Arteriovenous fistula formation after a closed proximal tibial fracture in a child

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Arteriovenous fistula formation after a closed extremity fracture is rare. We present the case of an 11-year-old boy who developed an arteriovenous fistula between the anterior tibial artery and popliteal vein after closed fractures of the proximal tibia and fibula. The fractures were treated by closed reduction and casting. A fistula was diagnosed 12 weeks after the injury. It was treated by embolisation with coils. Subsequent angiography and ultrasonography confirmed patency of the popliteal vein and anterior and posterior tibial and peroneal arteries, with no residual shunting through the fistula. The fractures healed uneventfully and he returned to full unrestricted activities 21 weeks after his injury.

Arterial injuries associated with fractures of long bones are uncommon, with a reported incidence of 0.28%.1 A vascular injury associated with a significantly displaced or open fracture is usually recognised acutely and treated accordingly.1,2 Vascular injuries associated with blunt trauma and minimally displaced, closed fractures are rare and may not be apparent on initial assessment. The three major delayed vascular injuries with long bone fractures are false aneurysm, arteriovenous fistula and thrombosis.1,2 The effects of an untreated arteriovenous fistula in an extremity include aneurysmal dilatation of the involved artery and vein, limb-length discrepancy, congestive heart failure and limb ischaemia.3 The treatment of an arteriovenous fistula of the extremity can involve interventional radiological procedures, such as embolisation, or operative intervention to ligate the abnormal arteriovenous connections, with grafting as necessary.4-6

We present an unusual case of an 11-year-old boy who developed an arteriovenous fistula after closed fractures of the proximal tibia and fibula. The vascular injury was recognised 12 weeks after the injury and treated successfully by embolisation with coils inserted through a microcatheter.

Case report
An otherwise healthy 11-year-old boy was brought to the emergency room having been struck by a car travelling between 10 mph and 20 mph, while riding his bicycle. He was haemodynamically stable and complaining of pain in his right leg. Plain radiographs showed mildly displaced fractures of the proximal tibia and fibula (Fig. 1). This was a closed injury and there was no neurovascular abnormality. The leg was splinted and frequent clinical examinations were undertaken throughout the night to monitor for compartment syndrome. The neurovascular status remained unchanged. He underwent closed manipulation and casting on the following day. The fracture was unstable and reduction was achieved by keeping the knee extended and applying extension and varus stress to the proximal tibia. As such fractures may heal with a valgus deformity,7,8 he was followed closely with serial radiographs.

The reduction was maintained in the cast, which was converted to a hinged knee brace at six weeks after injury. At a routine visit 12 weeks after the injury, his mother reported that he had persistent swelling of the right leg. He was weight-bearing comfortably in the brace, with no limitation of movement. Neurovascular examination of the right leg was normal, with capillary refill < two seconds.

Fig. 1
Anteroposterior (left) and lateral (right) radiographs of the initial fractures of the proximal right tibia and fibula.
Fullness was noted around the proximal tibia and popliteal fossa, where a thrill was palpated and a bruit heard on auscultation. Radiographs showed the fractures to be healing in satisfactory alignment. Doppler sonography demonstrated a direct communication between the anterior tibial artery and popliteal vein, with abnormal, low resistance arterial flow within the artery, turbulent phasic venous flow within the vein and turbulent flow increasing and decreasing in magnitude around a steady baseline flow rate within the fistulous tract (Fig. 2). There was oedema around the fistula but the more distal arteries and veins, including the peroneal and anterior and posterior tibial vessels, were patent, with normal arterial flow.

A CT angiogram was performed to define the position of the fistula relative to the trifurcation (Fig. 3). This revealed a tortuous set of vessels, characteristic of a direct communication between the right anterior tibial artery and popliteal vein, approximately 6 cm below the tibial plateau. The fistula drained via a sizeable vein into the popliteal vein, causing the popliteal and femoral veins to fill in the arterial phase. The popliteal artery divided into the anterior tibial artery and tibioperoneal trunk approximately 5.3 cm above the fistula. The tibioperoneal trunk divided normally into the posterior tibial and peroneal arteries 1 cm distal to the fistula, with normal runoff to the ankle and foot.

A total of five weeks after the diagnosis of the fistula and 17 weeks from the injury, angiography confirmed a 9 mm fistulous tract between the right anterior tibial artery and adjacent popliteal vein (Fig. 4). A microcatheter was passed into the tract using a 0.016 inch microwire. Through this catheter, five coils were used to embolise the fistula (Fig. 5). During the procedure several arteriograms and venograms were performed to ensure patency of the right anterior tibial artery and right popliteal vein. There was no residual shunting through the fistula following embolisation and the popliteal vein and anterior tibial, posterior tibial, and peroneal arteries were patent.

On examination four weeks later, the right leg was much less swollen and there was no pain or tenderness. The superficial veins were still a little more noticeable on the right leg than the left, but the overall diameter of the right was the same as the left and the pedal pulses were equal on both sides. Doppler sonography confirmed the absence of recurrence of the fistulous tract and radiographs showed satisfactory healing of his fractures, with the coils visible at the site of the fistula (Fig. 6). At the most recent follow-up 34 weeks post-injury, he had resumed his usual activities including ice hockey, snowboarding and gymnastics without difficulty. His lower limbs were symmetrical on clinical examination and a Doppler scan showed no evidence of recurrence of the fistula. He will be followed up until skeletal maturity.

**Discussion**

It is rare for patients with a closed fracture to have a late vascular complication, such as an arteriovenous fistula. Bowers et al reported three cases of traumatic lower extremity arteriovenous fistulae in children. Two of these
followed an operation, one for exertional compartment syndrome and the other for a slipped capital femoral epiphysis. The third involved a closed distal tibial fracture. In contrast to our patient, this fracture was completely displaced with a compartment syndrome and required fixation and fasciotomies. The traumatic arteriovenous fistula was discovered intra-operatively. Apart from that case, arteriovenous fistula formation after a closed tibial fracture has been described in isolated reports, most of which were recorded about 20 years ago or more. Although our patient’s fractures were minimally displaced at the time of presentation, this was a high-energy accident and at the moment of injury the fractures may have been significantly displaced, with associated risk to vessels. This is borne out by the location and configuration of the fractures, along with the observation that they were unstable under anaesthesia.

There is no report of an association between a proximal tibial metaphyseal fracture in childhood, the so-called Cozen fracture and an arteriovenous fistula. The most common complication from this fracture is a valgus deformity.

The unusual presentation of our patient’s delayed vascular complication highlights the need for continued clinical vigilance after any extremity trauma.

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References

Fig. 5
Angiogram showing coils being inserted into the arteriovenous fistula.

Fig. 6
Anteroposterior (left) and lateral (right) radiographs of the right leg 21 weeks post-injury, showing healed fractures and embolisation coils in place.