Tibial and fibula fractures

Anatomy and function

The tibia is the main bone of the lower leg. The diaphysis is triangular in cross section with an anteriorly directed apex. The medial border of the tibia lies subcutaneously. Proximally it articulates with the distal femur at the knee joint and distally with the talus at the ankle. It allows the limb to weight bear, acts as a lever arm for the calf muscles and helps transmit the neurovascular structures to the ankle and foot.

The fibula is the lesser bone on the lateral aspect of the leg. It plays no role in the knee joint but has an important role in ankle stability. The fibula is attached to the tibia by an interosseous membrane. The common peroneal nerve winds around the neck of the fibula and is not infrequently injured in proximal fibula fractures.

The calf is divided into four compartments by intermuscular septums: anterior, lateral, deep posterior and superficial posterior. These form separate musculofascial compartments each with its individual neurovascular structures (*Figure 1*, *Table 1*). Knowledge of these compartments is essential in the diagnosis of compartment syndrome (see below).

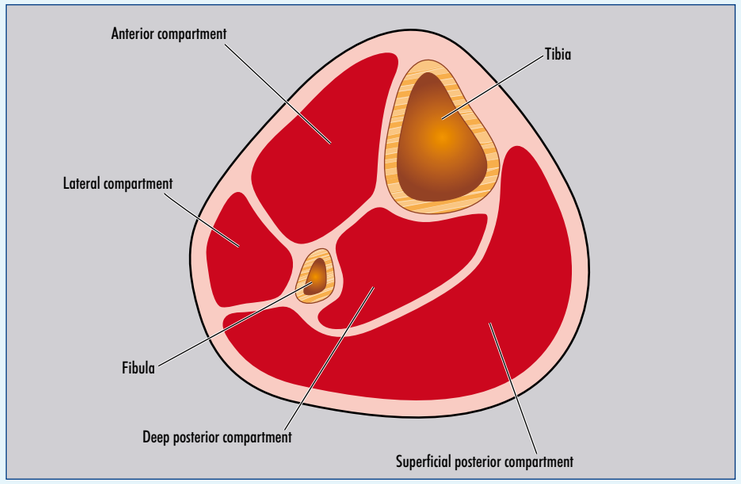


Figure 1. Cross section of calf showing musculofascial compartments.

Mechanism of injury

The tibia is the commonest diaphyseal fracture with an incidence of approximately 2 per 10 000 population. The mechanism of injury varies. It can be as simple as a fall with a twisting force to road traffic accidents, sports accidents (football, skiing) or crush injuries. Direct blows result in transverse fractures with or without butterfly fragments, twisting injuries cause spiral fractures. It is important to differentiate early between low and high-energy injuries. The former tend to be more benign and have a better prognosis than the latter which may be associated with multiple injuries sustained by the patient and have a more sinister prognosis based on the degree of soft tissue injury sustained.

Ms Claire F Young *is Clinical Fellow in the Division of Orthopaedic Surgery, London Health Sciences Centre – University Campus, London, ON, N6A 5A5, Canada and*
Mr Fares Haddad *is Consultant Orthopaedic and Trauma Surgeon, Department of Trauma Surgery, Middlesex Hospital, London*

Correspondence to: Ms CF Young

Clinical picture

Patients usually present with a history of trauma, following which they have pain in the lower leg, are unable to weightbear, have limb instability and may or may not have a deformed limb.

Initial assessment involves determining whether it is an isolated injury or part of multiple injuries sustained by the patient. Is the injury open or closed (see below)? The distal neurovascular status of the limb needs to be assessed documenting the presence or absence of both the dorsalis pedis and posterior tibial pulses. If pulses are absent then Doppler assessment of flow in the vessels is required.

Anteroposterior and lateral radiographs of the limb confirm the nature of the injury. The images need to include the knee joint and the ankle joint on the same film to determine if any rotational deformity to the fracture is present (*Figure 2*).

Classification

Tibial fractures are classified descriptively according to:

Table 1. Muscle groups contained in each lower leg compartment

Compartment	Muscles	Function	Sensory distribution
Anterior	Tibialis anterior Extensor hallucis longus Extensor digitorum communis Peroneus tertius	Toe and ankle dorsiflexion	First and second dorsal web spaces (deep peroneal nerve)
Lateral	Peroneus brevis Peroneus longus	Ankle eversion	Lateral dorsum of foot (superficial peroneal nerve)
Superficial posterior	Gastrocnemius Soleus Plantaris	Ankle plantar flexion	Lateral side of heel (sural nerve)
Deep posterior	Flexor digitorum longus Flexor hallucis longus Tibialis posterior	Toe plantar flexion Ankle inversion	Sole of foot (posterior tibial nerve)

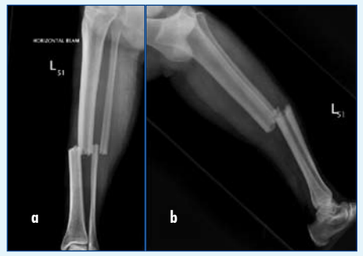
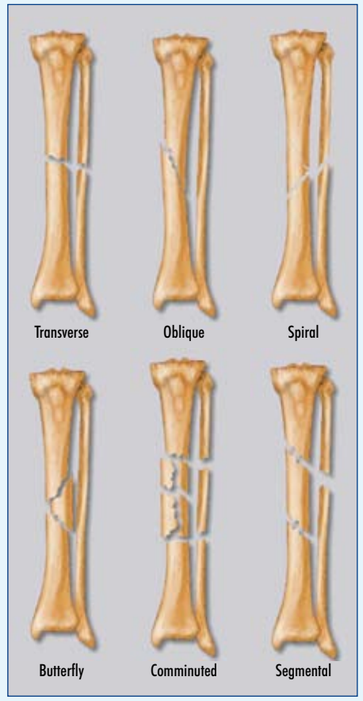


Figure 2. a. Anteroposterior (AP) and (b) lateral radiographs of transverse fracture of the middle third of the left tibia. Note associated rotational deformity and knee dislocation (lateral view of ankle joint with AP view of dislocated knee joint on same film).

1. Open or closed
2. Geographical location in bone (proximal, middle or distal third)
3. Fracture geometry (transverse, oblique, spiral, segmental) (*Figure 3*)
4. Displacement, angulation, rotational deformity of fracture fragments.

Open fractures are classified according to Gustilo and Anderson (1976):

Figure 3. Diagrammatic representation of fracture geometry.



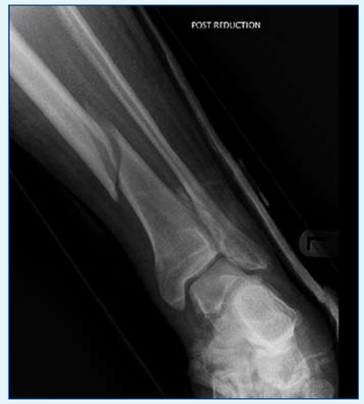
Grade I A wound less than 1 cm
Grade II A wound less than 10 cm
Grade III A wound greater than 10 cm (a high energy injury, a highly contaminated wound or underlying segmental fracture).

Grade III is subdivided into:
A Adequate soft tissue coverage possible
B Massive soft tissue disruption
C Associated vascular injury.

Initial management

The patient requires appropriate analgesia, reduction and immobilization of the fracture. A backslab should be applied from midthigh to toes with the knee flexed approximately 20° and the ankle at 90° to the tibia. The plaster slabs should comprise one along the back of the thigh and calf running onto the sole of the foot and one running as a U-slab along both sides of the leg to give rotational stability to the splint. The patient requires further radiographs following plaster application to check the reduction of the fracture (*Figure 4*).

Figure 4. Anteroposterior radiograph of short spiral fracture of the junction of the middle/distal thirds of the left tibia.



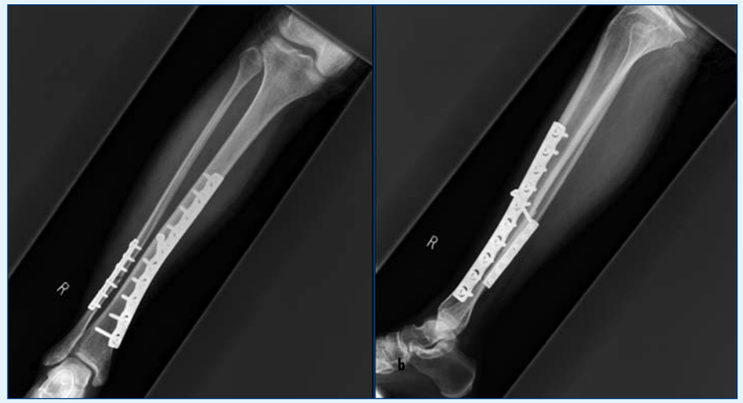
Definitive treatment

The definitive treatment of tibial fractures depends on the fracture configuration and stability, and the condition of the surrounding soft tissue envelope. Closed fractures that are well aligned can be treated non-operatively with an above-knee plaster for 4–6 weeks followed by a patella tendon-bearing cast or splint until fracture union. Initial weekly radiographs are taken to ensure alignment is maintained.

Indications for operative intervention are open fractures, failure closed reduction, a multiply injured patient, an ipsilateral femoral shaft fracture, and fractures associated with compartment syndrome or vascular injuries.

Open fractures require the wound to be thoroughly debrided and washed to deal with the bone and soft tissue contamination followed by fracture stabilization. The options for bony stabilization are intramedullary nailing (*Figure 5*), external fixation (*Figure 6*) and internal plate fixation (*Figure 7*). Stabilization in the presence of significant soft tissue injury would tend to involve intramedullary fixation to allow adequate access to the soft tissues for their management and any reconstructive surgery by the plastic surgeons.

Figure 5. a. Anteroposterior and (b) lateral radiographs of a locked intramedullary nail fixation of an oblique fracture of right tibia.



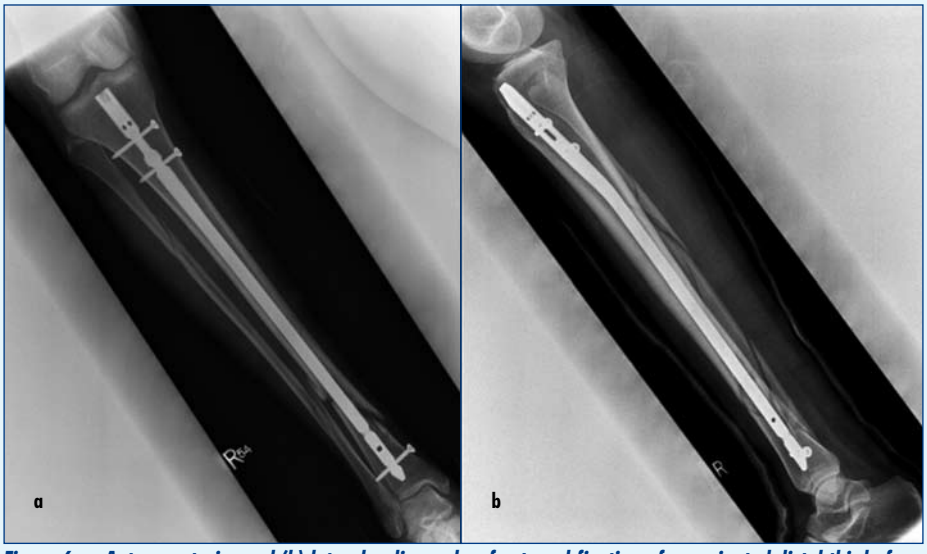


Figure 6. a. Anteroposterior and (b) lateral radiographs of external fixation of comminuted distal third of a tibial fracture.

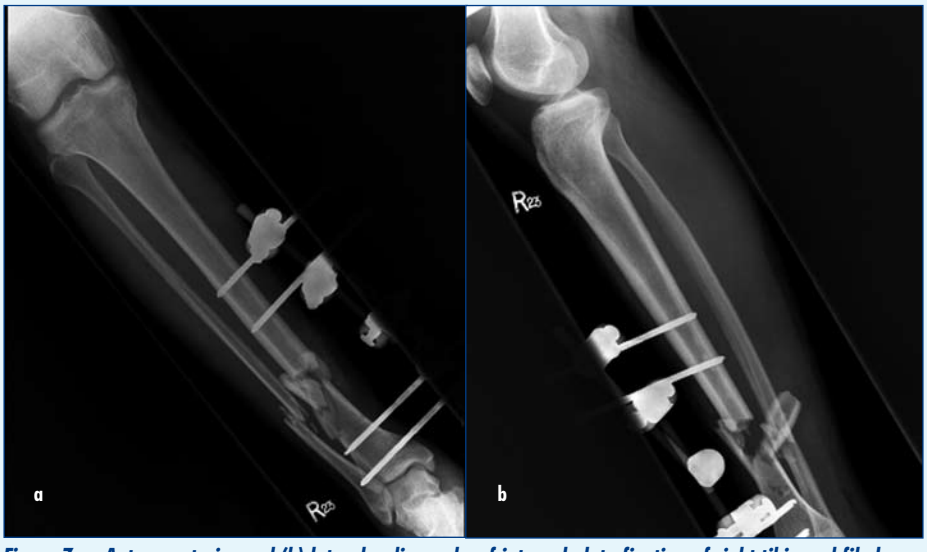


Figure 7. a. Anteroposterior and (b) lateral radiographs of internal plate fixation of right tibia and fibula fractures.

Compartment syndrome

This occurs when the intracompartmental pressure rises to greater than the capillary perfusion pressure and there is failure of oxygenation of the compartments contents. The muscles of the limb are surrounded by a fascial membrane that has a finite degree of expansion. When the limb is injured or the bone fractured there is bleeding into the compartment. The compartment can swell and expand to its maximum volume causing pain but still allowing adequate capillary perfusion of its contents. Any additional swelling will cause the intracompartmental pressure to rise, as it can no longer expand. This initially blocks venous drainage from the compartment, which only exacerbates the volume problem and leads to a further rise in intracompartmental pressure until it exceeds capillary filling pressure and oxygenation of the tissues ceases.

Compartment syndrome presents with pain out of proportion to the injury sustained. There is increased pain on passive stretching of the muscles in the involved compartment. By the time the patient has signs of reduced capillary refill, loss of palpable pulses and paraesthesia in the limb muscle necrosis has undoubtedly already commenced.

Compartment syndrome is a clinical diagnosis. Intracompartmental pressure monitoring is of value in the unconscious patient, otherwise patients suspected of having compartment syndrome should be assessed for consideration of fasciotomy and decompression of all four compartments.

Open tibial fractures

There are published guidelines by the British Orthopaedic Association and British Association of Plastic Surgeons (1997) on the initial treatment of open tibial fractures to improve the prognosis for these patients. The wound is initially assessed, a swab taken for bacterial culture and a digital or Polaroid photograph taken of the wound (this allows for documentation of the initial injury and prevents constantly disturbing the wound to allow others to view it). The wound is then dressed with an iodine-soaked dressing.

Prophylactic broad-spectrum antibiotics are administered intravenously (usually 1.5 g cefuroxime, with the addition of 500 mg metronidazole and gentamicin, appropriately dosed, depending on the degree of wound contamination). The patient should also receive anti-tetanus medication as appropriate. The patient will require thorough surgical debridement and lavage of the wound to reduce the bone and soft tissue contamination and prevent infection from taking hold. BJHM

Conflict of interest: none.

British Orthopaedic Association and British Association of Plastic Surgeons Guidelines (1997) *The Management of Open Tibial fractures.* BOA/BAPS Working Party, London

Gustilo RB, Anderson JT (1976) Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones. *J Bone Joint Surg* **58-A:** 453–8

KEY POINTS

- Tibial fractures are common lower limb injuries.
- Careful evaluation is required to monitor for symptoms of compartment syndrome.
- Initial treatment requires fracture reduction and above-knee backslab application.
- Definitive treatment is dictated by fracture configuration and stability.
- Open injuries necessitate thorough surgical debridement and lavage before skeletal stabilization.