anterior and lateral compartments were more severely affected and developed complete muscle necrosis.

In conclusion, proximal tibia epiphyseal fractures should be clearly distinguished from the innocuous proximal metaphyseal fractures in children. Epiphyseal fractures at this location are high energy injuries and can be accompanied by severe neurovascular damage. In clinical practice, these injuries should be regarded as equivalent to a knee dislocation and managed as a true emergency. A pink pulseless foot, even if Doppler examination demonstrates blood flow, should immediately raise the suspicion of vascular occlusion necessitating angiography and exploration to maximize the opportunity for limb salvage and to decrease subsequent complications. 

Conflict of interest:

The authors declared no conflicts of interest.

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Kontogeorgakos VA, Drakou AA, Argyriou C, Rigopoulos N, Giannoukas AD, Malizos KN. Popliteal artery thrombosis resulting from a fracture of the proximal tibial epiphysis in a 12-year-old boy. *Acta Orthop Trauma Hell* 2017; 68(1): 30-34.

ΠΕΡΙΛΗΨΗ

Σε αντίθεση με τα κατάγματα της εγγύς μεταφύσεως της κνήμης, τα κατάγματα δια της εγγύς επιφύσεως της κνήμης στα παιδιά είναι αρκετά σπάνια και είναι γνωστή η συσχέτισή τους με αγγειακές κακώσεις. Η προοδευτική εξέλιξη των σημείων της θρομβώσεως της ιγνυακής αρτηρίας μπορεί εύκολα να παραβλεφθεί στα παιδιά και να οδηγήσει σε απειλητική για το άκρο ισχιαμία. Περιγράφουμε την περίπτωση ενός αγοριού 12 ετών, που τραυματίστηκε σε τροχαίο ατύχημα και υπέστη κάταγμα δια της εγγύς επιφύσεως της κνήμης τύπου Shalder-Harris I και συνοδό θρόμβωση της ιγνυακής αρτηρίας λόγω κάκωσης του ενδοθηλίου. Παρότι η τριχοειδική επαναφορά ήταν μικρότερη των 2 δευτερολέπτων και στα δύο πόδια, στο τραυματισμένο άκρο δεν υπήρχαν ψηλαφητές περιφερικές σφύξεις. Ο ασθενής αντιμετωπίστηκε με κλειστή ανάταξη της παρεκτόπισης του κατάγματος και σταθεροποίηση με 2 χιαζόμενα KW. Η αποκατάσταση της ιγνυακής αρτηρίας έγινε με τη χρήση ανεστραμμένου μοσχεύματος σαφηνούς φλέβας. Σε κακώσεις εγγύς επιφύσεως της κνήμης στα παιδιά πρέπει να υπάρχει υψηλός δείκτης υποψίας αγγειακής κάκωσης ακόμα και όταν το άκρο εμφανίζεται ζεστό με τριχοειδική επαναφορά. Σε ασυμμετρία ψηλαφητικού περιφερικού σφυγμού στα κάτω άκρα πρέπει να γίνεται περαιτέρω διερεύνηση του αγγειακού δικτύου. Η έγκαιρη διάγνωση και θεραπεία της οστικής και αγγειακής κάκωσης επιτρέπει την διάσωση του σκέλους.

ΛΕΞΕΙΣ ΚΛΕΙΔΙΑ: κατάγματα κνημιαίων κονδύλων, θρόμβωση ιγνυακής αρτηρίας, σύνδρομο διαμερισματος