# ADULT TRAUMATIC FEMORAL SHAFT FRACTURES: A REVIEW OF THE LITERATURE

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## ABSTRACT

***Background:*** *Fractures of the shaft of the femur are common. Injuries leading to femoral shaft fractures are equally common. The femur presents itself to these injuries more than any other bone in the body.*

***Methods:*** *A review of the literature on epidemiological data, mechanism of injury, fracture classification and methods of treatment for adult traumatic femoral shaft fractures was done based on journal articles and on information from standard text books.*

***Results:*** *The epidemiology, injury classifications and various treatment options are presented. The biology of fracture healing following various options of treatment is also presented. Femoral shaft fractures constitute over 50% of all femoral fractures and most of them occur in the middle third of the femur. The mean age of adults involved is about 35 years. More males than females are affected in a ratio that ranges from 1.5:1 to 2.5:1.*

*The majority of femoral shaft fractures are caused by road traffic injuries. Operative fixation is the gold standard for the treatment of adult femoral shaft fractures. The adult femoral shaft fracture may take 12-24 weeks to unite.*

***Conclusion:*** *Most adult femoral shaft fractures are traumatic in origin. Operative reduction and fixation is practiced in most centres around the world, but few indications for non operative treatment are recognized.*

***Keywords:*** *Adult, Traumatic, Femoral shaft, Fracture.*

## INTRODUCTION

Fractures of the shaft of the femur are common. They are estimated to constitute 5-10% of all fractures[1,2]. In most instances, they are produced by high energy trauma and, therefore, may be accompanied by multiple and life threatening injuries elsewhere in the body system[3,4]. The traumatic events by which the femoral shaft may be fractured include road traffic crashes, falls, assaults, gunshot injuries and industrial accidents[1-3,5]. Fractures due to severe trauma are preponderant in young patients and show a predilection for males. This may become important in the economic implications of these injuries to a society such as ours.

Fractures of the femoral shaft may be treated by traction alone, traction followed by a standard cast brace, external fixation, or open reduction and internal fixation[6,7]. The options in internal fixation include intramedullary nailing, and plate and screw fixation. The choice of method of treatment in any particular case may be influenced by such factors as type and location of the fracture, the degree of comminution, the age of the patient and the patient's social and economic standing[7]. The surgeon's preference may also be an important consideration.

Operative fixation using intramedullary nailing has been widely accepted as the procedure of choice for femoral shaft fractures. On the other hand, plate and screws fixation of femoral shaft fractures is an acceptable alternative to intramedullary nailing, but is believed to have a higher risk of complications[8].

The effect on early outcome of the various modalities of treatment can be measured with respect to the functional status of the knee, total hospitalization time, bony union, and presence or absence of complications[6,8-10]. The most consistently reported disability with conservative treatment is malfunction of the knee through stiffness and weakness in 30-50% of patients in some series[6].

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## THE FEMORAL SHAFT

The femur is the longest and strongest bone in the body. The shaft of the femur is also known as the femoral diaphysis. It is that portion of the bone lying between a portion 5cm distal to the lesser trochanter and a point 8cm proximal to the adductor tubercle[11]. It is divided into proximal, middle and distal thirds.

The isthmus is the portion where the thick cortices of the femur encroach on the medullary canal and, therefore, corresponds to the narrowest part of the medullary canal as well as to the junction of the proximal and middle thirds of the shaft[7].

A femoral shaft fracture, therefore, is a break in the continuity of the femur anywhere between a point 5cm distal to the lesser trochanter and a point 8cm proximal to the adductor tubercle.

## EPIDEMIOLOGY OF ADULT FEMORAL SHAFT FRACTURES

Fractures of the shaft of the femur are among the most common fractures encountered in orthopaedic practice[2,7]. The incidence of femoral shaft fractures in adults is of the magnitude of 1520 fractures per 100,000 person-years[11]. The incidence is close to that of humeral shaft fractures, but approximately one half of the incidence of tibial shaft fractures[11]. They constitute over 50% of all femoral fractures and most of them occur in the middle third of the femur[1,12,13].

The mean age of adults involved is about 35 years. More males than females are affected in a ratio that ranges from 1.5:1 to 2.5:1[9,11]. In both males and females, the most commonly involved age range is 21-45years[13-15].

Bilateral femoral shaft fractures may reflect a complex mechanism of injury or a more serious high-energy interaction. In a certain series, three (1.8%) out of 167 patients, had bilateral fractures[8]. Also, four (6.0%) out of 66 patients who sustained type III open Femoral Shaft Fractures were found to have bilateral injuries[16]. Magerl et al[17] reported bilateral fractures in 6.4% of their series. In unilateral injuries, the right and the left sides are equally affected [17].

## MECHANISMS OF FEMORAL SHAFT FRACTURES

Considerable force or energy is usually required to fracture the femur, and possible causes include road traffic crashes, falls from height, and crushing injuries. Others include gunshot injuries, industrial accidents and sports[1,2,11,14,15,18]. The majority of femoral shaft fractures come under road traffic injuries[9,11,14,15]. Analysis of road traffic crashes shows that motor vehicle crash, motorcycle and pedestrian accidents are the most common variants[1,9,19]. In extremity gunshot injuries, the femur is the most common site of fractures[18]. All these factors produce fractures of the femoral shaft either through a direct transmission of force, or through an indirect or twisting force to the shaft of the femur.

## CLASSIFICATION OF FEMORAL SHAFT FRACTURES

The general principles of classification of fractures also apply to the femoral shaft.

**Open or Closed**

This depends on the presence or absence of a wound in the skin over the fracture site. Closed femoral shaft fractures are those not associated with skin wound in direct communication with the fracture site. On the other hand, open fractures are accompanied by varying extent of skin and soft tissue disruption, linking the fracture site into direct communication with the exterior.

The classification of open shaft fractures is according to the Gustilo-Anderson criteria as applicable to fractures elsewhere[20]. The overall incidence of all open femoral shaft fractures has been variously quoted as 14.4%, 13.4% and 16% in different series[11,17,21]. Roberts[8], however, reported 3.6%.

**Based on level of Fracture**

Femoral shaft fractures may either occur at the proximal, middle or distal third of the shaft. Also such classification as fractures of the junction of proximal and middle thirds as well as junction of middle and distal thirds are also applicable[22]. For the purposes of research, it is the authors' opinion that fractures at these levels be regarded as proximal and middle shaft fractures respectively. Also fractures between the junction of the distal third and the supracondylar region should be regarded as distal third fractures.

The middle shaft (middle third) is the commonest site of traumatic femoral shaft fractures[1,12,13,23]. It is followed by the proximal shaft and distal shaft in that order, giving a reported incidence of 47.5%, 39.3% and 13.1% respectively[23]. Fractures at more than one level are termed segmental fractures.

**Based on Pattern of Fracture**

Femoral shaft fracture patterns include transverse, short oblique, long oblique, comminuted, and spiral variety[24]. These classifications are based on roentgenographic appearances and observations confirmed at operations[17]. Hansen et al[24] reported transverse fractures as the commonest fracture pattern, accounting for up to 38.3% of the fracture patterns. This does not agree with the work of Magerl et al[17], in which comminuted fractures accounted for as much as 63% of the overall patterns.

**Classification of Fracture Comminution by Winquist and Hansen Criteria**

Fractures of the femoral shaft can be classified based on the degree of comminution using the Winquist and Hansen criteria[3,7,23]:

**Type I** Fracture with minimal or no comminution. It is a fracture in which a small piece of bone has broken off, but does not affect fracture stability.

**Type II** Fractures have additional small fragments involving as much as (but not more than) 50 percent of the circumference of the shaft. There is at least 50% contact of abutting cortices of the shaft.

**Type III** Fractures with 50-100% comminution of the circumference of two major fragments. There is less than 50% cortical contact.

**Type IV** There is circumferential comminution of the shaft, with no contact of the cortices of the major fragments after reduction.

The Winquist and Hansen grading system has direct use in operative decision making and planning. Worthy of note is the fact that the largely intact cortices of the major fragments in type I and type II fractures resist shortening and malrotation around an unlocked intramedullary nail. Such stability after unlocked nailing cannot be expected for type III or IV fractures[3].

Apart from the Winquist and Hansen system, the Wingo and Carr grading system is another mode of classification for femoral shaft fractures[25].

## FRACTURE HEALING

The current concepts of fracture healing are based on two variables, namely blood supply and stability[26]. Fracture healing occurs in a series of phases, which overlap to some extent. Since the processes by which untreated fractures heal are very efficient in terms of the union process itself, the principal responsibility of the Surgeon is to ensure that when the fragments do unite, they are in a position consistent with the restoration of full function[27].

**Fracture healing in the absence of rigid fixation**

Fracture healing of a long bone under this condition proceeds through a set of steps, which include:

**Haematoma formation**: Due to haemorrhage from the highly vascular severed ends of bone and surrounding tissue.

**Inflammation and cellular proliferation:** Acute inflammatory response to injury and demolition by macrophages rapidly give way to massive cellular proliferation of specialized cells derived from the periosteum and the severed ends of the endosteum.

**Callus formation:** Massive cellular proliferation involving the fibroblasts and osteoblasts occurs at such a rate that the fracture becomes literally buried by the mass of new cellular material, and movements of the fragments gradually diminish to the point where a bridge can be established between the fragments. When this cellular accumulation eventually becomes mineralized, the tissue is recognized clinically as external callus[27].

**Consolidation:** The callus is largely made up of woven bone. Consolidation entails conversion of woven bone to lamellar bone through phagocytic resorption by multinucleate osteoclasts, and concomittant collagen deposition by osteoblasts.

**Remodeling**: Lamellar bone is remodeled over many months by continuing osteoclastic and osteoblastic activities. The final contour of the bone appears to be dictated by the lines of stress set up within it on mobilization.

**Fracture healing following internal fixation**

Primary callus response in fractured bones as described above does not occur following rigid fixation of the fracture[26]. It is a response that is enhanced by movement at the fracture site. The effects of rigid internal fixation on fracture repair have been studied extensively. Closure of the fracture after rigid plate fixation is accomplished morphologically by a widening of the Haversian canals, formation of resorption cavities and finally by the formation of intraosseal new bone across the fracture gap. This is the concept of primary bone healing. It is devoid of external callus formation, but the fracture line itself gradually disappears[26-28]. It has also been shown that the cortical bone under rigid plate undergoes cancellous transformation as well as a decrease in its mineral content usually between the 2nd and 17th postoperative weeks[28].

Intramedullary fixation after reaming can damage the intramedullary circulation and this often leads to a compensatory increase in the periosteal blood supply.

This is an important consideration if internal fixation is being contemplated for a severe open fracture, because total devascularization of the bone could occur. Intramedullary fixation does not necessarily produce a completely stable fixation. This, together with the hypertrophy of the periosteal circulation, usually means that the fracture heals by abundant external callus[26,27]. Bridging of the fracture fragments is, therefore, usually rapid though completion of remodeling and the disappearance of the original fracture gap may not be complete for many months after function is restored[27].

**Assessment of fracture healing**

Clinical and radiologic parameters assist in assessing fracture healing. Clinically, fracture healing is assumed when there are no demonstrable abnormal movements at the fracture site, and when the fracture site stops being painful with absence of local tenderness and crepitus upon palpation and weight bearing. Radiologically, disappearance of the fracture line accompanied with bridging of all cortices on anteroposterior and lateral radiographs of the fracture site suggests fracture healing. Sometimes, disappearance of fracture line may not occur until remodeling is complete[23]. The adult femoral shaft fracture may take 12-24 weeks to unite[8,22], but the exact point of union is very difficult to define[29]. Similarly, numerical guidelines for defining delayed union and non union remain arbitrary, but some authors[23] have defined delayed union in the femur as the failure of clinical and radiologic union by 26 weeks, while this state of affair at 52 weeks is regarded as non union[23]. Delayed union implies slow healing, but non union signifies that the fracture will not heal without some further intervention.

## TREATMENT OF FEMORAL SHAFT FRACTURES

Adult femoral shaft fractures are amenable to a variety of treatment modalities which can be operative or non operative. Non operative therapy has remained relevant in selected cases in spite of the necessity for a prolonged course of therapy and the incidence of recognized complications such as loss of knee motion, chondromalacia patellae, delayed union and malalignment[8]. The non operative methods include skeletal traction alone, and skeletal traction followed by a standard cast brace which is hinged at the knee.

The operative methods of treatment include external fixation and internal fixation. The options of internal fixation include intramedullary nailing, and plate and screw fixation. Internal fixation restores alignment, corrects rotation, restores length and reduces hospital stay. The choice of treatment modality in any particular case is influenced by the various factors already mentioned[7].

**Non operative treatment**

**a) Skeletal Traction**

Proximal tibia skeletal traction is commonly chosen when femoral shaft fracture is to be treated by skeletal traction. It involves passing a Steinmann's pin through the proximal tibia, two-finger breath distal and posterior to the tibia tubercle. This is connected to a stirrup and then to a weight by means of a cord, which also passes over a pulley device well away from the foot of the patient's bed. The patient is nursed supine with the affected limb supported in a Bohler Braun frame in which the patient's knee assumes some degree of flexion and posterior displacement of fracture fragments prevented to some extent. Static quadriceps exercises as well as active movements of the ankle and toes are possible in this position. The force of traction is transmitted along the long axis of the femur with the patient acting as counter traction. The result is reduction and immobilization of the fracture. Inadequate maintenance of reduction during traction is common.

Fracture union following traction has been reported to occur at about 13-16.5weeks[3,6]. In a series of gunshot fractures of the femur treated by traction, union was reported at 20.6weeks[30]. Forty percent (40%) of patients treated by traction in a comparative study developed significant complications, including delayed union, malunion, shortening, and pin tract infection[6]. Other possible complications include problems of prolonged immobilization (such as thromboembolism), knee stiffness due to patellofemoral and capsular adhesions, malrotation and tethering of the quadriceps muscles[3,6,8,9,15]

**b) Cast Brace**

The cast brace offers the opportunity of early ambulatory conservative management with advantage of early discharge from the hospital[9]. It is preceded by initial traction for a period of about 6 weeks. This is predicated on the finding by Connolly and King upon cineradiography that most midshaft and distal femoral fractures become "sticky" and attain stability by 6weeks[6]. Following application of cast brace, the patient is mobilized with crutches or walking frame and discharged with maximal comfortable weight bearing possible. Active flexion of the knee is encouraged. When the patient is able to bear full weight, the cast brace is removed and union assessed clinically and radiologically[6].

The basic mechanism of cast brace is in preventing bending and rotational forces, while allowing safe intermittent axial compression of the fracture during walking.

The force transmitted across the fracture steadily increases to full body weight as union occurs, but about 20-30% of body weight is consistently carried through the brace throughout union[29].

The results of functional cast bracing of femoral shaft fractures are good with added advantage of short hospital stay and without the risk of infection[6,8,29]. Thomas and Meggit[6] recorded no cases of delayed union or shortening and the time for union was 15.1weeks. Also, good recovery of the knee was observed with over 90 degrees of flexion being present in 50% and 92% of patients at 16weeks and 24weeks respectively.

## Operative treatment

### a) Intramedullary Nailing

Intramedullary nailing was introduced after the second world war and has been widely accepted as a standard procedure for those fractures to which it is applicable, offering excellent healing potential and a low complication rate[8,31,32]. The intramedullary nail is a load-sharing device that has a widespread interface with the bone. It produces little or no stress riser effect because it extends from end to end and requires no holes in the diaphyseal portion of the bone. It can sustain the high stresses of ambulation without breaking or losing fixation because the major stress (that of axial load bearing) is taken up primarily by the bone. For the same reason, the bone cannot be distracted but rather is allowed to impact. Theoretically, this impaction leads to a very low rate of nonunion[24]. This biomechanical situation is enhanced by the particular shape of the femoral medullary canal, which is easily accessible, is almost round, and has a gentle anterior bow. Also, the femur is completely surrounded by heavy soft tissue, from which it can derive periosteal blood supply rather quickly and easily.

Intramedullary nailing can be done closed or open. It can also be done with or without reaming of the medullary canal.

### Intramedullary Devices

A variety of intramedullary devices are available and the most commonly used include[7]:

**Standard Intramedullary Nails-** Examples include Kuntscher, AO, Schneider and Sampson nails. The main objective is to insert the largest diameter nail possible to fill the medullary canal and rigidly control angulatory and rotatory forces.

**Interlocking Intramedullary Nails-** Examples are Klemm Shellmann, Grosse Kempf, Russell Taylor, and the titanium alloy femoral interlocking nail. These devices have transfixing screws for proximal and distal locking. The interlocking devices offer better control in cases of segmental or multi fragmentary shaft fractures.

**Retrograde Interlocking Intramedullary Nails-** Designed to be inserted through the knee joint via an intercondylar portal.

**Flexible Intramedullary Nails-** Examples include Rush and Ender nails. These utilize the three-point principle to stabilize the fracture.

The Kuntscher nail still finds relevance in the intramedullary fixation of femoral shaft fractures in the developing countries in spite of the advent of the interlocking intramedullary devices. This is probably because the kuntscher nail is readily available and cheaper too. Also, it does not require the use of traction table and image intensifier. Traction tables and image intensifiers are not available in a lot of centres in the developing countries because of lack of requisite funds needed to acquire them.

The indications for intramedullary nailing of the femoral shaft fractures include transverse fractures of the femoral midshaft or isthmus, short oblique fractures in the femoral midshaft or isthmus, femoral nonunion at about the isthmus, segmental shaft fractures and comminuted shaft fractures. The relative stability achieved with unlocked intramedullary nail in the fixation of Winquist types I and II fractures cannot be expected for segmental fractures as well as for Winquist types III and IV fractures of the femoral shaft fixed with such unlocked intramedullary device as the kuntscher nail[3].

### Open or Closed Intramedullary Nailing

Open intramedullary fixation requires surgical exposure of the fracture and its reduction under direct vision as prerequisite for inserting the nail. This method of fixation is still very much in use in the developing countries as already noted. Some of its advantages are that no fracture table is required, it does not require image intensifier, and absolute anatomic reduction is easier to obtain unlike in closed technique. Its disadvantages include increased blood loss, increased infection rate, loss of fracture haematoma needed in fracture healing and presence of skin scar[7].

The closed method of intramedullary nailing does not involve surgical exposure of the fracture site, but fracture reduction is carried out with fluoroscopic guidance and with the aid of a fracture table. It is a further refinement in operative technique whose advantages include reduced risk of infection, reduced blood loss, early mobilization, absence of unsightly scar, and an excellent adjunct in the polytraumatized patient[7,24]. Its limitation lies in it being more exacting in detail than open nailing and also in not being applicable where there is soft tissue interposition between fracture fragments. Image intensifiers and fracture tables are not readily available in many centers in our environment and elsewhere in the developing countries, making this technique relatively less popular than the conventional kuntscher device.

**Reamed Intramedullary Nailing**

Intramedullary nailing with reaming has been argued to be the biomechanically ideal method of internal fixation for weight bearing long bones. It permits the use of larger and stronger nails, which provide better stabilization and allows increased torsional resistance, thereby giving a lower rate of implant failure[24,31,32]. Reaming provides internal bone graft which acts locally to stimulate union of the fracture[26,27,31]. On the other hand, concerns have been raised that reaming increases intramedullary pressure and causes the release of bone marrow into the systemic circulation, thus increasing the chances of Adult Respiratory Distress Syndrome (ARDS) by activating the coagulation system. It has also been argued that increased temperature generated in the bony cortex during reaming may cause thermal necrosis of bone, affecting bone healing. Also increased risk of infection has been suggested as a result of disturbance in the endosteal blood supply[23,31]. Although extensive reaming destroys endosteal circulation, some authors believe there is no evidence to suggest that it has any untoward effect on healing of the fracture[13]. The periosteal circulation appears to be at least partly preserved as shown by the external callus that forms[13,26,27]. Similarly, the risk of fat embolism has been suggested to be related more to the fracture than to the technique of fixation[13].

Reaming is either closed or open. Closed reamed intramedullary nailing has been accepted as the treatment of choice for closed and open (Gustilo type I and II) femoral shaft fractures. However, for open types, it must be after thorough wound debridement[14].

**Unreamed Intramedullary Nailing**

The diameter of the intramedullary nail used in unreamed nailing is significantly lower in comparison with reamed nails. This probably strengthens the earlier suggestion that unreamed nailing may lead to implant failure, especially in the case of nails manufactured with steel alloy. However, it is claimed that the introduction of new stronger implants made of titanium alloy has made unreamed femoral nailing an effective option for stabilization of femoral shaft fractures. These new implants have better biomechanical qualities, allowing the use of nails with smaller diameter but sufficient mechanical strength[23,32]. Clatworthy et al[33], however, showed that even with these titanium nails, unreamed nailing performed poorly in comparison with the reamed. Fracture union was slower and the rate of implant failure was higher with unreamed nailing in their study. They further strengthened the suggestion that reaming aids fracture healing and recommended the use of reamed nails.

**Plate Fixation of Femoral Shaft Fractures**

Plate Fixation of the femoral shaft is not considered the surgical procedure of choice for management of femoral shaft injuries. It is usually recommended when the fracture is judged unsuitable for intramedullary nailing[8]. The use of plating is, however, reputed to allow more exact reconstruction of normal anatomy and rigid fixation. Modern techniques of plate fixation using lag screws and compression may succeed in reducing the fracture gap to the point of near invisibility, while at the same time virtually eliminating movement between the fragments. Under these conditions, primary bone healing (contact healing) occurs without the formation of irritation callus as is the situation following intramedullary nailing[27,34]. In addition to a better stabilization, the medullary vascular supply of the bone is less extensively destroyed than by the nailing procedures with reaming[35].

The theoretical advantages of anatomical reduction and rigid fixation are allegedly out weighed by the clinical problems inherent in the use of plating. Plating a fracture of the femoral shaft necessitates extensive operative exposure, increased intra operative blood loss as well as extensive periosteal stripping of the bone. These may be associated with greater possibility of injury to the extensor mechanism, wound haematoma, increased risk of infection, delayed union and implant failure[3,8]. The eccentrically placed plate is exposed to more bending stresses than an intramedullary nail and the risk of fatigue fracture of the implant material is greater. There is also the risk of secondary fracture through an end-screw hole where stress from relatively elastic bone is transmitted to the rigid plate. There is, therefore, the necessity for non weight bearing during the time of fracture healing[8,35]. Furthermore, the possibility of cancellous transformation and disuse osteoporosis in the segment of bone covered by the plate may necessitate a second operative procedure for removal of the plate. Some authors have opined that, although excellent results can be obtained by plate fixation even in very demanding femoral shaft fractures in individual cases, the complication rate with plate fixation can reach unacceptable levels especially in less competent hands[11].

The indications for the use of plate and screws in the operative fixation of femoral shaft fractures are varied. Fractures of the distal third below the flare of the medullary isthmus and other fracture patterns where intramedullary fixation (especially with the unlocked devices) may be inadequate are indications for the use of plates and screws. These include comminuted fractures, long spiral fractures and fractures in or near the junction of the proximal two thirds with the distal one third of the femoral shaft. Also, fractures of the ipsilateral tibia or presence in a multiply injured patient of fractures in three or four limbs may inform the use of plate and screws for the femur. It is believed that positioning of these patients on the operating table in any but the supine position or manipulating a femur in association with a fractured tibia would be difficult and perhaps hazardous[8]

## TIMING OF INTERNAL FIXATION OF FEMORAL SHAFT

Although internal fixation is clearly a major advance in the treatment of femoral fracture, the optimal timing of fracture fixation is still somewhat debated. Timing of femur fracture fixation has been defined as the difference between emergency unit admission time and the time of the operative fixation. It is categorized as Immediate (within 24 hours), Early (within 2-5 days) and Late (after 5 days)[36].

Fixation within the first 24 hours is increasingly performed in the majority of patients in some centres[3,36]. It reduces inflammation at the fracture site, reduces pain and promotes early mobilization of patients and improved pulmonary mechanics. The risk of fat embolism syndrome and Adult Respiratory Distress Syndrome (ARDS) is believed to be less. Fixation within 2-5 days has been reported to be associated with a significantly increased incidence of ARDS. From a pathophysiologic viewpoint, 2-5 days is thought to represent a period when the lung is vulnerable to the insult of reaming and nailing[36]. Delay beyond 5 days appears to allow the aberrant inflammatory response occasioned by elevated circulating Interleukin 6 (IL-6) levels to abate. Also, pulmonary injuries are allowed to resolve sufficiently to withstand surgical intervention with a decreased incidence of ARDS[36].

In our centre and probably elsewhere in this environment, immediate operative fixation of femoral fractures is not a common practice. This is partly due to the policy that patients must pay prior to surgery. In practical terms, most of these patients are hardly able to do so in the immediate post injury periods. Also, such other factors as infrastructure breakdown, lack of implant materials, and lack of operation time have been named as reasons for delayed surgery in our environment[9]. Harry also reported a mean preoperative length of hospital stay as 13 days in a series treated by Kuntscher nailing[9].

Notwithstanding the situation in this environment, there is a consensus among orthopaedic surgeons that femoral fractures in multiply injured patients should be stabilized soon after resuscitation, while stabilization of isolated fractures of the femoral shaft can be performed either electively or immediately[3].

## PREOPERATIVE PREPARATIONS AND PRINCIPLES OF INTERNAL FIXATION

Adequate and careful planning prior to surgery is necessary for a successful outcome. Patients for open reduction and internal fixation of femoral shaft fractures would have had adequate resuscitation to achieve haemodynamic stability in the initial post injury period. Also, the fractured femur is given temporary immobilization by skin or skeletal traction to prevent pain, shortening and angulation at the fracture site.

A typical preoperative routine may include:

a) Determination of the appropriate implant material to be used for a given fracture. This is done after a careful study of the radiographs of the fracture, and taking cognizance of available implant devices in the hospital;

b) Ensuring the availability in the operating theatre of the chosen implant and other instrumentation components necessary for successful conduct of the surgery;

c) Ensuring patients' fitness for anaesthesia by a thorough anaesthetic review;

d) Ensuring basic investigations, including haemoglobin estimation, grouping and cross matching of blood for intraoperative and perhaps postoperative use;

e) Provision of broad spectrum antibiotic for prophylactic use;

f) Provision prior to surgery of prophylactic drugs against thromboembolism for use in the postoperative period. In our centre, the low molecular weight heparin preparations (eg Enoxaparin) are widely used for this purpose in femoral shaft fractures fixation, and indeed in other major orthopaedic and trauma surgical procedures;

g) Obtaining Informed consent for the surgery.

In addition to the foregoing, strict adherence to principles also contributes to good outcome. These principles include adequate and anatomic reduction of fractures, atraumatic soft tissue techniques, minimal periosteal stripping, stable fixation and suction drainage of operation site[34].

## CONTRAINDICATIONS TO INTERNAL FIXATION OF FEMORAL SHAFT FRACTURES

Like in other long bones requiring internal fixation, there are no absolute contraindications. However, when the possibility of a successful outcome with surgery is overshadowed by the probability of complications and failure, non operative treatment is recommended. Some of the contraindications include osteoporotic bones, poor quality of soft tissue overlying bone, active infection, severe contamination, general medical conditions that contraindicate surgery, and inadequate equipment, instrumentation, manpower, training and experience[20].

## PROBLEMS OF OPEN REDUCTION AND INTERNAL FIXATION

The local complication rates after intramedullary nailing and plate fixation were recorded as 4.7% and 24% respectively in the series by Bostman et al[11]. Magerl et al[17] recorded local complication rate of 17.9% among patients treated by plate osteosynthesis. Roberts[8] reported complication rate following plate fixation as 20%. Hansen and Winquist[24], who reported complication rate of 9.6%, further corroborate that lower complication rates follow intramedullary nailing.

These local complications following internal fixation for femoral shaft fractures can be prevented. They include wound haematoma, wound infection, mechanical failure of implant, limb length discrepancy, inadequate fixation, and problems of fracture healing such as delayed union, nonunion and malunion

### Wound Haematoma

Studies have shown that about 20-25% of postoperative haematomas contain bacteria. Aspiration of bacteria-habouring haematoma from the wound by suction drainage reduces the risk of infection[34]. Despite postoperative suction drainage, a haematoma can sometimes form in the operative area. Large haematomas require operative evacuation.

### Wound Infection

Postoperative wound infection may occur despite strict adherence to discipline, and may involve bone as well as soft tissue. In a series by Bostman et al, total infection rate after plate fixation and intramedullary fixation was 5.3%[11]. This figure agrees with that of Katchy et al (5.2%)[14] and compares closely with 6.5% reported by Salawu[37]. Deep infection following intramedullary nailing alone is reported as varying from 3.8% to 5.7% by different authors[9,11,31]. Plate fixation carries higher risk of infection as corroborated by rate of 8.8% reported by Bostman et al[11]. The most common causative organisms were staphylococcus aureus followed by staphylococcus epidermidis and Enterococcus.

### Mechanical Failure

This can be seen as Nail fracture, Nail migration, bent plate, plate fracture and iatrogenic Femoral neck fracture[11,17]. Mechanical failure of fixation is the most common indication for reoperation.

## THE USE OF EXTERNAL FIXATORS IN FEMORAL SHAFT FRACTURES

Although internal fixation is considered the best choice for stabilization of most femoral shaft fractures[38], there are situations where primary internal fixation is unsuitable. These include open fractures, extensive soft tissue damage and when the patient's general condition precludes major surgery. Often, in these situations, external fixation is used for temporary fixation. The standard practice is to convert such external fixations to intramedullary nailing within one to two weeks of the injury[39]. However, due to financial constraints, in many parts of the world, external fixation of femoral shaft fractures is often the definitive treatment, and reasonable results have been reported[40]. The external fixator devices that have been variously used include the AO external fixators, the Hoffmann external fixators, the Wagner device, the custom fixators and the Illizarov- tpye ring external fixators[40,41,42].

The outcome of external fixation of femoral shaft fractures has been reported by various authors. De Bastiani et al[43] reported healing rates of 98% in closed femoral fractures and 89% in open femoral fractures, when external fixation was used as definitive treatment. The reported union rates for external fixation of femoral shaft fractures in series with significant number of open fractures range between 70% and 100%. Also, the reported average healing time was between 3 and 7.5months[44,45,46,47,48,49]. The common complications after external fixation of femoral fractures are pin tract infections and decreased range of motion of the knee joint.

The reported rates of pin tract infections range between 7% and 57%[40,46,48,49]. Decreased range of knee joint motion can be significant after external fixation of femoral shaft fractures, especially when the external fixator is applied across the knee. Murphy et al[47] reported an average flexion of 91 degrees, with 44% of the patients achieving less than 90 degrees. Loss of extension of more than 5 degrees and a range of flexion between 60 and 90 degrees was reported in 28% of patients by Barquet et al[44].

Satisfactory results can be obtained with definitive external fixation of femoral shaft fractures if stable fixation is achieved. A strict postoperative protocol, including early ambulation, physical therapy, stagged removal of the external fixator and protection of the bone after complete removal, is advised[40].

## CONCLUSION

Traumatic femoral shaft fractures are common. Road traffic accidents account for the majority of these fractures. Considerable violence and complex high-energy interactions are required for the normal femur to fracture. Operative fixation is the treatment of choice. However, the use of external fixators in carefully selected cases can be rewarding.

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