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CLINICAL PRACTICE

Conservative management of femoral shaft fractures

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Introduction

Fractures of the femoral shaft are common surgical problems in Papua New Guinea. In Port Moresby there are around 70 cases seen per year. To date, no set protocol has been outlined to follow, and surgical trainees over the years have learned and adopted the dogmas from their respective pioneers. A large number of workers have undoubtedly practised a conservative approach for a long time.

In Papua New Guinea (PNG) the population is mainly rural so that medical services are widely dispersed. Patients with fractured femur are usually transferred to base hospitals. To help improve their management there some general guidelines and protocols are required which are based on standard texts (1-3) but adapted for PNG.

Anatomical considerations

Anatomical aspects of the femur and classification of femoral fractures are considered in Figure 1. The thigh over the shaft fracture is usually shorter and grossly swollen, and lies externally rotated and adducted. Muscle contraction, the type of fracture and gravity all determine displacement at the fracture site (Figures 2 and 3).

a) The muscles attached to the upper and lower ends contract leading to shortening.

b) The proximal fragment in upper third fracture is flexed by the iliopsoas, abducted by the gluteal muscles and everted by external rotators.

c) The two important muscle groups — adductors, attached to the distal fragment, and abductors to the upper fragment — are separated by the fracture and then act unopposed. The lower fragment is adducted by the adductors, proximally drawn by quadriceps and hamstrings and everted by the weight of the leg.

d) Middle and lower third fractures exhibit backward angulation deformity of the distal fragment and shortening.

Management

Immediate care

Haemorrhage from a fractured femur may be 1-2 litres regardless of whether it is open or closed. The management begins with fluid resuscitation and crossmatching. Blood transfusion may be required, particularly if there are other associated injuries. Other injuries may pose the most immediate threat to life so the patient must be fully examined. Always exclude other fractures to the limb and also posterior dislocation of the hip. The femur X-ray should always be taken AP (antero-posterior) and lateral and should include the hip and knee joints.

Open fractures should be debrided meticulously under general anaesthesia and all foreign bodies and devitalized tissue must be removed. Loose chips of bone separated from periosteum in a gunshot wound also need to be removed. Ideally wide excisions should be done on all gunshot wounds.

Two of the primary aims of femoral shaft fracture management include:

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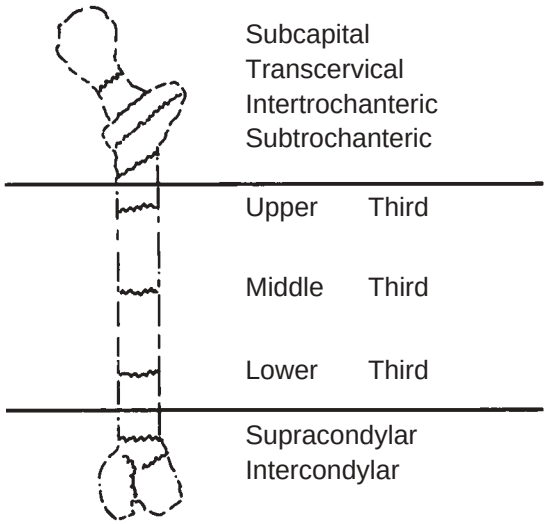
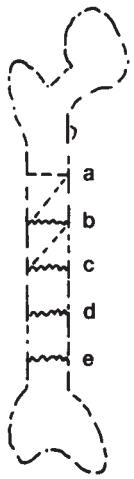
• Femoral Fractures can occur anywhere along the entire length:

Fig. 1 (a)



• Femoral Shaft Fractures may involve:

Fig. 1 (b)



a. proximal third
b. junction of proximal and middle thirds
c. middle third
d. junction of middle and distal thirds
e. distal third

Figure 1. Anatomical considerations and classification of femoral fractures.

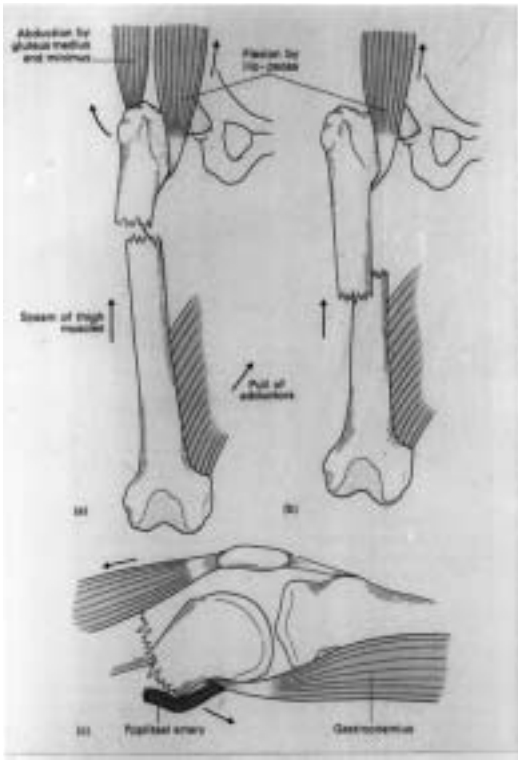


Figure 2 a. Proximal shaft femoral fracture: the proximal fragment is flexed by the iliopsoas and abducted by the glutei.

Figure 2 b. Midshaft fracture: flexion of the proximal fragment by the iliopsoas.

Figure 2 c. Distal shaft fracture: the distal fragment is angulated backwards by the gastrocnemius. The popliteal artery may be torn in this type of injury.

Figure 3. Radiograph showing the force of abduction by glutei muscles of the proximal fragment.

NOTE: This patient had his clothes on at the time of X-ray, hence the coin and belt buckle shown.

1 **Avoiding malunion** which occurs as a result of shortening as well as external rotation of the distal fragment. Shortening is due to fragments overlapping and flexion and abduction of the proximal third.

2 **Avoiding knee stiffness** which comes about quite soon when the fractured limb is not moved, even as early as one week. It is therefore advisable in the course of management that knee flexion exercises should be encouraged within the first week.

Following stabilization of the patient's general condition and once the wound has been dealt with, the fracture can be immobilized in one of the following ways:

1 Traction
2 External fixation
3 Internal fixation.

Traction

The technique of traction is quite simple but it requires continual vigilance and careful supervision. Problems are bound to occur if patients on traction are left unattended until the fracture has united. Considerable attention is required when it comes to setting up traction, and to maintain it requires even more.

In modern orthopaedic and trauma centres there is a Traction Sister who plays a

significant role in managing patients on traction (4). She ensures that traction complications and general complications are avoided by checking all the tractions regularly. In PNG the surgical resident medical officer (RMO) should play this role.

The leg lengths must be measured daily in the first week until leg length is equal and any rotation corrected.

Practice Point. Malunion for femoral shaft fracture equals

1 shortening greater than 1 cm

2 external rotation of the distal shaft.

A Denham or a Steinman pin is inserted 2 cm behind the tibial tubercle (Figures 4 and 5).

A Thomas splint or other suspension splint which controls rotation and sagging of the fracture site is applied with flannel slings or soft elastic bandaging passed under the limb and secured to side bars with tapes or pins.

Manipulation and reduction are attempted and traction maintained by tightening all ropes and by a weight (1/10 of body weight) suspended through pulleys at the foot of the bed. Countertraction is provided by elevation of the foot end of the bed.

The objectives of treatment are to position the distal end of the shaft to align with the proximal end which is displaced by muscle pull.

Pads are placed in front of the flannel slings or elastic bandaging to maintain the normal anterior bow of the femur.

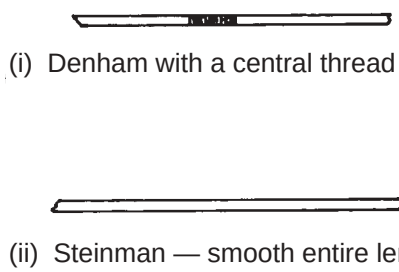


Figure 4. Types of pin used for skeletal traction.

The traction should be maintained and checked daily to ensure that all ropes are tight, and the slings, pads and pulleys are in good form and position.

X-rays should then be taken regularly to ensure that position and alignment are maintained. A practical point to bear in mind is that lateral angulation exceeding 10 degrees is unacceptable.

In adults, union occurs around 8 weeks for a spiral fracture and 16 weeks for a transverse fracture (Table 1). Mobilization (non-weight-bearing) is begun once union has occurred clinically and radiologically. Once consolidation has taken place, which takes twice as long, weight bearing must begin.

Practice Point: Traction.

1 The weight must be off the bed rail and **not** sitting on the floor.

2 Avoid friction, which reduces effective traction.

3 Direction of traction must be as horizontal as possible (Figure 6).

4 The adductor muscles tend to pull the distal fragment into adduction. This should be corrected by having the line of traction towards the corner of the bed in an abducted position.

5 Begin Perkins exercises early (2).

Perkins exercises

1 Prevent knee stiffness.
2 Encourage bony union by increasing blood supply to the fracture site.

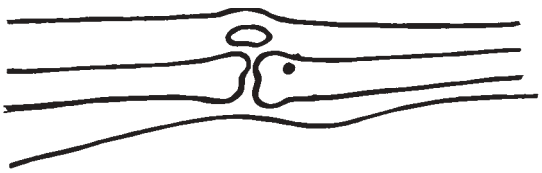


Figure 5. Shows site for pin insertion in the tibia in skeletal traction.

NOTE: Insertion is 2cm below the tibial tubercle for a firm grip.

TABLE 1

TABLE OF TIME TO UNION BY AGE AND TREATMENT

Age	Time to union	Treatment
Infants	2 weeks	Gallow's traction
Children	3-6 weeks	Gallow's or skin traction
Adults	6-12 weeks	Skeletal traction or intramedullary nailing

3 Help splint fracture by maintaining quadriceps muscles.

Complications of traction

Four main complications are known when treating patients with traction:

1 Overdistraction
2 Loss of position
3 Pressure sores
4 Pin track infection.

1. *Overdistraction*

Excessive traction leads to vascular problems and nerve damage due to stretching and, more importantly, holds the bony fragments apart causing problems of union. The amount of weight to be suspended should be one tenth of the body weight, which is sufficient to pull the bones out to length but not overdistract them.

2. *Loss of position*

Slipping or overlapping should be avoided by taking portable X-ray views at the bedside at least twice a week for the first two weeks.

3. *Pressure sores*

Usual pressure areas and areas under the splint need to be carefully observed for pressure sores.

4. *Pin track infection and pin loosening*

Occasionally infection occurs where the pin passes through and may progress along the pin track. The skin around the pin becomes red and painful and the bone becomes tender; consequently the pin loosens, particularly if a Steinman pin has been used. When it occurs the pin should be removed, and the infection treated by cleaning the skin carefully and by giving antibiotics.

A new pin should be replaced, preferably a Denham pin, 1.5 cm above or below the previous site.

Conservative treatment of femoral shaft fractures

We recommend the following protocol for the conservative treatment of shaft fractures in adults (5).

1 Skeletal traction until union occurs after a minimum of six weeks.

2 Begin isometric exercises at the end of the first week.

3 X-ray twice a week for the first two weeks, then every two weeks.

4 Encourage knee flexion within the first week.

5 Between 6 and 8 weeks when bony union has occurred ambulate and allow light partial weightbearing on crutches.

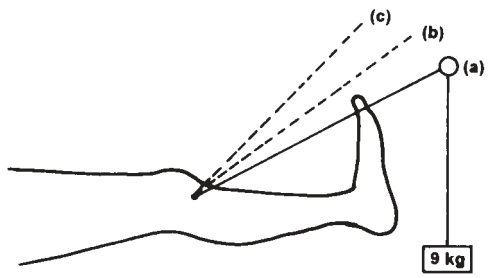


Figure 6. Position (a) shows the correct direction of traction in skeletal traction.
NOTE: (b) and (c) are unacceptable directions of traction.

At 12 weeks union should be rock solid.

External fixation

With improved technology, a unique way of stabilizing bones and soft tissues following bone trauma was developed. Historically, the origins go back to Malgaigne (6), who in 1853 developed strapped-on metal points and 'claws' to treat his displaced fractures. Parkhill (7) of Denver built the first external fixator in 1898. Codvilla (8) in 1905 treated leg lengthening by using pins and plaster.

In the 1930s, transfixion pins, longitudinal distractions and compression principles and mechanisms were introduced. These ideas and mechanics led to the development of very sophisticated devices by Anderson (9) in 1936. Following the Second World War, Ilizarov et al. (10) devised more complex but versatile ring fixators which were built ideally for treating limb length discrepancies, malalignments and segmental transport after corticotomy.

All of these achievements have culminated in the development of simple, mechanically sound devices which have become invaluable in the treatment of open and infected fractures.

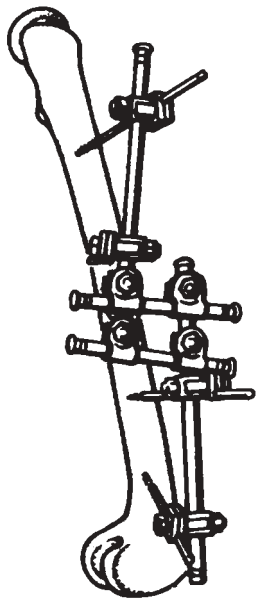


Figure 7. External fixator applied to the femur. For increased stability, two intermediate tubes have been used.

An external fixator is a device which holds a fracture firmly by transfixing screws which pass through both cortices of the bone above and below the fracture. These are then attached to an external frame or scaffold which gives the support (Figure 7).

The main indications are:

1 Stabilization of severe open fractures in which the wound is required to be left open for regular dressings, inspections and ultimate skin grafting.

2 Very unstable fractures which are severely comminuted at the same time.

3 Stabilization of infected nonunions.

4 Correction of both extremity malalignments and length discrepancies.

The use of external fixators in femoral shaft fractures in PNG hospitals is fairly rare because there is a very low incidence of open femoral fractures and the actual device is not available.

Most centres, apart from Port Moresby General Hospital, either do not have the apparatus or have only parts of it which when assembled do not form the entire device.

More importantly, doctors do not have the expertise to apply it on patients. We advocate the use of the AO tubular fixator because it has a simple design, is easy to apply and is highly versatile.

If this equipment is not readily available, at its simplest external fixation can be applied by transfixing two Steinman pins running parallel below the fracture and two above the fracture and incorporating all 4 pins in a plaster of Paris (POP) cast with a window over the wound for regular inspection and dressings.

Complications of external fixation

External fixation has three main complications:

1. *Overdistraction*

   The fragments are held rigidly apart, which can result in nonunion.

2. *Reduced load transmission through the bone*

This is considered to be the main cause of delayed union and resultant osteoporosis. External fixators should therefore be removed after six weeks and replaced by a POP cast which will allow bone loading.

3. *Infection of pin tracks*

This should call for immediate pin removal and antibiotic therapy. It is hoped that by the time this occurs the fracture may be sticky enough to be held by some other means.

Internal fixation — intramedullary nailing

The principles of the intramedullary technique were first introduced in 1940 by Kuntschner (11). Splinting from this technique provides relative stability with no interfragmentary compression; however, in stable fractures early weightbearing produces axial compression between the fragments and because it is a load-sharing device it allows load bearing across the fracture site (12).

In modern trauma and orthopaedic establishments in Australia, UK and USA intramedullary AO locking rods would be an ideal form of management in proximal and middle third shaft fractures (13). It is certainly an excellent form of fixation in that it provides longitudinal stability as well as alignment and enables patients to be mobilized rapidly enough to be discharged from hospital after a week or so.

The surgery itself is time-consuming and requires experience, an orthopaedic table or distractor for fracture reduction, a good quality image intensifier which controls reaming and nailing, and modern AO locking rods with the correct tools for insertion. The theatre facilities themselves should be safe in terms of infection, which is a disaster in internal fixation.

The technique of intramedullary nailing basically involves passing a nail (Figure 8) down the femur over a guide wire through a small incision above the greater trochanter under image intensifier control.

To overcome rotation, the femoral nail has two locking holes at the proximal and the distal end which are accessible percutaneously under X-ray control, both medially and laterally (2,12). The main advantages of this form of fixation are minimal damage to soft tissue and periosteal and muscular vascularity and, most importantly, earliest possible mobilization can be achieved. Ideally it is indicated for transverse fractures along the shaft, and comminuted fractures with shortening provided the bone can be pulled out to length and held.

In Papua New Guinea and in other tropical countries (14), because we lack some of the essential ingredients described above, we need to seriously consider a more conservative approach to femoral shaft fractures.

During World War II when intramedullary Kuntschner nailing was becoming popular, many surgeons tended to resort to open femoral Kuntschner nailing when treating shaft fractures. Because of the frequency and severity of reported complications, conservative treatment became more popular, possibly too much so.

Figure 8. AO-ASIF universal femoral nail. a. AP view. b. mediolateral view.

AO = Arbeitsgemeinschaft für Osteosynthesefragen.

ASIF = Association for the Study of Internal Fixation.

Kuntschner nailing is not suitable for all shaft fractures and the indications should strictly be confined. Basically they hinge around two important factors:

1. *The fracture pattern along the shaft*

   Simple transverse and short oblique fractures are considered good indications and do very well with this method of fixation (12).

2. *The location of the fracture in relation to the shaft*

   Kuntschner nailing is ideal for fractures which lie within these limits: 2 inches distal to the lesser trochanter and 7 inches proximal to the adductor tubercle.

Shaft fractures which do not fit the above criteria should all be treated conservatively with skeletal traction applied via a tibial pin. If these rigid criteria are not used in selecting the fractures and if technique is less than ideal, complications will be frequent. The basic principle in Kuntschner intramedullary nail fixation is stable osteosynthesis through flexible impingement of the nail in the bone. The nail should be wide enough to occupy the entire cross section of the medullary canal and to bear the weight and stresses of the surrounding musculature.

The well-known complications are infection, nonunion and malunion. Nonunion or malunion occurs as a result of poor fixation because the nail is too small or the fracture is too high or low and in these situations the nail will not fill the intramedullary canal and control rotation. This is the biggest problem we are faced with in Papua New Guinea because many general surgeons nail shaft fractures of all types and locations without set protocols because they do not understand these basic principles.

An excellent way of controlling rotation and preventing malunion is the application of a well-padded plaster boot with a transverse rod incorporated behind the heel after an internal fixation of a shaft fracture.

Removal

Normally femoral nails should not be removed unless they are causing complications (15). Do not remove the nail unless there is good bony union and normally not in the first year after fracture.

Shaft fractures in children

Fracture patterns are basically the same as in adults; however, treatment differs (16). In children, skin traction is usually enough for most fractures anywhere along the femur. Applying this form of traction requires no anaesthetic, therefore care and gentleness must be exercised. The limb should be cleanly shaved followed by spraying or swabbing the skin with some form of antiseptic solution, which facilitates adhesion of the strapping.

Adhesive strappings are then placed along almost the entire length of the limb medially and laterally around a small squared piece of wood at the foot end with a small hole through its centre through which a rope is passed to suspend the weight. It is vitally important to incorporate in the strapping plenty of wool over prominent pressure points such as the malleoli and the knee medially and laterally.

Finally encircling crepe bandages are applied to secure the plaster strapping throughout the entire length; then the weight is suspended.

In modern centres, commercial traction sets are available; they come with traction cords, and a spreader band which has a foamy protection pad for pressure points such as the malleoli etc.

Skin traction is suitable for children over the age of 3 years. Children up to the age of 3 years are ideally treated by Gallow's traction(1) (Figure 9).

The technique of Gallow's traction is quite simple. Plaster strappings are applied to **both** legs as one would normally do for skin traction and these are fixed to an overhead bar. The buttock should be raised just clear of the bed and this facilitates nursing.

Instead of a longitudinal traction as in skin traction, the legs are flexed 90 degrees at the hip in relation to the body and the body weight is responsible for the traction. Its application on older children holds the risk of vascular spasm and peripheral gangrene. Intramedullary nailing in children is not advocated because of the possible damage to the growth plate (12).

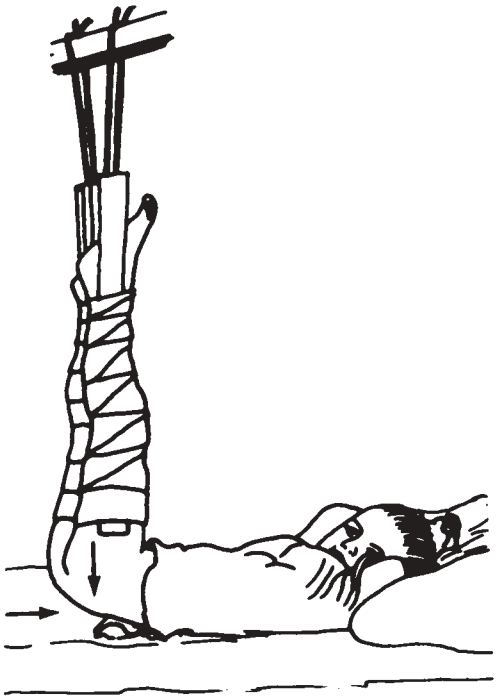


Figure 9. Gallow's traction.

Complications

There are very few complications of femoral shaft fractures in children. Vascular injuries are rare in closed fractures and nerve injury may result from treatment rather than from the injury itself (16). Lateral popliteal nerve palsy during traction is a classical example and this is where the importance of vigilance must be reemphasized.

Conclusion

Conservative treatment still remains a reliable and effective way of treating femoral shaft fractures in most patients if good alignment is maintained without soft tissue interposition. This is particularly true in Papua New Guinea, where facilities are limited, the possibility of purchasing modern equipment is fairly remote and technical expertise and skills are limited.

Furthermore, with conservative management there is none of the morbidity associated with internal fixation. Nevertheless, it requires a cooperative patient as well as skilled nursing and ancillary staff who are familiar with the demanding requirements of this form of treatment.

It must be borne in mind that elderly or multiply injured patients who require early mobilization do not appropriately meet these requirements.

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