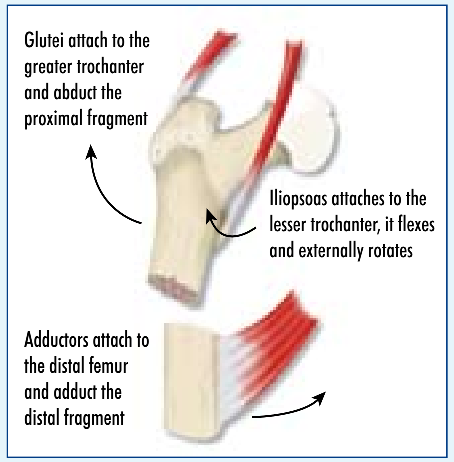
Femoral shaft fracture

Anatomy and function

The femur is a long bone that extends from the hip to the knee. At its proximal end is the head, neck, greater and lesser trochanters, at the distal end a metaphyseal flare to the medial and lateral condyles. The femoral diaphysis (shaft) is bowed anteriorly. The femur is a tubular bone, which gives it strength to withstand axial loading; this enables it to perform its main function of allowing standing and walking.

Muscle attachments to the femur dictate deformities of bone fragments following fractures (*Figure 1*). Gluteus medius and minimus attach to the greater trochanter and lead to abduction of the proximal fragment when there is a fracture distal to their insertion. The iliopsoas tendon is attached to the lesser trochanter, which causes flexion of the proximal fragment when the femur fractures. The two heads of gastrocnemius (medial and lateral) take origin from the metaphyseal flare of the posterosuperior aspect of the femoral condyles; they cause flexion of the distal fragment in distal third fractures. The adductor muscles attached to the medial aspect of the femur cause an adduction deformity of the distal fragment.

Figure 1. Diagrammatic representation of muscle attachments and direction fracture displacement.



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

Mechanism of injury

Fractures of the femoral diaphysis result from major trauma, e.g. road traffic accidents or falls from a height, usually a direct blow or axial loading. In the elderly, with osteoporotic bone, they can result from rotational forces, which lead to spiral fractures. Comminution of the bone is a result of the amount of energy absorbed by the bone from the impact.

Clinical picture

A femoral shaft fracture presents with pain, limb shortening, swelling and deformity. Common associated injuries are pelvic injuries, femoral neck fractures, hip dislocations, knee ligament injuries and multiple injuries. Ipsilateral femoral injuries are frequently missed and need to be specifically excluded. Neurovascular injuries associated with a diaphyseal femoral fracture are rare; however, neurovascular examination of the limb is mandatory before and after limb immobilization. If distal pulses are not palpable then the peripheral pulses need to be assessed with a Doppler.

Associated injuries are common when major trauma is involved. These patients should be assessed using Advanced Trauma Life Support (ATLS) guidelines. Priority is placed on ABCs: assess the patency of the patient's airway while immobilizing the cervical spine appropriately (A), check that the patient is breathing and administer oxygen via a rebreathing mask (B), assess the patient's circulation (pulse and blood pressure) and administer intravenous fluids (C).

Radiographical evaluation should include an anteroposterior view of the pelvis, anteroposterior and lateral views of the ipsilateral hip and knee and the entire femur. Care must be taken that any immobilization device does not obscure the bone, especially the femoral neck, leading to an associated fracture being overlooked.

Classification

Femoral shaft fractures are classified by description:

1. The status of the soft tissues, open or closed
2. Geographical location, proximal, middle or distal third
3. Fracture geometry, transverse, oblique, spiral, segmental
4. Comminution (*Figure 2*)
5. Shortening, angulation, translation or rotatory deformity
6. Associated injuries, is it an isolated fracture or one of multiple injuries.

Initial management

Administer adequate analgesia to the patient. Fracture immobilization or initial stabilization is achieved by applying a Thomas splint (see below). This usually helps with pain control. Patients who sustain femoral shaft fractures can lose up to 2 litres of blood into the thigh and therefore need to receive appropriate fluid resuscitation.

Definitive management

Femoral diaphyseal fractures are usually displaced as a result of the significant muscle forces exerted on the fracture fragments. Operative treatment is therefore required to reduce and maintain fracture reduction and allow early mobilization of the patient.

Figure 2. Anteroposterior and lateral radiographs showing comminuted short oblique fracture of the mid-shaft right femur. There is adduction and flexion of the distal fragment, shortening and medial translation of 100% of the diaphyseal diameter.

Methods of fixation range from plate fixation, intramedullary nailing and external fixation. The application of an external fixator to a femoral shaft fracture requires inserting the fixator pins through a large muscle bulk and pin tracks are then more prone to infections. Intramedullary nail fixation is more often the treatment of choice in an adult. Following closed reduction on traction table a nail can be inserted by a relatively percutaneous approach through the piriformis fossa at the greater trochanter and statically or dynamically locked depending on the fracture configuration. An intramedullary device is more biomechanically stable compared to plate fixation and will enable immediate weight bearing (*Figure 3*).

In immature patients who sustain femoral diaphyseal fractures standard nailing techniques are contraindicated as they breach the trochanteric physis, and thus have the potential for growth arrest. In children less than 5 years of age conservative management with a Thomas splint or hip spica cast until fracture union is the treatment of choice. In those patients older than 5 years retrograde flexible nailing can be performed, avoiding the distal femoral physis, to allow early mobilization.

Application of a Thomas splint

A Thomas splint (*Figure 4*) uses the principle of fixed traction with counter traction being applied against the perineum by the proximal ring to maintain femoral fracture reduction. It will not reduce the fracture; this must be achieved before splint application by manipulation. Splints come in different sizes. To select the correct size the circumference of the thigh needs to be measured. This is difficult to achieve on the injured side and therefore the uninjured side is measured and 5 cm added to this, allowing for swelling (the ring should fit the thigh as snugly as possible without causing skin irritation). The splint is prepared by placing sheets of calico bandaging over the metal sides as slings (*Figure 5*), cotton wool padding is then used on top of this. The splint is then carefully placed under the affected limb.

Skin traction is applied to the leg from the distal femur to the ankles, taking care that the padding protects the malleoli. The traction is then wrapped around the sides of the splint winding the medial cord from inside to out and the lateral cord from outside to in (*Figure 6*). The cords are then crossed and tied to the distal end of the splint. Sufficient tension is added to the traction by winding the cord over two tongue depressors (two are used to prevent the depressor from breaking with the strain). Following splint application the distal neurovascular status of the limb should be reassessed. The distal fracture fragment tends to flex because of the pull of the gastrocnemius. This backward angulation can be corrected by placing a large pad behind the distal fragment to act as a fulcrum (*Figure 7*).

Further radiographs are taken of the femur in the splint to ascertain appropriate fracture reduction has been achieved.

The Thomas splint then needs to be suspended from an overhead beam so that it moves with the patient in the bed. BJHM

Conflict of interest: none.

Further reading

Charnley J (1999) Fractures of the shaft of the femur. In: *The Closed Treatment of Common Fractures*. Golden Jubilee Edition. Colt Books, Cambridge: 166–96

Figure 3. Anteroposterior and lateral radiographs showing intramedullary nail fixation of left femoral shaft fracture.

Figure 4. A Thomas splint.

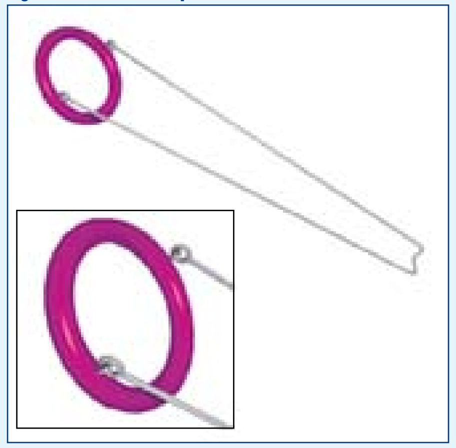


Figure 5. Diagrammatic representation of calico sling preparation of Thomas splint.

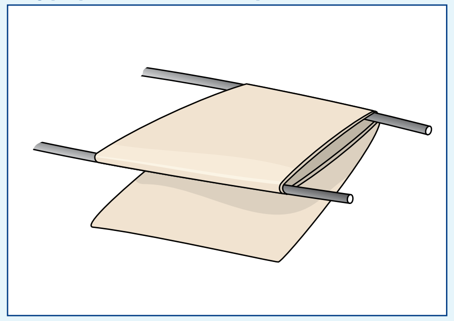


Figure 6. Application of traction cord to Thomas splint.

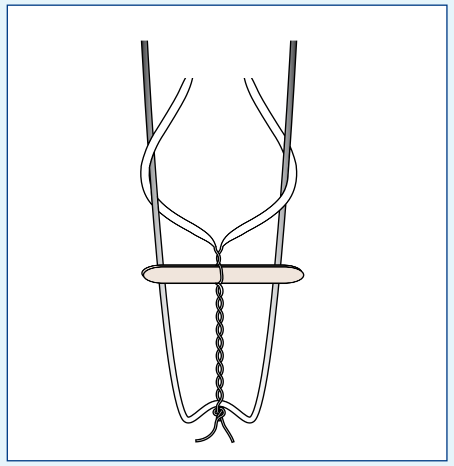
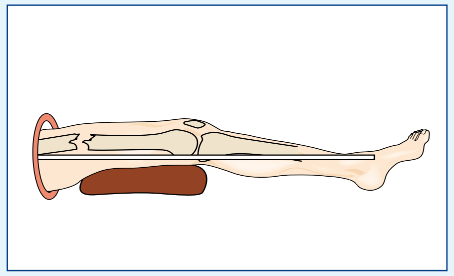


Figure 7. Placing a pad beneath the distal femoral fragment corrects flexion deformity.



KEY POINTS

- Femoral shaft fractures tend to result from high energy trauma.
- Advanced Trauma Life Support principles should be applied in initial patient management.
- Thomas splint application gives initial temporary fracture stabilization and aids pain control.
- Definitive fracture management is operative by intramedullary nail fixation.