IRREDUCIBLE FRACTURE-SEPARATIONS OF THE DISTAL TIBIAL EPIPHYSIS

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Three cases of a rare complication of Salter Type II fracture-separations of the distal tibial epiphysis are described. Interposition of the anterior tibial neurovascular bundle between the displaced epiphysis and the lower tibia prevented reduction and, in two patients, the blood supply to the foot was compromised. Open reduction and internal fixation resulted in a satisfactory outcome in each case.

The numerous reports of traumatic separations of the distal tibial epiphysis in the literature bear testimony to the frequency of this injury (Bishop 1932; Carothers and Crenshaw 1955; Bartil 1957; Kleiger and Mankin 1964; Duhaime et al. 1972). Surprisingly, the prevention of accurate reduction of the fragments by the interposition of soft tissue has only been described once (Johnson and Fahl 1957). This paper describes three fracture-separations of the distal tibial epiphysis, all of which were complicated by the interposition of soft tissue, including the anterior tibial neurovascular bundle, which prevented reduction.

CASE REPORTS

Case 1. A 16-year-old motorcyclist collided with a car and injured his right ankle. His ankle was swollen and deformed and although the circulation to the toes appeared satisfactory, the dorsalis pedis pulse was impalpable. Radiographs showed a Salter Type II fracture-separation of the distal tibial epiphysis with posterior displacement, together with an undisplaced spiral fracture of the lower fibula. The medial malleolus was also fractured with minimal displacement (Figs 1 and 2).

Manipulative reduction under general anaesthesia was attempted, but it resulted in blanching of the foot which persisted until the fracture was allowed to redisplace. Exploration of the fracture through an anterior approach revealed that the anterior tibial vessels and the anterior tibial nerve were being compressed between the fragments as reduction was attempted. Furthermore, the extensor retinaculum together with some small detached fragments of bone and periosteum were interposed. Clearance of the soft tissues and isolation of the neurovascular bundle enabled accurate reduction to be achieved, and internal fixation was carried out (Figs 3 and 4). The circulation to the foot was restored, but swelling precluded primary closure of the wound. Secondary suture was performed at seven days and the wound was fully healed at four weeks. One year later, the ankle had normal function.

Case 2. A 13-year-old schoolboy was knocked off his bicycle by a motorcyclist. His right ankle was grossly deformed and swollen; radiographs showed a severely displaced Type II injury to the distal tibial epiphysis, together with a comminuted transverse fracture of the fibula. The sharp, subcutaneous shaft of the tibia was stretching the anterior skin but did not pierce it. The foot was dusky in colour and both distal pulses were absent, but there was no neurological deficit.

Adequate closed reduction was impossible and the ankle was explored operatively. The tendons of tibialis anterior and extensor hallucis longus, together with the neurovascular bundle, were found to...
be bowstrung between the displaced fragments and were blocking reduction. These structures were hooked clear of the fracture and accurate reduction and internal fixation was carried out. The skin was sutured primarily, but the clinical progress was marred by a delay of three months in the healing of the wound. One year later the result was excellent.

**Case 3.** A 16-year-old boy injured his right ankle when a moped struck him from behind. In view of the gross deformity at presentation, the casualty officer reduced the ankle immediately. Subsequent radiographs showed a Type II injury to the distal tibial epiphysis with a comminuted spiral fracture of the fibula.

Manipulation under anaesthesia using an image-intensifier resulted in an imperfect reduction. Open reduction was not considered because of the swelling, but the vascular supply to the foot was unimpaired. Radiographs taken after the ankle had been elevated for five days showed further loss of position of the fracture. A second closed reduction failed, and exploration of the injury confirmed interposition of the periosteum and the neurovascular bundle. Internal fixation was achieved after clearance of the interposed soft-tissues. Primary closure of the skin was followed by an uneventful recovery.

**PATHOLOGICAL ANATOMY**

In order to demonstrate the precise mechanism by which interposition of soft tissue may occur in this type of injury, an ankle from a cadaver of a 16-year-old boy was studied. The distal tibial epiphysis was cleaved with an osteotome which reproduced exactly a Type II fracture-separation with its large posterior metaphysial bone "spike". The lower fibula was also divided. With external rotation and abduction of the distal fragment, the structures lying in front of the ankle, namely the tibialis anterior tendon, the neurovascular bundle and the extensor hallucis longus tendon could be dislocated around the anterolateral margin of the lower tibia. In this displaced position, they could easily become interposed when reduction of the fracture was attempted (Figs 5 to 7).

**DISCUSSION**

Interposition of soft tissue appears to be an uncommon complication of epiphysial separations at the ankle. The three patients described illustrate that interposition may preclude accurate closed reduction. Furthermore,
attempted closed reduction may compromise the blood supply to the foot.

Despite the clarity of the pathological anatomy described in these patients, a clinical diagnosis of interposition cannot be made with confidence. Failure to achieve an accurate closed reduction may imply soft-tissue obstruction and, moreover, loss of the dorsalis pedis pulse during manipulation should raise suspicion of arterial interposition. Signs of neurapraxia of the anterior tibial nerve were not observed in these patients.

It might be expected that interposition occurs more frequently in fractures that are severely displaced but radiographs may grossly underestimate the magnitude of the original displacement. In the three patients described, the average degree of displacement recorded as a percentage of the total epiphysial width was 31 per cent, whilst in a series without apparent interposition, the average displacement was 27 per cent (Carothers and Crenshaw 1955).

Internal fixation near the growth plate has obvious hazards, and extreme care should be taken in placing the screws (see Figures 3 and 4). Not surprisingly, delayed healing of the wound due to severe swelling was observed in the two patients who underwent primary open reduction. Study of the pathological anatomy of these three cases implies that open reduction may occasionally be indicated in a common injury which is traditionally treated by closed methods (Salter and Harris 1963).

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REFERENCES