

**“A COMPARATIVE STUDY OF MANAGEMENT OF
FRACTURE SHAFT OF FEMUR BY OPEN VERSUS CLOSED
INTRAMEDULLARY INTERLOCKING NAILING”**

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**BY
*DR. DEBOJYOTI MUKHERJEE***

**UNDER THE GUIDANCE OF
DR. B.SHAIK NAZEER
PROFESSOR**



***DEPARTMENT OF ORTHOPAEDICS*
SRI DEVARAJ URS MEDICAL COLLEGE,
TAMAKA, KOLAR - 563101**

MAY 2013

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled “A Comparative Study Of Management Of Fracture Shaft Of Femur By Open Versus Closed Intramedullary Interlocking Nailing” is a bonafide and genuine research work carried out by me under the guidance of DR.B.SHAIK NAZEER, MS. (Ortho), Professor, Department of Orthopaedics, Sri Devaraj Urs Medical College, Tamaka, Kolar.

DR. DEBOJYOTI MUKHERJEE

**Department of Orthopaedics,
Sri Devaraj Urs Medical College,
Kolar – 563 101.**

Date :

Place : Kolar

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled “A Comparative Study Of Management Of Fracture Shaft Of Femur By Open Versus Closed Intramedullary Interlocking Nailing” is a bonafide research work done by Dr. Debojyoti Mukherjee under my direct guidance and supervision in partial fulfillment of the requirement for the Degree of Masters of Surgery in Orthopaedics, Sri Devaraj Urs Medical College, Tamaka, Kolar.

Date :

DR. B.SHAIK NAZEER, MS. (Ortho)

Place :

Professor,

Department of Orthopaedics,

Sri Devaraj Urs Medical College,

Kolar – 563 101.

**ENDORSEMENT BY THE HOD, PRINCIPAL/HEAD OF
THE INSTITUTION**

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research work done by Dr. Debojyoti Mukherjee under the guidance
of Dr. B. Shaik Nazeer, M.S (Ortho), Professor, Department of
Orthopaedics, Sri Devraj Urs Medical College, Kolar**

DR. P.V MANOHAR
Professor and HOD,
Department of Orthopaedics,
Sri Devaraj Urs Medical College
Kolar – 563 101.

DR. M.B.SANIKOP
Principal,
Sri Devaraj Urs Medical College
Kolar – 563 101.

Date :
Place :

Date :
Place :

ETHICAL COMMITTEE CERTIFICATE

This is to certify that the Ethical Committee of Sri Devaraj Urs Medical College Tamaka, Kolar has unanimously approved DR. DEBOJYOTI MUKHERJEE, student in the Department of Orthopaedics at Sri Devaraj Urs Medical College, Tamaka, Kolar to take up the dissertation work entitled “A COMPARATIVE STUDY OF MANAGEMENT OF FRACTURE SHAFT OF FEMUR BY OPEN VERSUS CLOSED INTRAMEDULLARY INTERLOCKING NAILING” to be submitted to the Sri Devaraj Urs Academy of Higher Education and Research Centre , Tamaka, Kolar.

**Signature of the Member Secretary
Ethical Committee
Sri Devaraj Urs Medical College
Tamaka, Kolar – 563101.**

**Signature and seal of the Principal
Dr. M. B. Sanikop
Sri Devaraj Urs Medical College
Tamaka, Kolar – 563101**

**Date :
Place : Kolar**

**Date :
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Date :

Dr.Debojyoti Mukherjee

Place :

ABSTRACT

TOPIC: A COMPARITIVE STUDY OF SURGICAL MANAGEMENT OF FRACTURE SHAFT OF FEMUR BY OPEN VERSUS CLOSED INTRAMEDULLARY INTERLOCKING NAILING.

BACKGROUND:

Orthopaedic surgeons often encounter diaphyseal femur fractures, which most often result from high-energy trauma, one must have high index of suspicion for complications. Currently surgery is indicated for most femur fractures because of high rate of union, low rate of complications and advantage of early rehabilitation which decreases the morbidity and mortality rate in patients. While the main stay of the treatment has been reamed interlocking intramedullary nailing.

OBJECTIVES OF THE STUDY:

To compare the time taken for bone union and the functional outcome in patients with fracture shaft of femur treated with interlocking intramedullary nail. Open versus closed method.

METHODS:

Patients who were admitted with fracture shaft of femur to the department of Orthopaedics in R.L .Jalappa Hospital & Research Centre, attached to Sri Devraj Urs Medical College, Tamaka, Kolar. Duration of study 2 years.

The time taken for bone union, range of movements and the complications encountered during the procedure and later were compared between open versus closed method of intramedullary nailing for fracture shaft of femur.

RESULTS:

In our series age was between 16-70 years, the mean age was 43 years and the incidence was high in the age group of 21-30 years. 57 fractures were in men and 3 fractures were in females. 52 fractures were as a result of road traffic accident, 4 cases were due to direct trauma to the femur and 4 cases were due to fall from height . 40 patients had fracture on the right side and 20 patients had fracture on the left side. Based on Razaq MNU et al²⁶ modification of Thoresen et al³³ criteria results were graded as excellent in 47 cases (78.3%), good in 12 cases (20%) and poor in 1 case (1.7%).

CONCLUSION:

From our study we conclude both closed and open methods of nailing do not differ much with respect to the post operative complication, time of fracture union and the functional outcome. Closed nailing requires more surgical expertise , sophisticated instruments and more time consuming and increased exposure to radiation to patient and surgeon. . Open method of nailing on other hand is less time consuming and less radiation to patient and surgeon with an advantage of accurate anatomical reduction and primary bone grafting

Key words: Fracture shaft femur, interlocking intramedullary nail.

LIST OF ABBREVIATIONS USED
(in alphabetical order)

A.O	-	Arbeitsgemeinschaft für Osteosynthesefragen
DT	-	Direct trauma
HT	-	Height
I.M	-	Intramedullary nailing
OTA	-	Orthopaedic Trauma Association
RTA	-	Road traffic accident
Sup.	-	Superficial
Inf.	-	Infection
Align.	-	Alignment
Wt.	-	Weight
PROX.	-	Proximal
DIST.	-	Distal

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INTRODUCTION

Orthopaedic surgeons often encounter femoral shaft fractures. These fractures most often results from high energy trauma,¹ so one must have a high index of suspicion for complications and associated injuries. In developing countries, femoral shaft fractures are commonly due to increasing incidence of road traffic accident (RTA).¹ Advance in mechanization and acceleration of travel have been accompanied by increase in the number and severity of the fracture. Fracture femur results from the drawbacks of fast life and violence and are major source of mortality and morbidity in patients with such injury. Even with survival after initial trauma, disability usually results from femoral shortening, mal-alignment that can lead to limp and post traumatic arthritis.² The art of femoral fracture care is a constant balance of the often conflicting goals of early functional rehabilitation of limb and complications.

The art and science of fracture management has tremendously advanced over the years. From the use of external splints in the Hippocratic age, to the recent sophisticated instrumentation and implants, treatment of fracture has made an impact in the surgical field.

Currently surgery is indicated in most of the femur fractures because of high rate of union, low rate of complication and advantage of early rehabilitation which decreases morbidity and mortality in patients.³

Intramedullary (IM) nailing is one of the 20th century's greatest advances in treatment of fractures and in the past 2 decades IM nailing has become the gold standard in the management of femoral diaphysial fractures .

The advent of interlocking nailing has widened the spectrum of femoral shaft fractures that could be stabilized by IM technique. Use of interlocking nailing minimizes the incidence of leg length discrepancies, rotation and

angulation deformities , preserves the blood supply to aid union and prevent infection, and rehabilitate the extremity and thereby the patient early. ⁴

Intramedullary nail being close to centre of femur can tolerate bending and tortional loads better then plates and the locking mechanism provides less tensile and shear stress than plates. IM interlocking nail is a load sharing device and less loded than plates causing less cortical osteopenia of stress shielding which is feature of the load bearing plates.

Open nailing of the femur involves inserting the nail after exposing the fracture. The advantages of this method include less expensive equipment is required than is needed for closed nailing, no special fracture or operating table is required, no image intensifier is required ,no period of preliminary traction is required to distract the fracture, absolute anatomical reduction is easier to obtain than with closed techniques.,direct observation of the bone may identify undisplaced and undetected comminution not noted roentgenographically, precise interdigitation of the fracture fragments improves rotational stability, in segmental fractures the middle segment can be stabilized, preventing the torquing and twisting associated with closed reduction and medullary reaming,in nonunions opening of the medullary canals of the sclerotic bone is easier and rotational mal alignment is rare after open reduction. ⁴

The present study is to compare the functional outcome of open versus closed intramedullary interlocking nailing of fracture shaft of femur as we see many Road Traffic Accidents victims with femoral shaft fractures both open and closed type in R L Jalappa Hospital because it is situated on the national highway. We prospectively analysed 30 cases of closed nailing and 30 cases of open nailing from time of admission to a minimum of 6 months of post-operative period.

AIMS AND OBJECTIVES

1) To compare the functional outcome of closed intramedullary nailing versus open intramedullary nailing of fracture shaft of femur.

2) To assess the

- a) Intra-operative difficulties and complications.
- b) Operative time.
- c) C-arm exposure.
- d) Post-op complications.
- e) Time to fracture union.
- f) Time of ambulation.
- g) Range of motion.

HISTORICAL BACKGROUND

The treatment of midshaft fractures of the long bones has significantly evolved in the last 150 years.

Before the turn of the century, fracture shaft femur used to be treated with wood splints wrapped with leather or fibrous plants and various fabrics encased with wax or gum.

The history of intramedullary (IM) nailing for the treatment of long bones fractures started from Mexico in the 16th Century. Since then, there has been great change in design, materials and basic science principles which have led to well accepted and successful methods of intramedullary nailing of diaphyseal fractures.⁵

To the early surgeons, stabilization of diaphyseal fractures was difficult more so in open fractures and dilemma was which way to go – Amputation by the radical surgeons or conservative treatment to save the limbs. At that time the surgeons had only the above two options.

During the American Civil War, Smith's anterior splint was used but led to ulcerations and malunion and was not popular. It was clumsy with the leg suspended from the ceiling and traction obtained by moving the bed forwards/backwards.⁵

The next was Hodgen Wire Cradle Extension Suspension Splint which was a wire splint suspension device to ensure complete extension of the limb and prevent contractures. Then followed the famous Thomas Splint used in the first world war.⁵

Methijesen a Dutch surgeon in 1852 reported the use of plaster of Paris for immobilization of fractures.⁵

Advances in asepsis in 1856 by Pasteur, and introduction of X-rays in 1895 further improved management of these fractures. The first allowed clean surgery while the latter allowed closed reduction of fractures.

Buck a U.S.Military surgeon in 1861 described skin traction for femoral shaft fractures with knees extended.⁵

In 1897, Ronsohoff promoted open reduction internal fixation for irreducible fractures.

Steinmann a Berlin surgeon in 1907 described his "pin" which when introduced in distal femur and weights added, was useful in femoral shaft fractures.⁵

Russel an Australian surgeon 1921 described a technique of treatment of femoral shaft fracture with skin traction and double pulley system which allowed motion of hip and knee.⁵

Bohler in 1929 published his text on non operative treatment of fractures. He developed his "Bohler's frame" which when combined with skeletal traction was used in treatment of femoral shaft fractures.⁵

Rush LV and Rush HL In 1939 described a technique, of introducing a longitudinal pin in fixation of certain fractures of femur.⁶

The first and second world wars had amputation as the surgery of choice until the development of the Kuntsher Nail (1939) for femoral shaft fractures.

Then followed interlocking nails, Ender nails, the telescoping nail and lastly the elastic intramedullary nails used in children and adolescents.

Intramedullary nailing is now the gold standard of the treatment of most diaphyseal fractures of the lower limbs.

Introduction of the technique was met with skepticism and hostility in Europe and America during the early 20th century but was later accepted as the main therapeutic method of choice and has greatly improved the patient outcome.

Evolution of Intramedullary Nailing

Gerhard Kuntcher of Germany in 1900 developed interest in intramedullary devices. He fought skepticism, hostility and outright rejection to eventually win the battle after his colleagues called for him to be forbidden from performing future nailing because “no one should be allowed to place iron rods into human bone.”⁵

He set out its principles i.e. closed procedure, stable fracture fixation, no external fixation, early weight bearing and a rehabilitation program. First he devised the nails which he called “the marrow nail”. He conducted cadaveric and animal studies.

The initial nail was V-shaped stainless steel nail but later changed to a hollow nail with slot and clover leaf section. It was inserted ante-grade.

The first human nailing was done in November 1939. He performed the operation with “trembling and quail”. He suggested the nail would act as an internal splint and create elastic union with the inner medullary cavity. He recommended closed fixation without interfering with the fracture hematoma and reduction of infections, risks, reduced blood loss, early mobilization and

decrease of non unions and decrease in overall morbidity. He achieved closed reduction by using traction slings and aid of head worn fluoroscopy gadget.

Intramedullary nailing in the 1940-80's

In the 1940s various other intramedullary designs were introduced.

In 1942 Fischer has reported in German Literature use of intramedullary reaming to increase area of contact with the nail and bone.

Westborn reported his experience with V-shaped nail in the Scandinavian literature in 1944.

In 1946, Soeur reported use of a V-shaped nail in the femur.

In America, the Hansen-street nail was introduced in 1947. This was a solid diamond shaped nail designed to resist fracture rotation by its compressive fit within cancellous bone. They were initially inserted by closed method to avoid infection but later changed to open retrograde nailing after introduction of penicillin.⁵

In 1950s the introduction of locking nail by Modny and in 1953 by Bambara , they reported 261 femoral fractures with excellent results. Their nail had multiple holes through out the length of the nail to allow interlocking screws at 90°.

In the 1950s Gerhard Kunstcher⁷ developed flexible reamers thereby allowing smooth reaming which led to wider acceptability by many surgeons. He showed that although intramedullary reaming destroyed endosteal blood

supply the periosteum and surrounding tissues would promote adequate bone formation for healing.⁵

Kuntscher in 1957 introduced the technique of reaming in AAOS meeting.⁸

AO/ASIF⁹ group to develop internal fixation was formed in 1958. AO/ASIF originally developed a thin walled flexible and partly slotted femoral intramedullary nail with a clover leaf cross section and a slight curvature of the axis. The slot was placed on the convex side.

The introduction of compression plate by the AO group led to many surgeons doing open reduction and rigid internal fixation with plates and screws which produced healing per primam without callus or “primary healing”. But later this was questioned by proponents of closed nailing by proving small imperfect reductions in IM nails far outweighed open reduction and internal fixation (O.R.I.F) in respect of fracture healing, good periosteal vascularisation and lot of callus formation which led to strong healing of the fractures with formation of “per secundam” periosteal callus.

In the 1960s, development of Image Intensifiers (C-arm), allowed more surgeons to do intramedullary nailing without fear of radiation to the patients and the health workers.

Kaessman in 1966 devised compressing nailing with distal locking bolt.⁵

In 1967 the Zickel nail was introduced which has a hole in the proximal portion to allow a screw to be placed into the femoral neck and head to prevent backout of the nail. Kuntscher in 1968 proposed a new device for intramedullary osteosynthesis in comminuted fractures. It was called the"

Detensor nail". It consisted of proximal and distal locking bolt and was forerunner of interlocking nails.¹⁰

Reduction during closed nailing was initially performed by traction applied through thigh straps above and below fracture site attached through ropes to hooks in the walls of the operating room.¹¹

The enthusiasm of compression plating of the femur diminished in the 1970s and renewed interest in refining closed intramedullary nailing techniques. The use of reaming gained acceptance and unreamed nailing was left only for the open fractures.

Klemm and Schellaman In 1972 introduced the interlocking nails, following initial success with this treatment of infected nonunion, they began treating comminuted fractures making appropriate changes in design and technique with experience.¹²

Grosse and Kempf in 1976 modified the nail further to include proximal cylindrical internally threaded portion and 45° proximal diagonal screw fixation and moved the distal transfixation holes closer to the tip of the nail.¹²

Steen Jensen et al¹³ 1976 compared results of plating and nailing of femoral shaft fractures. They reported frequency of non union, infection, implant failure more in plating. Early weight bearing was possible in nailed group, stressing the need for using intramedullary nailing.

Reis N.D. et al¹⁴ 1977 studied different modalities of treatment in infraisthmal fracture shaft femur. They showed need for additional derotation plate along with simple intramedullary nail.

Rothwell et al¹⁵ 1978 showed the importance of complete instrumentation, proper positioning of patient on table to improve results. Also observed the decreased infection rate following closed nailing, so insisting closed nailing.

William Allen et al¹³ 1978 studied the efficacy of fluted rod. It is stronger in torsion and bending thus allowing early mobilization. Effective in non-union and pathological fractures. No nail breakage reported. Anatomical reduction necessary before nail insertion to avoid comminution during nailing.

Aginski et al¹⁶ 1979 describes effect of reaming and biomechanics of nailing. They showed the need for use of compression nailing. Reaming causes blocking of blood supply causing ischemia of fracture fragments. So, reaming should be minimum. Vacuum suction along with reaming reduces blocking of blood vessels and thus reduces ischemia.

Kenneth Johnson et al¹⁷ 1984 describes failure rate of 66% with roller traction, 39% with intramedullary nailing with circlage wires and 4% failure rate with interlocking nailing. Proving superiority of interlocking nailing, this technique was technically demanding so complete set up and instrumentation was required.

Marion et al¹⁸ 1985 demonstrated correct entry point for nailing of fracture shaft femur was at the junction of neck femur and greater trochanter and just anterior or in the piriformis fossa.

Browner DB in 1986 studied the pit falls, errors and complication with Grosse-Kempf, Schellmann and suggested addition of percutaneously inserted transfixion screws or internally deployed fins supplements the stabilization potential of the cloverleaf nail for fractures with comminution or bone loss, malunions, and nonunions located outside of the isthmus region of the femur.¹⁹

Hanks A et al in 1988 treated fifty femur fractures with Brooker - Wills interlocking nail. They concluded that results were comparable with other interlocking systems and that Brooker - Wills nail is useful in treatment of complex fractures of femur and effective in controlling shortening, rotation and angulation.²⁰

Brumback RJ et al in 1988 suggested adequate analysis of high quality radiographs at each of these stages and to reserve dynamic locking for transverse and short oblique fractures at the femoral isthmus that have type I or II comminution.²¹

Brumback RJ et al in 1988 studied fracture healing with static Russel - Taylor interlocking fixation in 100 fractures to determine the incidence of union without dynamization 98% healed and 2 needed conversion to dynamic locking. They concluded that static locking does not appreciably inhibit the process of healing and routine dynamization occasionally necessary, need not be performed.²²

REVIEW OF LITERATURE

The management of femoral diaphyseal fractures evolved from the conservative approach to the most rational closed and open intramedullary interlocking nailing.

Closed technique of intramedullary nailing takes more operative time, use of image intensifier (C-arm), exposure to radiations, a special fracture table, likely rotational mal alignment that needs attention while locking. The prevalence of external rotation deformity, shortening and angulations was higher. With no damage to the fracture hematoma and fracture shavings caused by reaming duration of union was shorter and prevalence of non union was lower with less complications and early return to function. Early weight bearing, shorter hospital stay, low infection rate and short skin scars.^{23,24,25,2,26.}

Open technique of intramedullary nailing requires less operative time, no special operative table, least exposure to the image intensifier (C-arm) only during distal locking, anatomical reduction, direct observation of bone may identify undisplaced and undetected comminution not noted in X-ray and even bone grafting can be done if required and precise interdigitation of the fracture fragments that improve rotational stability and rotational mal alignment but fracture hematoma which is important for healing is evacuated and bone shavings created by reaming the medullary canal often are lost thus decreasing rate of union, infection rate is more, and longer skin scars.⁴

In a study of functional outcome of locked intramedullary nailing in 32 patients with diaphyseal femur fracture was found to be excellent.²⁷

In a study closed and open interlocking nailing showed 99.1% union rate. Advocates early nailing in polytrauma patients. Showed need for adequate preoperative traction whenever nailing was delayed, proper positioning on table and correct entry point through piriformis fossa. Rotational forces were well controlled by interlocking nails.²⁸ In another study

simple method of inserting the distal screws in a locked femoral nail using a 3mm k wire and an air drill was demonstrated.²⁹

In a prospectively study of 54 cases of closed nailing, 64 cases of open nailing and compared with 38 cases of conservative treatment group. They concluded that intramedullary nailing is definitely better than conservative treatment. They reported 86% good, 14% fair and no poor results in closed nailing whereas 79% good, 21 % fair and no poor results in open nailing. They also had increased intraoperative complication in closed nailing, equal rates of infection in both. They had no non union in any group. Their patients in closed nailing returned to work earlier than the open nailing group but noticed no significant changes in rates of union.³⁰

In a comparative study of treatment of femoral shaft fractures by open and closed intramedullary fluted rod it was reported postoperative complications in 10 cases of closed nailing which included 5 of malrotation. Four cases of open nailing had intra op complications which included 2 infection, 1 knee pain and 1 mal alignment. Their mean time to weight bearing was 8.8 weeks and 9.8 weeks in closed and open group, and average time to union 14.3 week and 13.9 week respectively. Difference in functional results at final follow up was insignificant both groups. They concluded to achieve near anatomical reduction before insertion of nail to prevent fracture comminution and some of the cases needed postoperative external splinting or traction to prevent malunion, mostly in comminuted fractures.³¹

In a study locked intramedullary nails control rotation and telescoping by locking nail with the bone. Closed nailing further increased advantages of early union . Dynamisation was required before weight bearing.³²

In a study of femoral shaft fractures with Groose - Kempf interlocking nailing. 30 had excellent, 8 had good, 7 had fair and two poor results. Median

time to weight bearing was 30 days, median time of radiographic consolidation was 16 weeks. Complications included shortening in 7 patients (1.5 to 9cms), varus, valgus or recurvatum In 5 patients (15° - 20° .) with one delayed union. They concluded that interlocking nailing was a useful method and recommended static method be used whenever in doubt about fracture stability, this had no impact on fracture healing.³³

In a retrospective study of open versus closed intramedullary nailing of femoral shaft fractures. Closed nailing had 92% satisfactory results; open nailing had 97% satisfactory results, not statistically significantly different.³⁴

In a study of thirty three segmental fractures (26 closed and 7 open fractures) by G.K nail, thirty two united at average of thirty two weeks with one non and one delayed union and two malunions. They concluded that closed interlocking nailing is the treatment of choice for most segmental fractures of shaft of femur.³⁵

In a comparative study of open vs closed nailing of 35 femoral fractures in the poly trauma patients. The median time to fracture healing was 5.0 months in the open group and 4.1 months in the closed group, with an average follow-up of 18 months in both groups. There were no superficial or deep infections in either group.³⁶

In a prospective study of 106 patients undergoing static interlocking nailing of femur to determine the relationship between duration and magnitude of intraoperative traction and development of pudendal nerve palsy in supine position. 10 patients developed pudendal nerve palsy. They concluded, that the magnitude of intraoperative traction not the duration of the procedure to be cause, and advised minimization of tractions during the procedure to decrease complication.³⁷

In a prospective study on 267 fractures of shaft femur treated with a static interlocking I.M. nail comparing one versus two distal screws. They concluded that proximal and middle third fractures of femur could be successfully treated with single distal screw without compromising fracture fixation, thus reducing operating and radiation exposure time and incidence of soft tissues irritation by new screw head. In distal third fractures, however two distal screws should be used to avoid potential angulatory deformity.³⁸

In a study of primary immediate and delayed reamed intramedullary nailing of open femoral shaft fractures, the infection and nonunion rate was 2.4%. Comparison between the two groups showed no significant difference in incidence of infection, nonunion, malunion or time to union.³⁹

In a study on improved intramedullary nail interlocking in osteoporotic bones, they showed the biomechanical benefits of increasing the bone-implant interface for improving the acute stiffness and strength of fracture fixation in osteoporotic bone. The fixator-bone construct withstood higher forces before failure in these fragile bones.⁴⁰

In a study on the image intensifier and orthopaedic surgeon. Femur interlocking was associated with higher scatter radiation than tibia due to larger surface area and difficult distal locking. The highest average dose of radiation up to 100 millirem can occur in interlocking nail of femur and maximum radiation can occur during distal locking of nail.⁴¹

In a study on the treatment of nonunions following intramedullary nailing of femoral shaft fractures. They concluded that exchange nailing without extracortical bone grafting seems to be the most effective method to treat a disturbed union of a femoral shaft fracture after intramedullary nailing.⁴²

In a study on distal locking of femoral nails under direct vision through a cortical window. Mean time to radiographic union was 12.5 weeks (range 9-

18 weeks) and all patients had regained at that time full, pain-free range of motion of the ipsilateral knee joint. All cortical windows healed uneventfully within 3 months. No infections, instrumentation failures, refractures, or fractures through the cortical window occurred.⁴³

In a study on computer-assisted image-guided intramedullary nailing of femoral shaft fractures. The main goals of computer-assisted surgery (CAS)-based systems were to reduce the cumulative radiation exposure; to reduce the complications stemming from alignment and positioning errors of bone fragments and surgical tools and to improve the accuracy of distal locking.⁴⁴

In a study on mini-open intramedullary nailing of 82 acute femoral shaft fracture: reduction through a small incision without a fracture table. The surgical technique involved a mini-wound at the fracture site, and fracture reduction was performed with 1 finger or a bone hook without the use of a fracture table. Seventy-four fractures (97%) healed in the first 6 months. The mean operation time for the procedure was 75 minutes.⁴⁵

In a study on trochanteric nail insertion for the treatment of 60 femoral shaft fractures, forty-six of 57 (81 %) surviving patients were available for follow-up at a minimum of 12 (range, 12-25) months. Union occurred in all but 1 fracture after the procedure. No patient sustained iatrogenic fracture comminution, and there were no angular malunions.⁴⁶

In a prospective study on close versus open interlocking nailing of 104 patients with fracture shaft of femur, the union rate at 12 months period was 93% in closed group and 87.7% in open group. They concluded that open interlocking nailing can be applied at the very basic level of Indian health infrastructure where the facilities of image intensifier and surgical expertise are still lacking.⁴⁷

In a study of closed versus open interlocking nailing of 136 adult patients shows total union rate of 96%, in which nonunion was observed in 2 cases in closed and 4 in open method.²³

In a study of management of closed femur shaft fractures in 47 patients by open interlocking nailing, union rate after evaluating both clinically and radiologically for 8 months was 97.83% in open group at 32 weeks after surgery and the Mean $\pm$ SD time of union was 19.65 $\pm$ 5.19 so open interlocking nailing technique has excellent results in fracture union.²⁶

ANATOMY OF FEMUR

The femoral shaft has a physiologic anterior curve .The external circumference of the femur is triangular exhibiting three surfaces: anterior, lateral, and medial .The greatest cortical thickness is posteriorly, where the fascia inserts to the linea aspera , a two-lipped roughened line The medial and lateral lips of the linea aspera diverge proximally and distally, the lateral lip becoming continuous proximally with the gluteal tuberosity. The medial lip extends up to the undersurface of the femoral neck. Lateral to this lip is a ridge, the pectineal line, descending from the lesser trochanter.

Both proximally and distally the femoral shaft loses its triangular form and becomes four-sided. The medullary cavity varies in diameter and shape .Slightly proximal to the midshaft is the isthmus, where the circular medullary cavity is its narrowest with a diameter of 8 mm to 16 mm compared with the otherwise more oval medullary canal .

On the posterior side of the femoral diaphysis attach the pectineus, adductor brevis, adductor magnus, adductor longus, and gluteus maximus muscles. From the femoral shaft originate muscle vastus lateralis (upper half of the intertrochanteric line), vastus medialis (medial lip of linea aspera and spiral line of femur), muscle vastus intermedius (anterior and lateral aspect of upper two thirds of femoral shaft), the short head of muscle biceps femoris (linea aspera and lateral supracondylar line of femur), and muscle articularis genu. The muscles of the thigh are encased by dense fibrous tissue.⁴⁸ The fascia lata reinforces the lateral aspect to form distally the iliotibial tract, which on the lateral side extends to the Gerdy's tubercle of the tibia .

The thigh extends superficially from the inguinal ligament anteriorly and the gluteal skin fold posteriorly to the knee level. Superficial fascia contains cutaneous nerve branches from the lumbar plexus (the lateral femoral

cutaneous nerve), the femoral nerve (the anterior and medial femoral cutaneous nerves), the obturator nerve (medial aspect of the thigh), and the genitofemoral nerve (the ilioinguinal branch). The included arteries are the superficial circumflex iliac, the superficial inferior epigastric, and the superficial external pudendal arteries branching from the common femoral artery. The great saphenous vein has the ramifications of the superficial circumflex iliac, the superficial inferior epigastric, and the superficial external pudendal veins at the region .

The thigh contains three distinct fascial compartments. The anterior compartment encases the knee extensor muscles (quadriceps femoris including rectus femoris, vastus intermedius, vastus medialis, and vastus lateralis; and sartorius) innervated by the femoral nerve from the lumbar plexus L 2-4 for the quadriceps femoris and L 2-3 for the Sartorius.

The rectus femoris muscle is also a weak flexor of the hip. The sartorius flexes, abducts, and medially rotates the thigh.

The anterior compartment also includes the tensor fasciae latae, the iliacus and psoas major muscles, and the femoral artery and vein, femoral nerve, and lateral femoral cutaneous nerve.

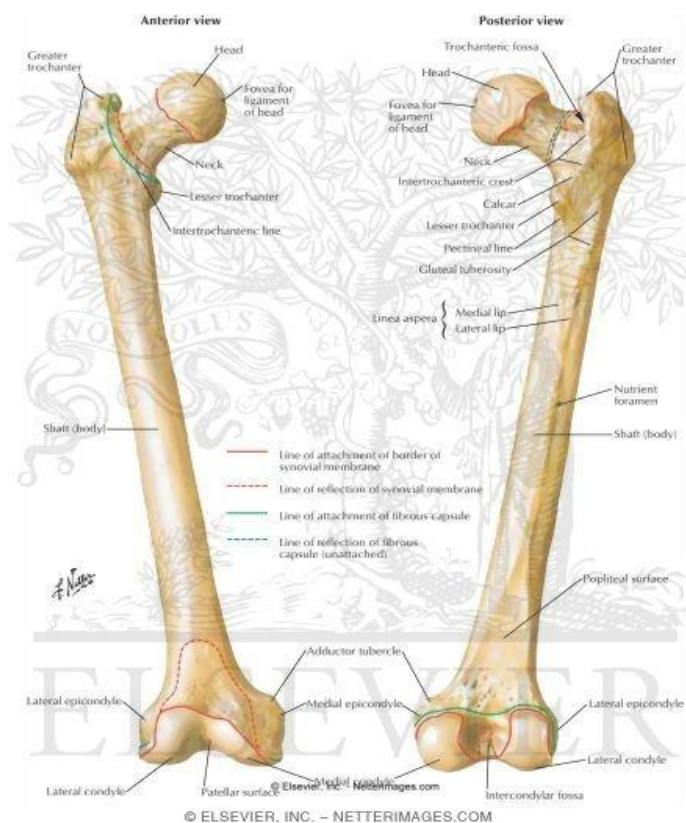
The medial compartment contains the adductor muscles (gracilis, adductor longus, adductor brevis, adductor magnus, pectineus) and the obturator externus muscle, which are supplied by the obturator nerve. The pectineus and the adductor magnus muscle receive dual innervation: the former from the femoral nerve and the latter from the sciatic nerve . The medial compartment also includes the deep femoral artery, obturator artery and vein, and obturator nerve.

The posterior compartment includes the flexor muscles (biceps femoris, semitendinosus, and semimembranosus), which extend the hip, and a portion of

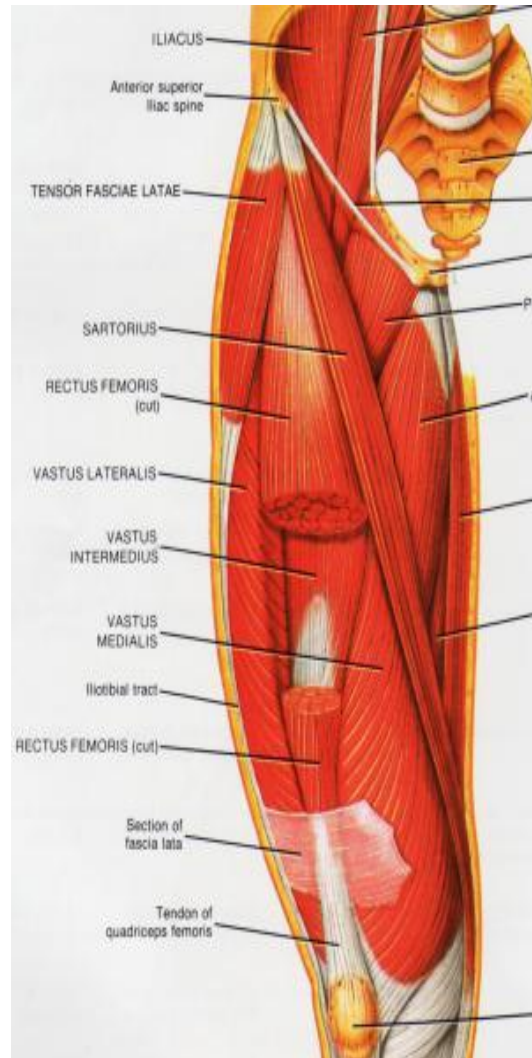
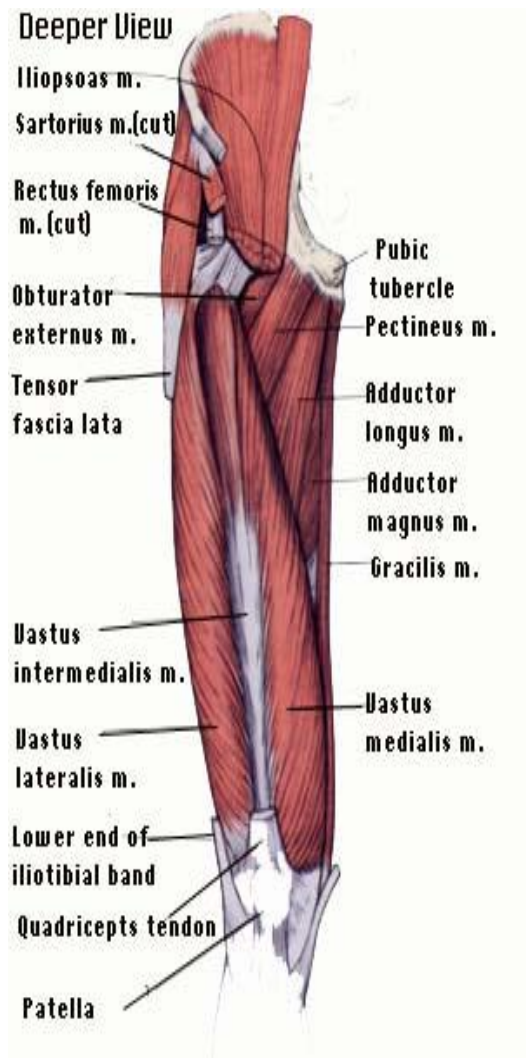
the adductor magnus muscles, as well as branches of the deep femoral artery, sciatic nerve, and posterior femoral cutaneous nerve. The posterior knee flexor group is innervated by the sciatic nerve. The biceps femoris extends, adducts and laterally rotates the thigh, as well as flexes the lower leg.

The long head of the biceps femoris is innervated by the tibial nerve (L5-S2), and the short head receives innervations from the common peroneal division (S1-2). The semimembranosus and semitendinosus muscles also act as medial rotators of the thigh, and are innervated from the tibial nerve (L5-S2) .

The intermuscular septum between the anterior and posterior compartments is thicker than the septa between the medial and anterior compartments.⁴⁸ Because of the high volume of these three compartments, compartment syndrome of the thigh is much less common than that of the lower leg.⁴⁸



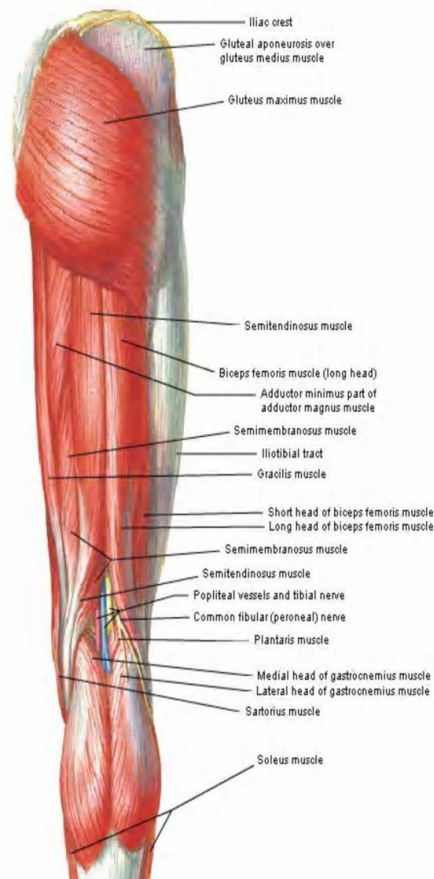
FEMUR BONE



MUSCLES OF ANTERIOR ASPECT OF THIGH

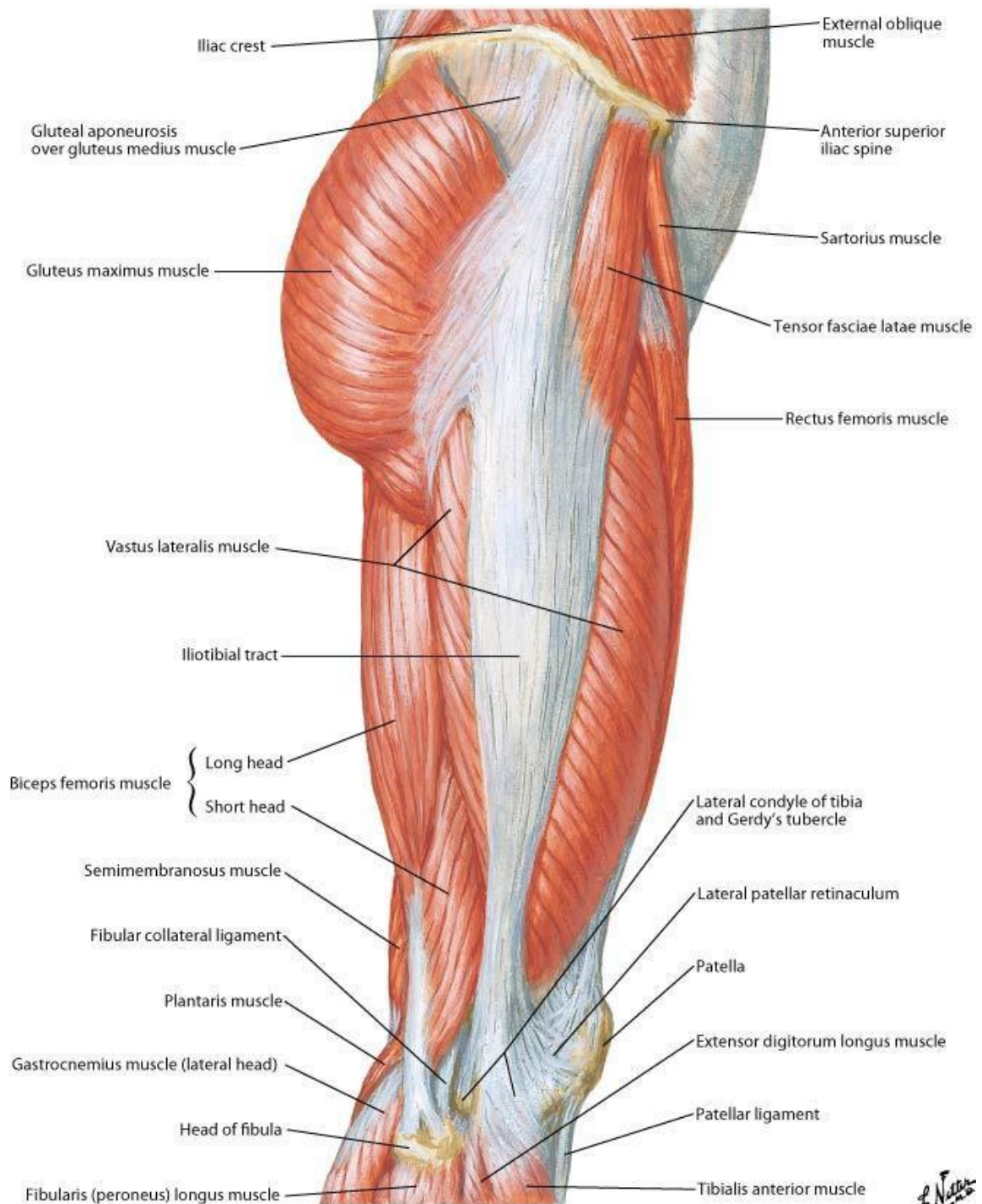
Plate 477A

Muscles of Hip and Thigh Posterior View - Superficial Dissection



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MUSCLES COVERING POSTERIOR ASPECT OF THIGH



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MUSCLES OF LATERAL ASPECT OF THIGH

BLOOD SUPPLY OF FEMUR

The arterial supply of the femur is mainly derived from the deep femoral artery (a. profunda femoris).⁴⁸ From its branches, the lateral circumflex femoral artery, supplies blood to the extensor muscles, while other proximal branches provide vascular supply to the adductor muscles, and, more distally, three perforating arteries supply the flexor muscles.

The muscular branch of the superficial femoral artery supplies blood to the vastus medialis muscle. The femoral shaft has periosteal and endosteal blood supply. The endosteal circulation of the femoral diaphysis is predominately derived from a nutrient artery that branches from the first perforating branch of the deep femoral artery, enters the bone proximally and posteriorly through a nutrient foramen in the middle of the diaphysis near the linea aspera, and arborizes proximally and distally.⁴⁸

Very seldom, a second nutrient artery exists distally, but no major artery enters the lower third of the shaft. Under normal physiologic conditions, the circulation is endosteal to the inner two thirds to three quarters of the, and periosteal to the outer one quarter of the cortex.

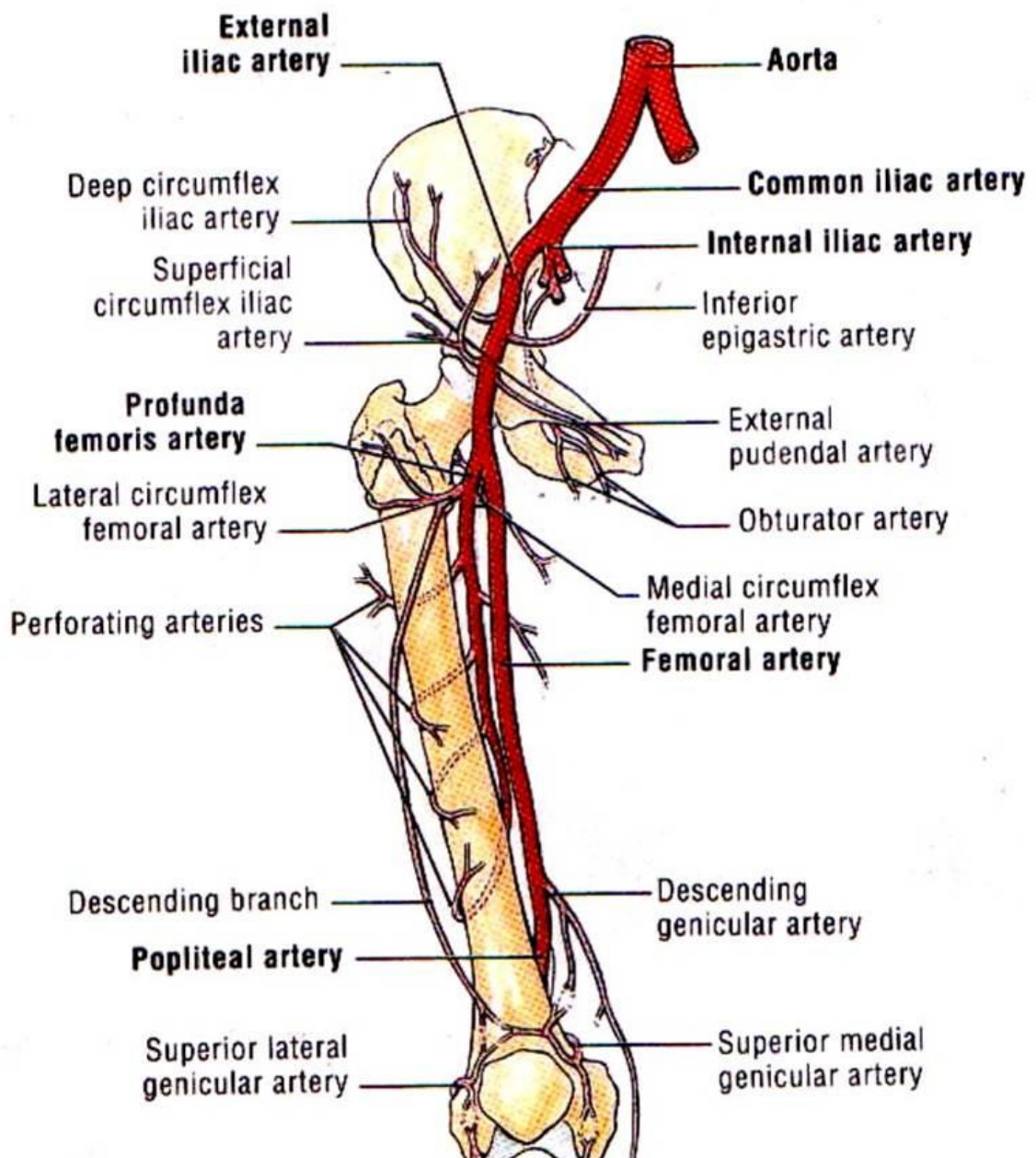
Endosteal circulation anastomoses with the numerous small periosteal vessels that are derived from the adjacent soft-tissues. The periosteum is protected from complete vascular disruption by an extensive collateral circulation and perpendicularly orientated vessels, which seldom undergo major stripping with the exception of severe open injuries or perioperative injuries that can possibly result in delayed fracture healing.⁴⁸

The normal blood flow is centrifugal, although some blood returns to the large venous sinusoids of the medullary canal. After diaphyseal fractures, the circulatory pattern is altered. In a nondisplaced fracture of the shaft, the endosteal supply can be relatively undisturbed and remains dominant, whereas

displacement results in a complete disruption of the medullary vessels. Proliferation of the periosteal vessels is the paramount vascular response to a fracture, and the rapidly enhanced periosteal circulation is the primary source of cells and growth factors for healing. The medullary blood supply is eventually restored during the healing process.⁴⁸

Preservation of the muscle envelope around the fracture enhances revascularization of the injured bone and promotes periosteal callus formation. Earlier studies on the blood circulation of long bone fractures treated with intramedullary nailing suggested that an intramedullary nail, when introduced into the medullary cavity, affects the intramedullary vascular system and causes ischemia of the inner 2/3 of the cortical bone, which has been concerned in several studies on different nail designs .

Intramedullary reaming causes additional destruction of the endosteal circulation of a long bone .Unreamed nailing diminishes the circulation of the inner cortex by 30%. Extensive reaming may reduce the cortical blood flow by 30-70% and the total bone blood flow by up to 50%. A sixfold increase in periosteal blood flow has been measured after reaming.



BLOOD SUPPLY OF FEMUR

MECHANISM OF FRACTURE SHAFT FEMUR

The femoral shaft fracture occurs as a result of motor vehicle accidents, fall from heights, house collapses, railway accidents and gun-shot injuries. The injury is more common in younger age group.

Fracture pattern varies according to the direction and quantity of force absorbed .

- Angular forces : Produces transverse fractures, with butterfly fragment, segmental fractures .
- Torsional forces : Produces oblique or spiral oblique fractures .
- Penetrating forces : Produces comminution of shaft of femur or segmental fractures.

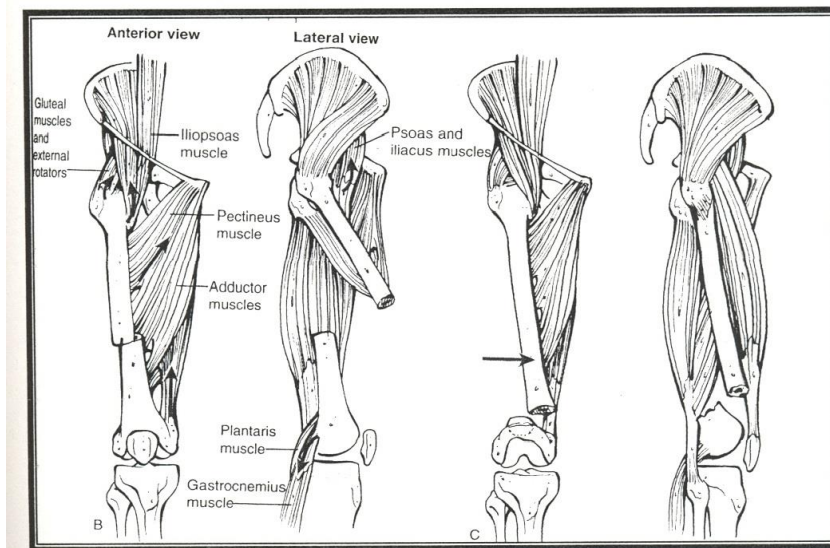
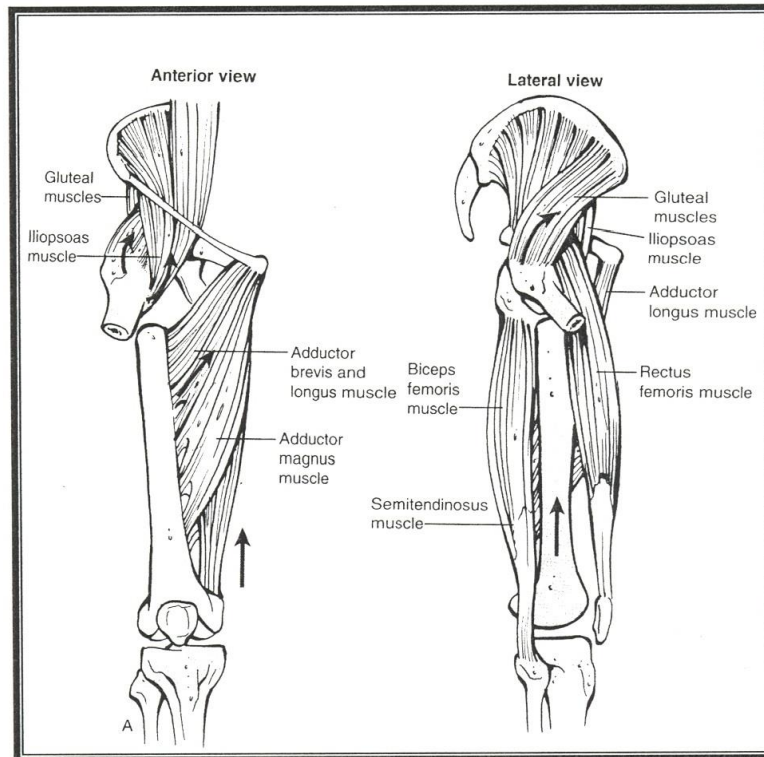
Displacement in femoral shaft fractures is a resultant of three forces: impinging violence, muscle action, and gravity. As an initial fracture deformity, the proximal fragment of a fracture of the proximal third of the femoral shaft is usually abducted by muscles gluteus medius and gluteus minimus, which both insert in the greater trochanter . The proximal fragment is flexed and externally rotated due to muscle iliopsoas that inserts in the lesser trochanter. The distal fragment is displaced upward and medially by the adductor and hamstring group of muscles. In the middle third, the proximal fragment is frequently adducted with a strong axial and varus load due to the adductor muscles, and flexed due to the iliopsoas muscle.

The distal fragment is externally rotated by the weight of the, and displaced upward and posterior due to the adductors and hamstring muscles. The distal fragment of the supracondylar fractures is usually flexed posteriorly secondary to the pull of the gastrocnemius muscle, and can cause damage to the popliteal artery, the popliteal vein, the tibial nerve, and the common peroneal nerve .

The proximal fragment is pulled in flexion and adduction by the iliopsoas and adductor muscles. The extensors, such as muscle rectus femoris,

muscle sartorius, and muscle gracilis, as well as the flexors, except the short head of muscle biceps femoris and the tractus iliotibialis, can also cause longitudinal dislocation of the fracture fragments of the femoral shaft .²¹

OBSERVED DEFORMITIES AND DISPLACEMENTS WITH RESPECT TO MUSCLE ATTACHEMENTS AND FRACTURE LOCATION



CLASSIFICATION OF DIAPHYSIAL FEMORAL FRACTURES

1. Based on anatomical location

- a. Proximal third
- b. Middle third
- c. Distal third

2. Based on relation of fracture to environment :

- a. Closed fracture
- b. Open fracture (by Gustilo Anderson's classification) ⁴⁹

Gustilo classification of open fractures⁴⁹

Grade I : The wound is less than 1 cm long. It is usually a moderately clean puncture, through which a spike of bone has pierced the skin. There is little soft-tissue damage and no sign of crushing injury. The fracture is usually simple, transverse or short oblique, with little comminution.

Grade II : The laceration is more than 1 cm long, and there is no extensive soft tissue damage, flap or avulsion. There is slight or moderate crushing injury, moderate comminution of the fracture and moderate contamination.

Grade III : These are characterized by extensive damage to soft tissues, including muscles, skin and neurovascular structures and a high degree of contamination. The fracture is often caused by high velocity trauma, resulting in a great deal of comminution and instability.

III A : Soft tissue coverage of the fractured bone is adequate.

III B : Extensive injury to, or loss of soft tissue, with periosteal stripping and exposure of bone, massive contamination, and severe comminution of the fracture. After debridement a local or free flap is needed for coverage.

III C : Any open fracture that is associated with a vascular injury that must be repaired, regardless of the degree of soft tissue injury.

3. Radiological classification⁴⁸

- a. Transverse fracture
- b. Short oblique fracture
- c. Long oblique fracture
- d. Spiral fracture
- e. Segmental fracture
- f. Comminuted fracture

4. AO / ASIF classification⁴ - AO/OTA Femur Diaphysis - Bone segment 32

A) Simple fracture

- A1 - Simple spiral
- A2 - Simple Oblique (30° or more)
- A3 - Simple transverse

B) Wedge fractures

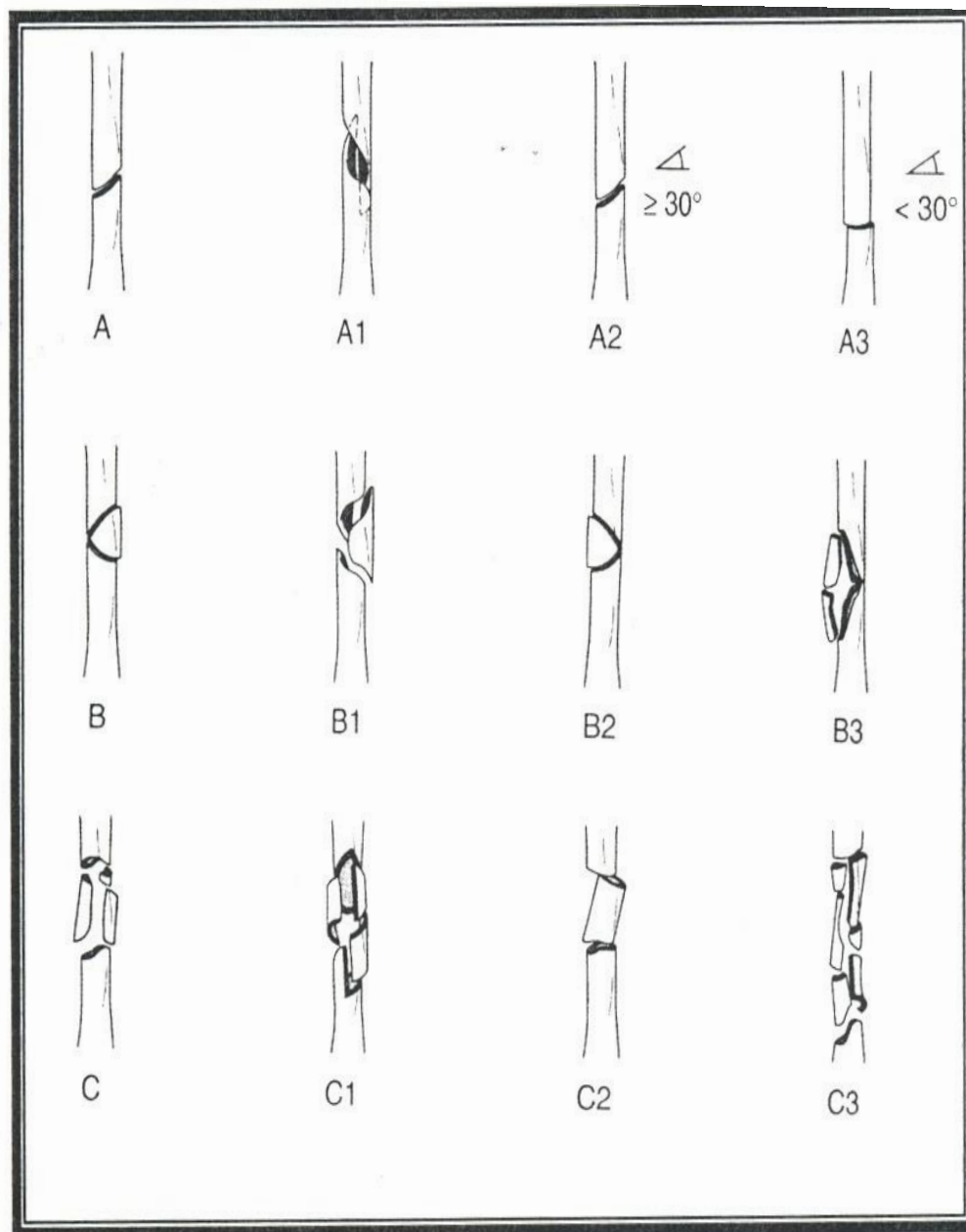
- B1 -Spiral wedge
- B2 - Bending wedge
- B3 - Fragmented wedge

C) Complex fractures

- C1 –Complex Spiral
 - i) With 2 intermediate fragments
 - ii) With 3 intermediate fragments
 - iii) With >3 intermediate fragments
- C2 – Complex segmental
 - i) With 1 intermediate segment
 - ii) With 1 intermediate segment
and an additional wedge fracture
 - iii) With 2 intermediate segments
- C3 – Complex irregular
 - i) With 2 or 3 intermediate fragments
 - ii) With shattering limited to <5cm length of bone

AO /ASIF (Association for the study of Internal fixation) classification of fractures of the shaft of the femur. Simple fractures (type A) are distinguished by the degree of obliquity of the fracture line. Wedge fractures (type B) are subclassified according to the anatomy of the wedge fracture. Complex fractures (type C) can be spiral, segmental, or irregular.

There are number of classification systems, however no system is universally accepted.



5. OTA Classification of fracture femur :

I Linear

- Transverse
- Oblique
- Spiral

II Comminuted

- Comminuted $\leq 50\%$
- Comminuted $> 50\%$
- Butterfly $< 50\%$
- Butterfly $> 50\%$

III Segmental

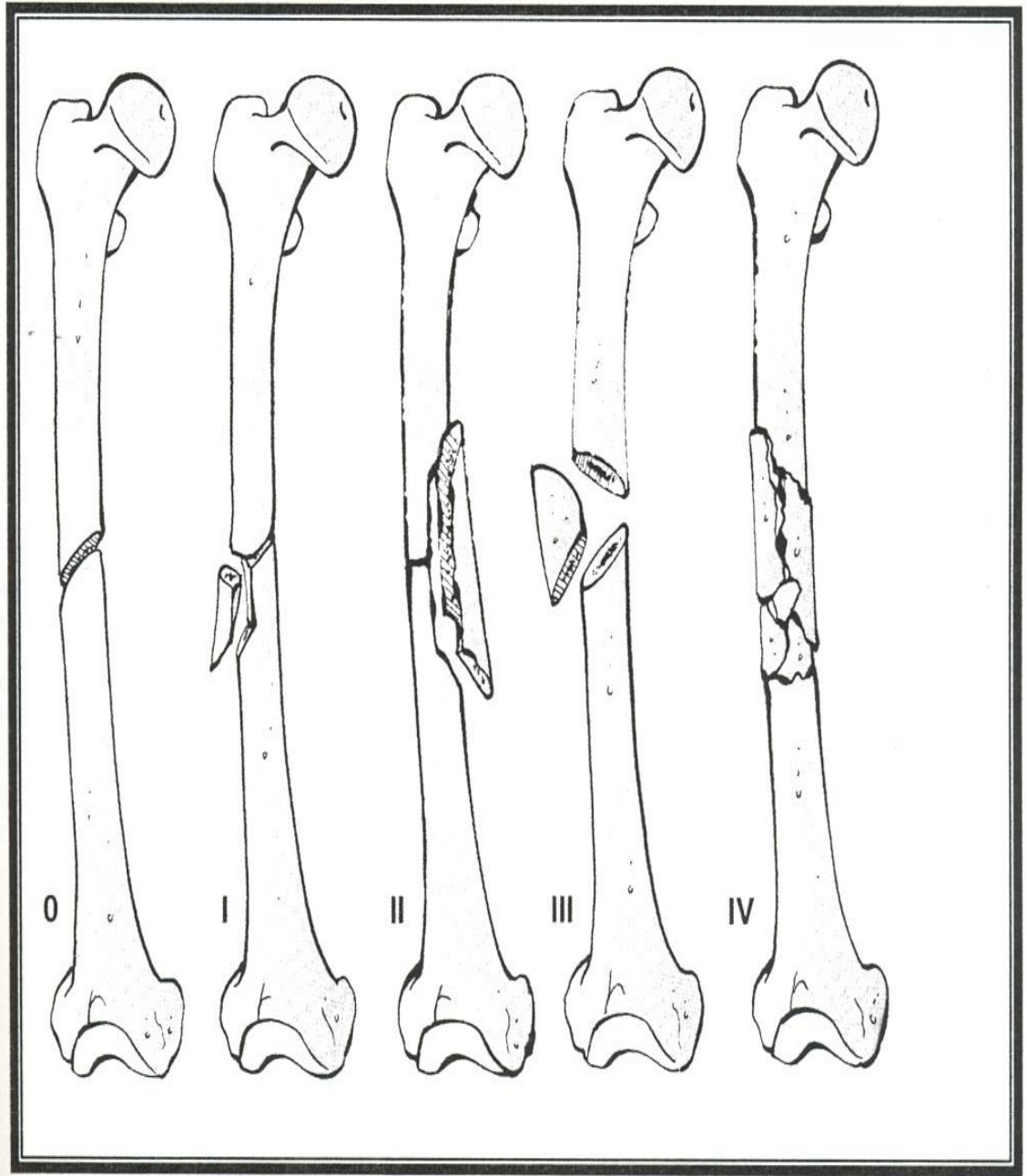
- Two level
- Three level or more
- Longitudinal split
- Comminuted

IV Bone loss

- Bone loss $< 50\%$
- Bone loss $\geq 50\%$
- Complete bone loss

6. Winquist and hansen classification of comminuted fractures²⁸

- **Grade 0** - No comminution
- **Grade I** - A very small fragment of bone is broken off. It does not affect the fracture stability.
- **Grade II** - Comminuted fragment larger than grade I but still at 50% contact of abutting cortices is present which prevents shortening, translation and controls rotation.
- **Grade III** - Fragment with less than 50% contact of abutting cortices. Shortening, translation and rotational instability are likely.
- **Grade IV** - Comminuted fragment which has lost circumferential buttress of bone. It has no fixed contact with proximal or distal cortex.



MATERIALS AND METHODS

DETAILS OF THE STUDY SUBJECTS:

Patients admitted from December 2010 to September 2012 to the department of orthopaedics in R L Jalappa Hospital and research centre attached to Sri Devaraj Urs Medical College ,Tamaka , Kolar with fracture shaft of femur were included in the study and followed up from the time of admission to a minimum of 6 months postoperatively.

Patient admitted with fracture shaft of femur were recruited and the alternative cases were allotted to each group in the study as per surgeons choice. In Group A Closed intramedullary interlocking nailing of fracture was done. In Group B Open method of intramedullary interlocking nailing was done. The sample size was 30 each.

The time taken for bone union, range of movement and complications encountered during the procedure and later were compared between open versus closed method of intramedullary interlocking nailing for shaft of femur

Inclusion Criteria:

- Age group more than 15 years
- 5cm distal to lesser trochanter and 9 cm from the distal articular cartilage
- Closed fractures
- Open type I , II, III A and B Gustilo Andersons

Exclusion criteria:

- Type III C – Gustilo Andersons
- Old age not fit for surgery
- Fracture shaft with supracondylar extension
- Pathological fracture

PRE OPERATIVE TREATMENT

All patients were stabilized starting from the vital parameters of airway, breathing, circulation and care of affected part. Initially Thomas Splint was used in all the patients to immobilize the fracture site, followed by X-ray of the affected site.

X-ray pelvis with both hips and X-ray of affected femur with knee joint was taken as standard protocol. Depending on the type of fracture (open or closed fracture), associated injuries, head injury, treatment was planned.

Upper tibial traction was put in 56 patients (close 25, open 21), calcaneal traction in 4 patients (close 1, open 3) 8 cases no traction was applied as they were operated within 6 hours of injury. Once patient was fit for surgery, group A closed nailing was done and in group B open nailing.

The length of nail was measured from tips of greater trochanter to the upper pole of patella. The diameter of nail was assessed at the narrowest portion of the isthmus on A-P view.

All patients received pre operative antibiotics.



Upper tibial skeletal traction



Surgical instruments

OPERATIVE PROCEDURE

GROUP - A (Closed Nailing)

Patient in supine position on a fracture table. Initially fracture site was visualized under image intensifier. The piriformis fossa was exposed through gluteal approach and curved bone awl positioned over the piriformis fossa, in line with the medullary cavity and position confirmed on both AP and lateral views passed till level of lesser trochanter . Ball tipped guide wire passed through the entry point, into the proximal fragment and then into distal segment after reduction of fracture. Position of guide wire was confirmed on AP and lateral imaging. Reaming was done over the guide wire to appropriate size with 1 mm increments. Exchange tube passed and ball tipped guide wire removed and plain guide wire was passed across the fracture site.

The nail length was confirmed under C-arm vision or measuring the length of guide wire jetting out in comparison with the same size guide wire. Proximal jig mounted interlocking nail of appropriate size and length passed over the guide wire. Guide wire was removed and proximal locking was done. Rotational alignment was confirmed and distal locking was done with free hand technique. For stable fractures dynamic locking was done. Wound was closed in layers after heamostasis under aseptic recautions.

CLOSED TECHNIQUE STEPS



Fracture table



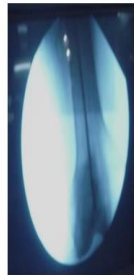
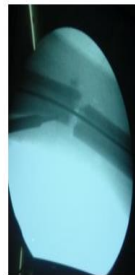
Incision



Entry point



Entry point in C-Arm



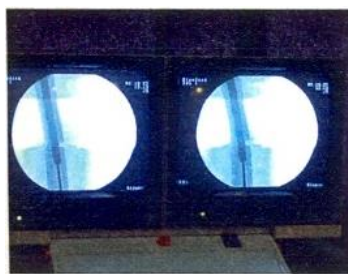
Guide wire insertion



Reaming



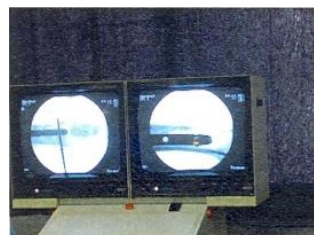
Nail insertion



Nail insertion under C-ARM



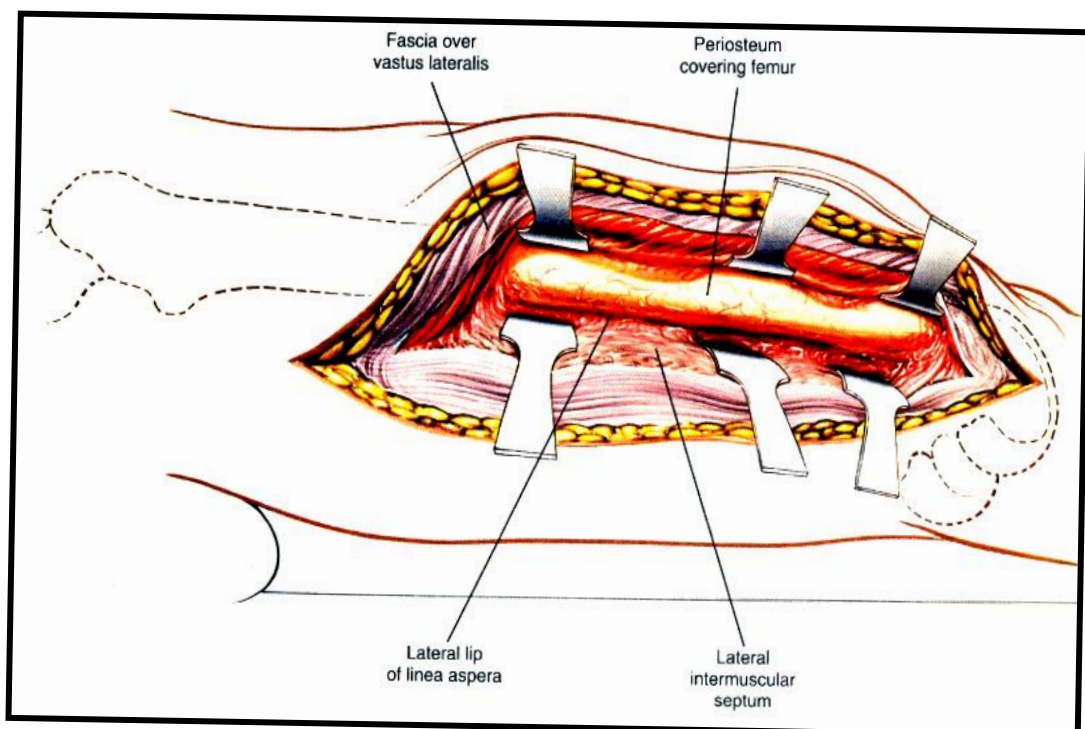
Proximal Locking



Distal locking

GROUP - B (Open Nailing)

Patient on operating table with patient on lateral decubitus position. Femur was exposed through postero-lateral approach. Fracture site identified and fracture hematoma evacuated. 6mm manual reamer passed across the proximal fragment and then guide wire was passed and extracted through the gluteal region. Reaming of the proximal fragment was done over the guide wire with 1 mm increments. Followed by the reaming of the distal fragment. The nail length was confirmed under C-arm vision or measuring the length of guide wire jetting out in comparison with the same size guide wire. Nail with proximal jig mounted and pass through the proximal fragment in antegrade fashion after reduction of fracture. The nail was passed across the distal fragment. Proximal locking was done followed by distal locking by free hand technique after confirming rotational alignment. Wound closed in layers after maintaining hemostasis under aseptic precautions.



Exposure to femoral shaft

OPEN TECHNIQUE STEPS



Lateral position



Posterolateral approach



Exposure of bone



Identification of fracture



Fracture hematoma



Fracture fragment



Opposition the ends



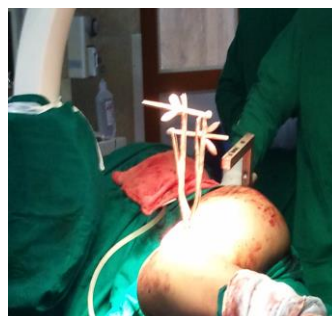
Proximal entry



Reaming with hand reamer



Nail insertion



Fracture reduced

POST OP MANAGEMENT

Post operative intravenous antibiotics were used in all the patients for minimum of 48 hours. Post operative check X-ray were taken to analyse fracture site reduction and alignment.

Static quadriceps exercises started within 24 hours of surgery followed by knee flexion extension exercises within 48 hours of surgery. Patients were mobilized on 2st post operative day with toe touch weight bearing in 1st post operative week depending on stability of fracture and patients compliance. Suture removal was done 10th post operative day.

The follow up in both group of patients was done at 1 month, 2, 3 and 6 months and were assessed clinically and radiologically.

Criteria for valuation :

Evaluation of functional outcome was done according to criteria laid by Razaq MNU et al ²⁶ modification of Thoresen et al ³³ criteria - 2009.

RESULTS AND ANALYSIS

Study Design: A Comparative two group study with 60 patients, 30 in Group A and 30 in group B was undertaken to study the surgical management of fracture shaft femur with Intramedullary interlocking nailing

Table 1: Age distribution of patients studied

Age in years	Group A		Group B	
	No	%	No	%
16-20	5	16.7	5	16.7
21-30	14	46.7	11	36.7
31-40	5	16.7	8	26.7
41-50	1	3.3	3	10.0
51-60	4	13.3	0	0.0
61-70	1	3.3	3	10.0
Total	30	100.0	30	100.0
Mean $\pm$ SD	32.13$\pm$14.35		33.03$\pm$13.84	

Samples are age matched with p value 0.806.

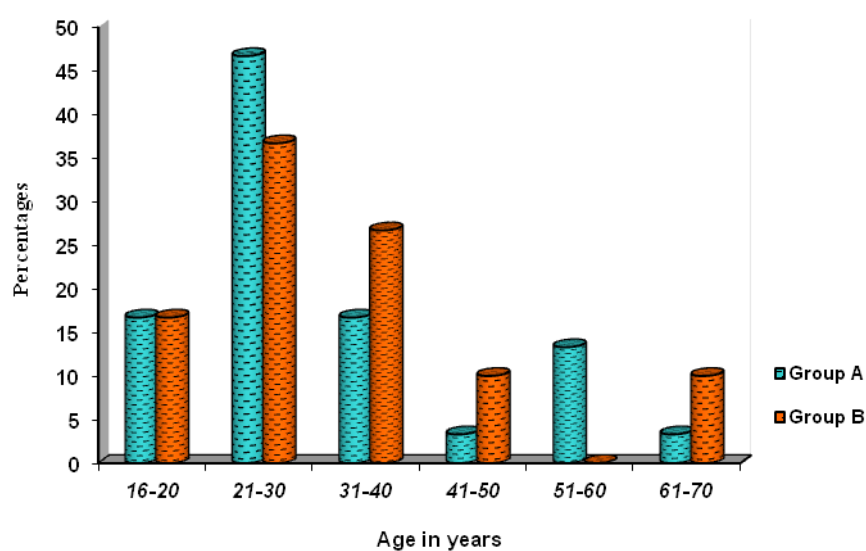


Table 2: Gender distribution of patients studied

Gender	Group A		Group B	
	No	%	No	%
Male	28	93.3	29	96.7
Female	2	6.7	1	3.3
Total	30	100.0	30	100.0

Samples are gender matched with p value 1.000.

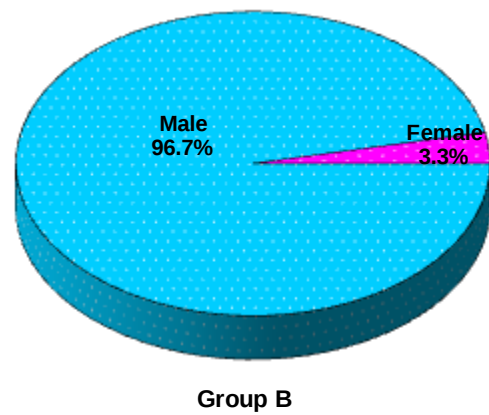
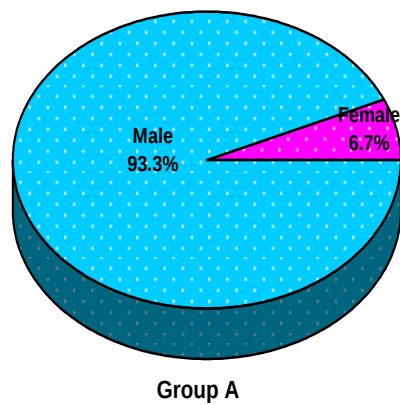


Table 3: Side involved in two groups of patients studied

Side	Group A		Group B	
	No	%	No	%
Left	11	36.7	9	30.0
Right	19	63.3	21	70.0
Total	30	100.0	30	100.0

Distribution of side is statistically similar in two groups with p value 0.785.

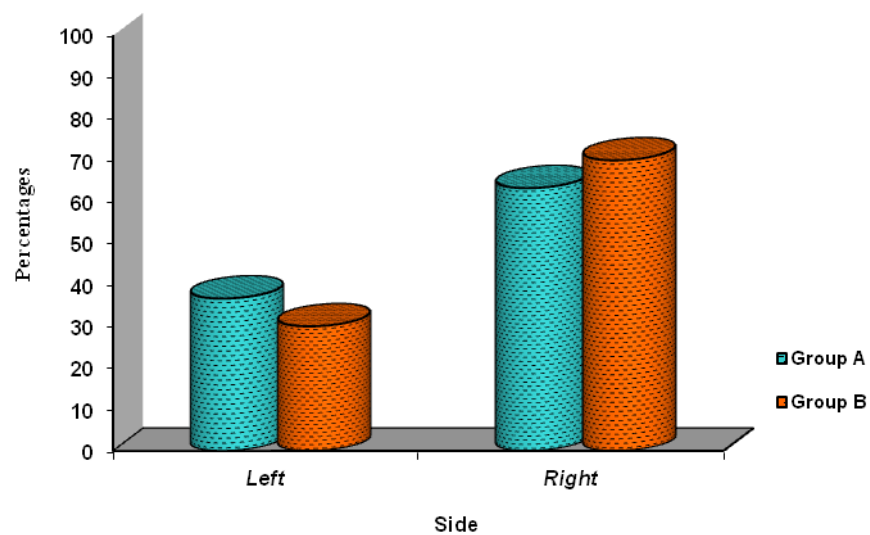


Table 4: Mode of injury in two groups of patients studied

Mode of injury	Group A		Group B	
	No	%	No	%
DT	2	6.7	2	6.7
HT	2	6.7	2	6.7
RTA	26	86.7	26	86.7
Total	30	100.0	30	100.0

Distribution of mode of injury is statistically similar in two groups with p value 1.000.

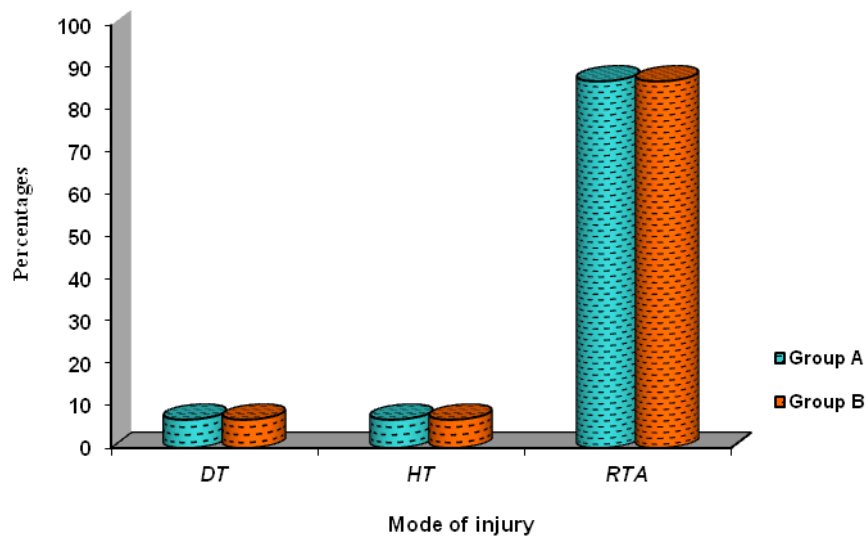


Table 5: Site of Fracture in two groups of patients studied

Site	Group A		Group B	
	No	%	No	%
Distal 1/3rd	5	16.7	3	10.0
Mid 1/3rd	21	70.0	23	76.7
Prox 1/3rd	4	13.3	4	13.3
Total	30	100.0	30	100.0

Distribution of site is statistically similar in two groups with p value 0.913.

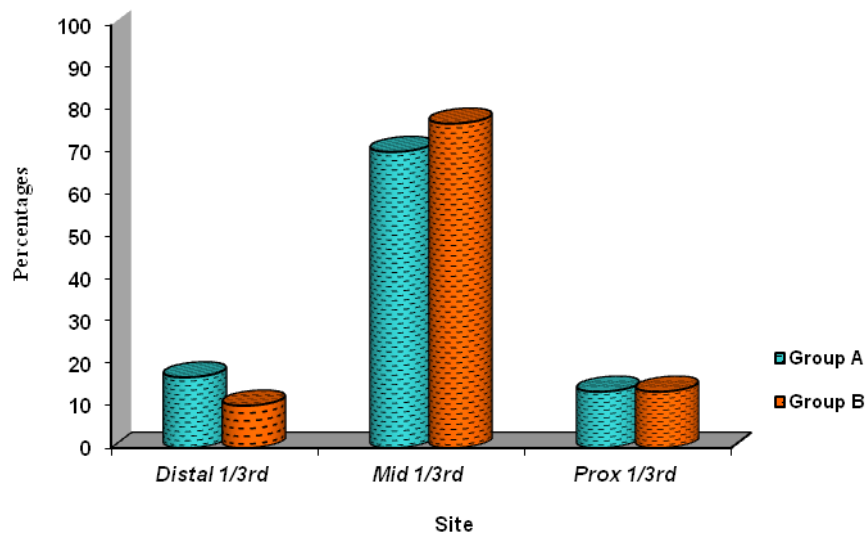


Table 6 : Radiological type of fractures in two groups

Type of fracture	Group A		Group B	
	No	%	No	%
1.TRANVERSE	13	43.3	16	53.3
2.SHORT OBLIQUE	1	3.3	1	3.3
3.LONG OBLIQUE	1	3.3	0	0.0
4.SPIRAL	0	0.0	0	0.0
5.COMMINUITED	13	43.3	12	40.0
6.SEGMENTAL	2	6.7	1	3.3
TOTAL	30	100.0	30	100.0

Distribution of radiological classification is statistically similar in two groups its p value 0.877.

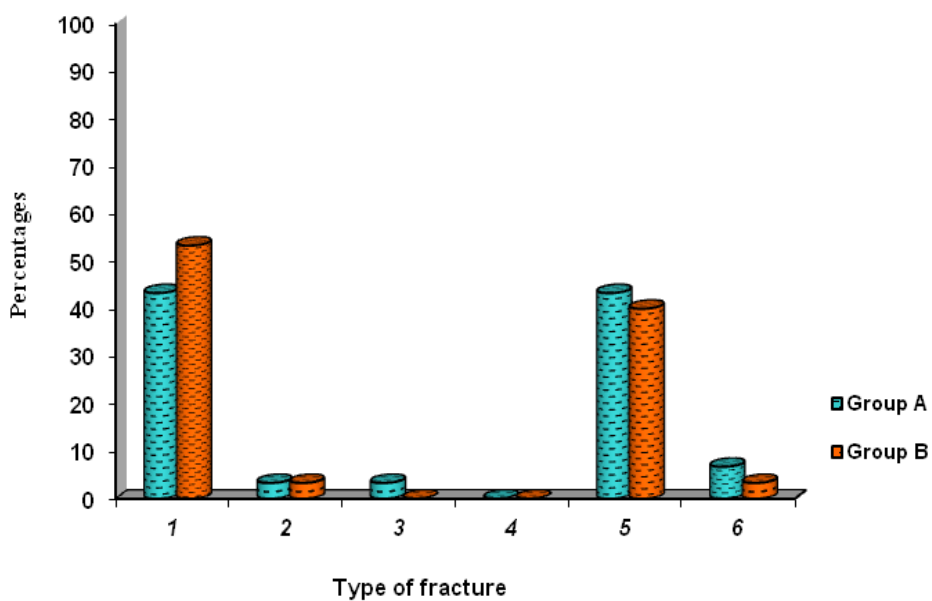


Table 7 : Type of fractures in two groups of patients studied

Type of fractures	Group A (n=30)		Group B (n=30)	
	No	%	No	%
Closed	25	83.3	23	76.7
Open (Gustilo Anderson's)	5	16.7	7	23.3
• Type I	3	10.0	4	13.3
• Type II	1	3.3	3	3.3
• Type III	1	3.3	0	0.0

Type of fracture is statistically similar in two groups with p value 0.519.

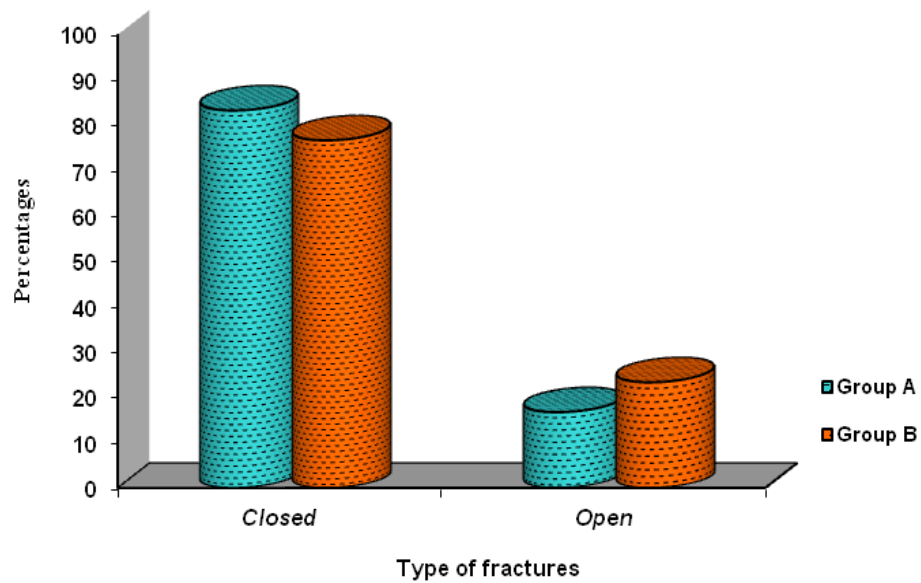


Table 8 : Grade of comminution of Fracture in two groups

Grade	Group A		Group B	
	No	%	No	%
0	17	56.7	18	60.0
1	5	16.7	5	16.7
2	4	13.3	5	16.7
3	3	10.0	2	6.7
4	1	3.3	0	0.0
TOTAL	30	100.0	30	100.0

Distribution of grade is statistically similar in two groups with p value 1.000.

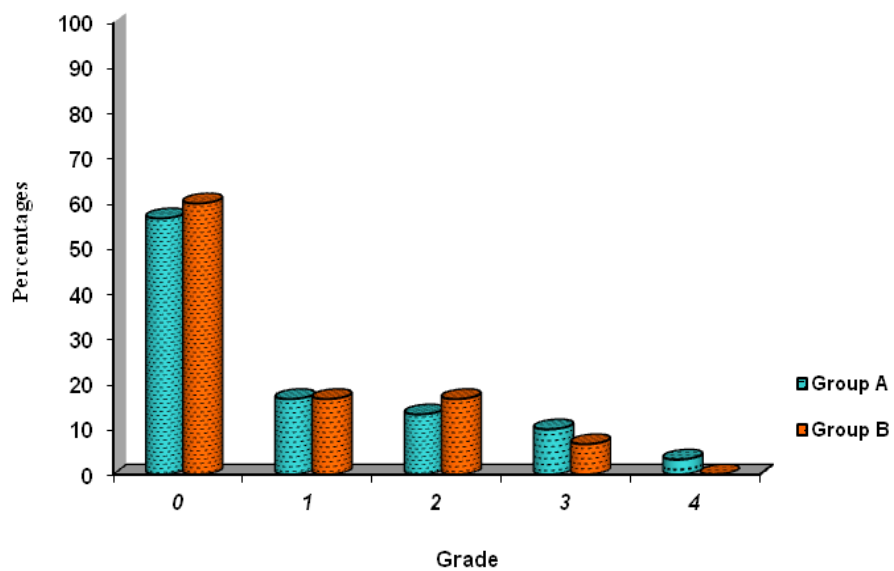


Table 9 : Associated injuries in two groups of patients studied

Associated injuries	Group A (n=16)		Group B (n=14)	
	No	%	No	%
1.Ipsilateral lower extremity	10	62.5	5	17.9
2.Head Injury	1	6.3	2	7.1
3.Pelvis	1	6.3	1	7.1
4.Upper extremity	3	18.8	3	21.4
5.Associated fracture of contra lateral femur	2	12.5	2	14.3
6.Patella fracture	2	12.5	4	28.6

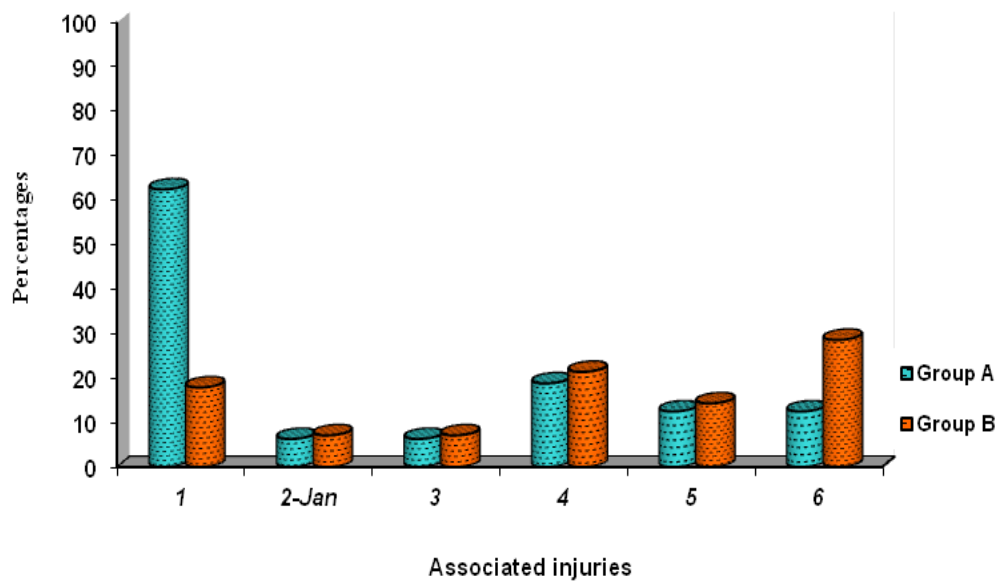


Table 10: Duration between injury and surgery two groups of patients studied

Duration b/w injury and surgery	Group A		Group B	
	No	%	No	%
<7 days	21	70.0	20	66.7
7-14 days	8	26.7	6	20.0
>14 days	1	3.3	4	13.3
Total	30	100.0	30	100.0

Duration between Injury and surgery is statistically similar in two groups with p value 0.361.

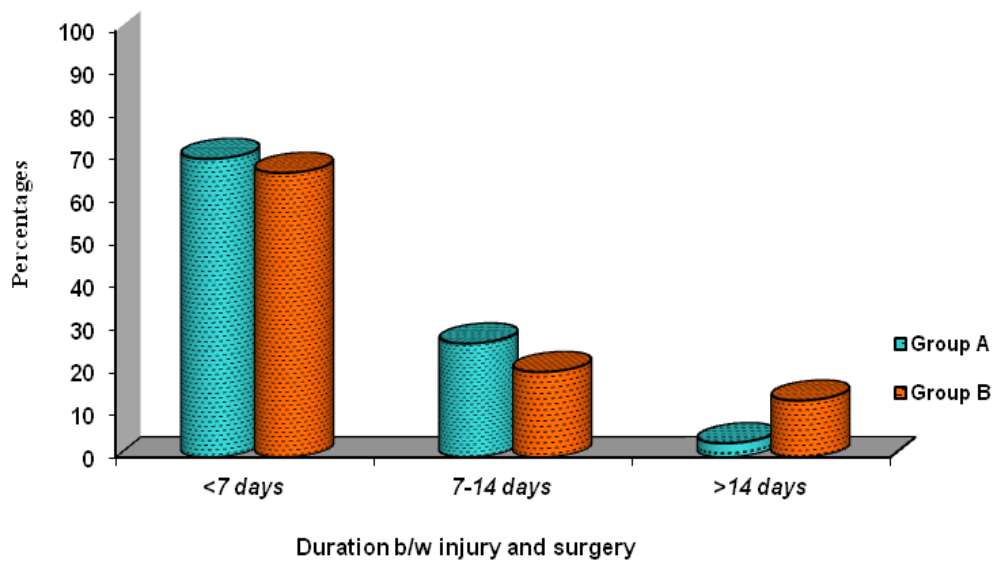


Table 11: Type of anesthesia in two groups of patients studied

Anesthesia	Group A		Group B	
	No	%	No	%
Epidural anesthesia	14	46.7	7	23.3
General anesthesia	2	6.7	2	6.7
Spinal anesthesia	14	46.7	21	70.0
Total	30	100.0	30	100.0

Distribution of type of anesthesia is statistically similar in two groups with p value 0.202.

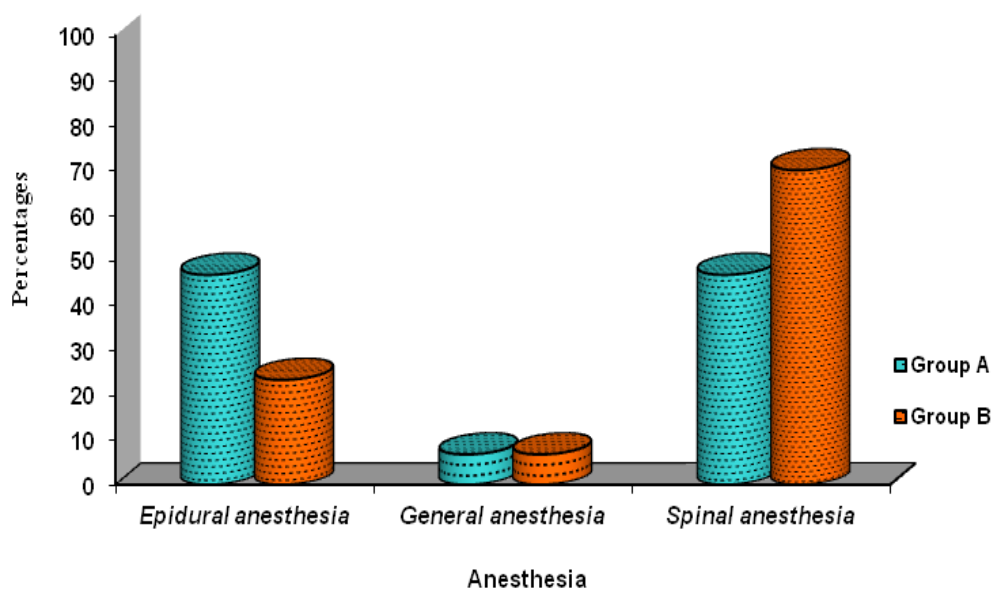


Table 12: C-ARM exposure in two groups of patients studied

C arm	Group A		Group B	
	No	%	No	%
<10	0	0.0	4	13.3
10-20	0	0.0	8	26.7
21-30	3	10.0	7	23.3
31-40	6	20.0	11	36.7
41-50	9	30.0	0	0.0
>50	12	40.0	0	0.0
Total	30	100.0	30	100.0

C-arm exposure is significantly less in Group B with $p < 0.001^{**}$.

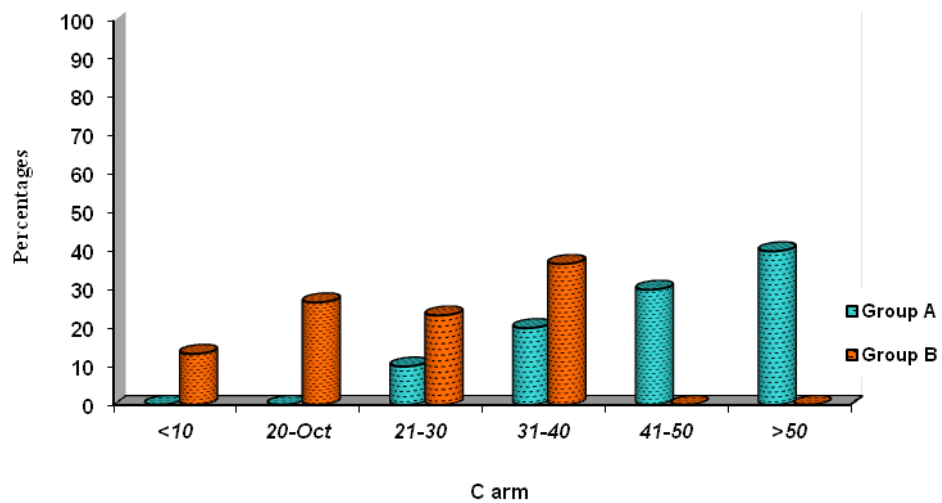


Table 13: OT in hours in two groups of patients studied

OT in hours	Group A		Group B	
	No	%	No	%
<1 hour	0	0.0	8	26.7
1-2 hours	9	30.0	16	53.3
2-3 hours	17	56.7	6	20.0
3-5 hours	3	10.0	0	0.0
>5 hours	1	3.3	0	0.0
Total	30	100.0	30	100.0

OT in hours is significantly less in Group B compared to Group A with $p < 0.001^{**}$.

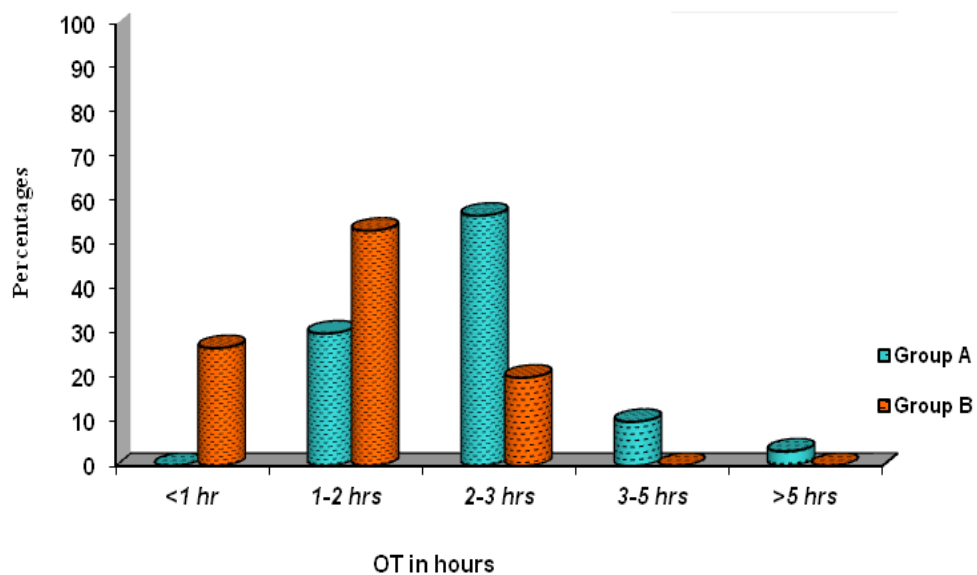


Table 14: Intra-op difficulties in two groups of patients studied

Intra-op difficulties	Group A (n=30)		Group B (n=30)	
	No	%	No	%
1.Difficulty in entry point	3	10.0	0	0.0
2.Difficulty in reduction	5	16.7	0	0.0
3.Difficulty in Guide wire insertion	3	10.0	0	0.0
4.Difficulty in distal locking	5	16.7	2	6.7
Total	16	53.3	2	6.7

Intra-op difficulties are significantly more in Group A when compared to Group B with $p < 0.001^{**}$.

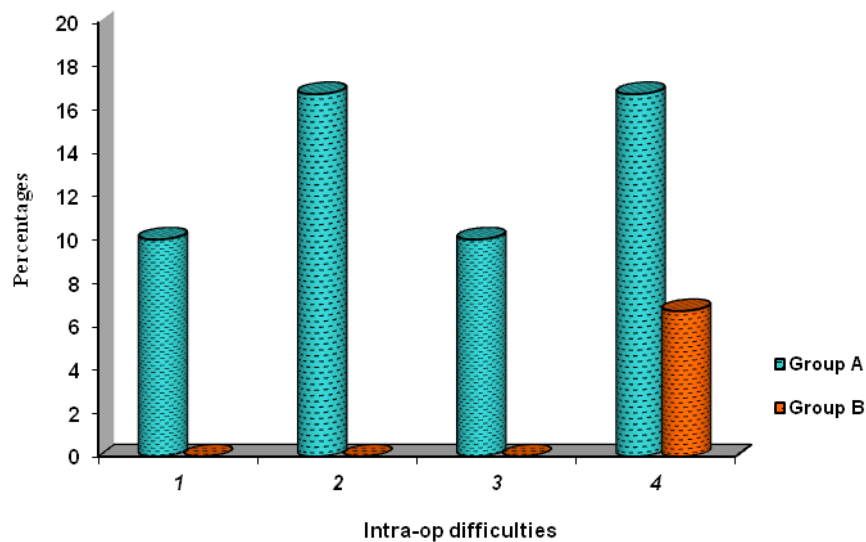


Table 15: RANGE OF MOTION (ROM) of hip and knee joint in two groups of patients studied

ROM	Group A (n=30)		Group B (n=30)	
	No	%	No	%
• Full	29	96.7	26	86.7
• Terminal restriction (TRMN rest)	1	3.3	4	13.3

Presence of ROM is statistically similar in two groups with p value 1.000.

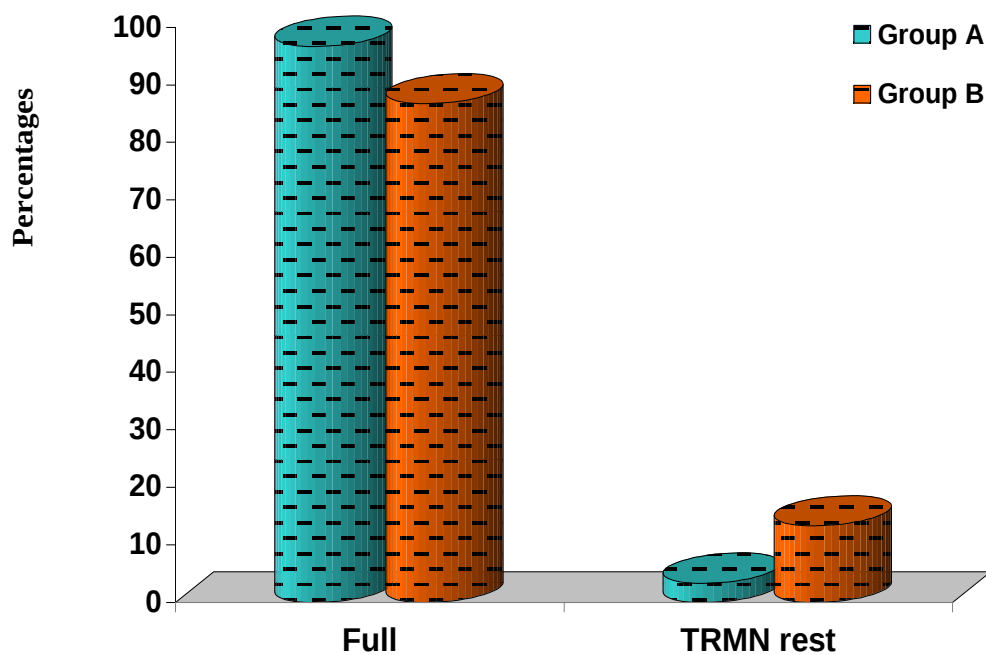


Table 16:Complications in two groups of patients studied

Complications	Group A (n=30)		Group B (n=30)	
	No	%	No	%
Nil	21	70.0	25	83.3
Present	9	30.0	5	16.7
• Sup. Inf.	2	6.7	3	10.0
• Shortening	2	6.7	1	3.3
• Deep Inf.	1	3.3	0	0.0
• Fracture hematoma	1	3.3	0	0.0
• Mal Align.	3	10.0	1	3.3

Incidence of complications are more associated with group A with $p=0.222$

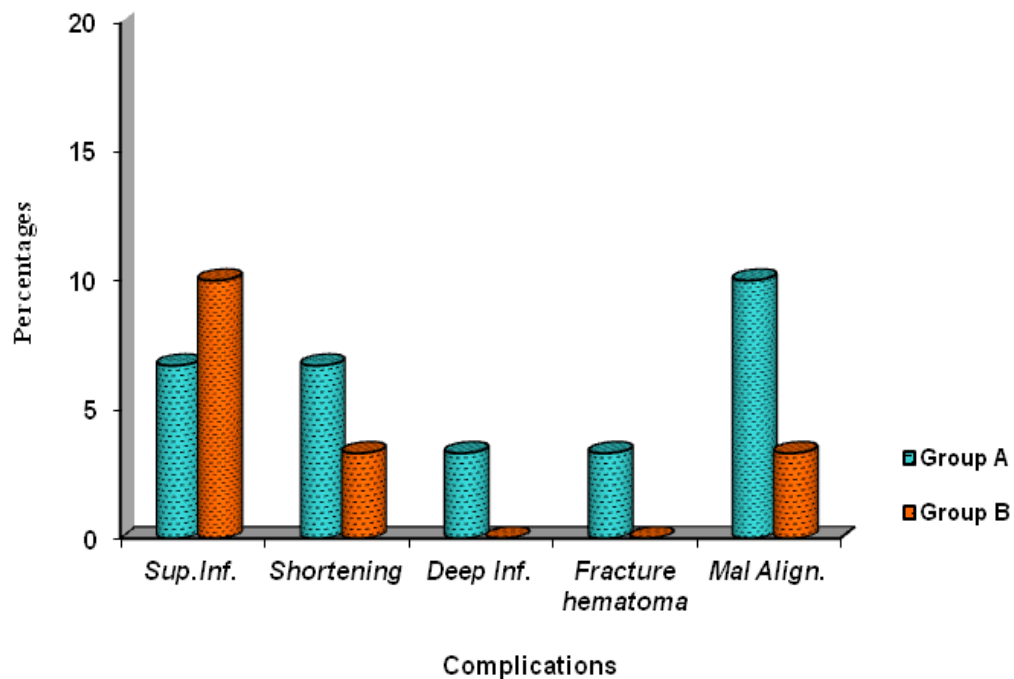


Table 17: Late complications in two groups of patients studied

Late complications	Group A (n=30)		Group B (n=30)	
	No	%	No	%
1.Deep infections	1	3.3	0	0.0
2.Implant removal	1	3.3	0	0.0
3.Non-union	0	0.0	0	0.0
4.Malalignment	3	10.0	1	3.3
5.Shortening	2	6.7	1	3.3
6.Implant breakage	0	0.0	0	0.0
7.Screw breakage	0	0.0	0	0.0
Total	7	23.3	2	6.7

Incidence of late complications are positively more associated with Group A with p value 0.145.

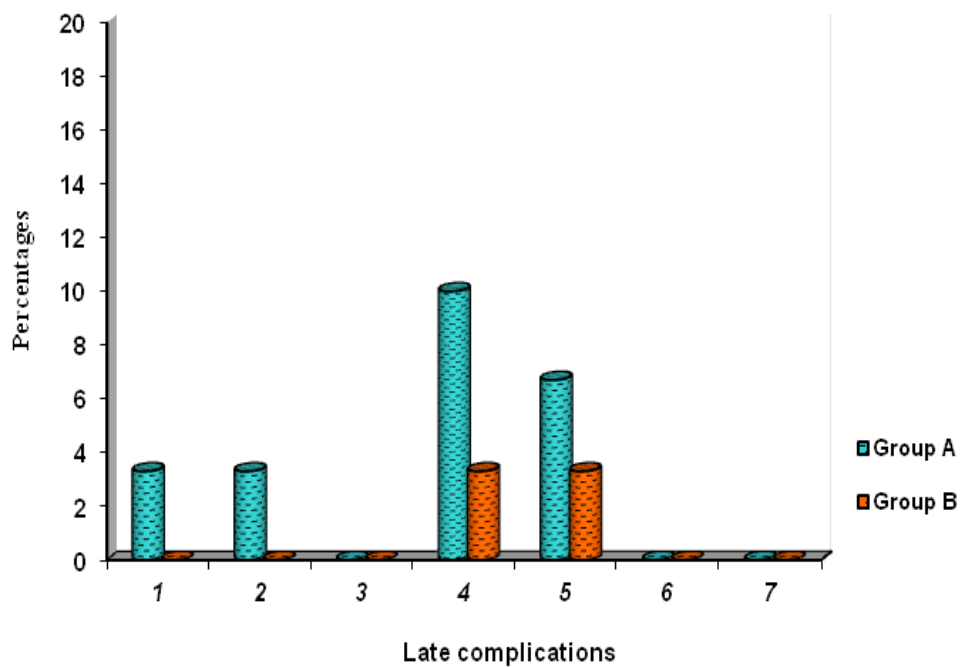


Table 18: Functional grading in two groups of patients studied

Grading	Group A		Group B	
	No	%	No	%
Excellent	24	80.0	23	76.7
Good	5	16.7	7	23.3
Poor	1	3.3	0	0.0
Total	30	100.0	30	100.0

Distribution of results are statistically similar in two groups with p value 0.872.

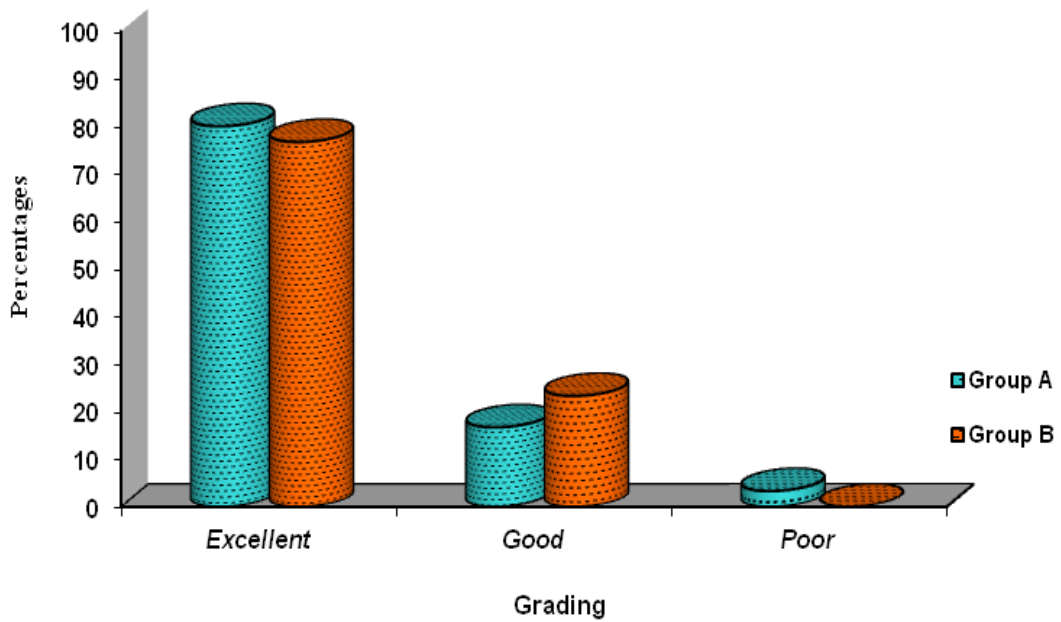
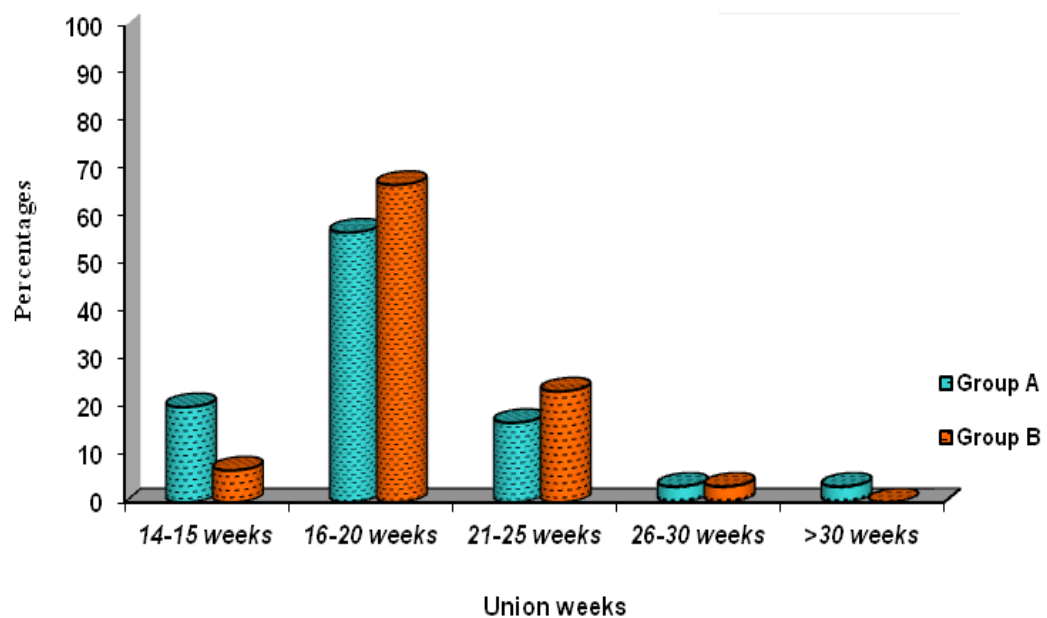


Table 19: Union weeks in two groups of patients studied

Union weeks	Group A		Group B	
	No	%	No	%
14-15 weeks	6	20.0	2	6.7
16-20 weeks	17	56.7	20	66.7
21-25 weeks	5	16.7	7	23.3
26-30 weeks	1	3.3	1	3.3
>30 weeks	1	3.3	0	0.0
Total	30	100.0	30	100.0
Mean $\pm$ SD	18.50$\pm$4.19		19.33$\pm$3.43	

Mean Union in weeks is statistically similar in two groups with p value 0.403.



Significant p figures

- + Suggestive significance (p value: 0.05<p<0.10)
- * Moderately significant (p value: 0.01<p ≤ 0.05)
- ** Strongly significant (p value : p ≤ 0.01)

OPEN NAILING (CASE 1)



Pre operative X ray

Post operative X ray



Fracture Healing in progress

Fracture Healed



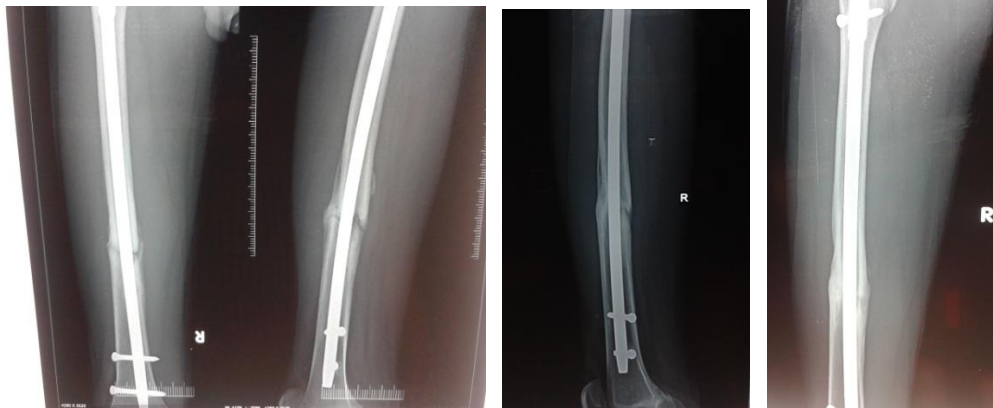
Nail removed

CLOSED NAILING (CASE 1)



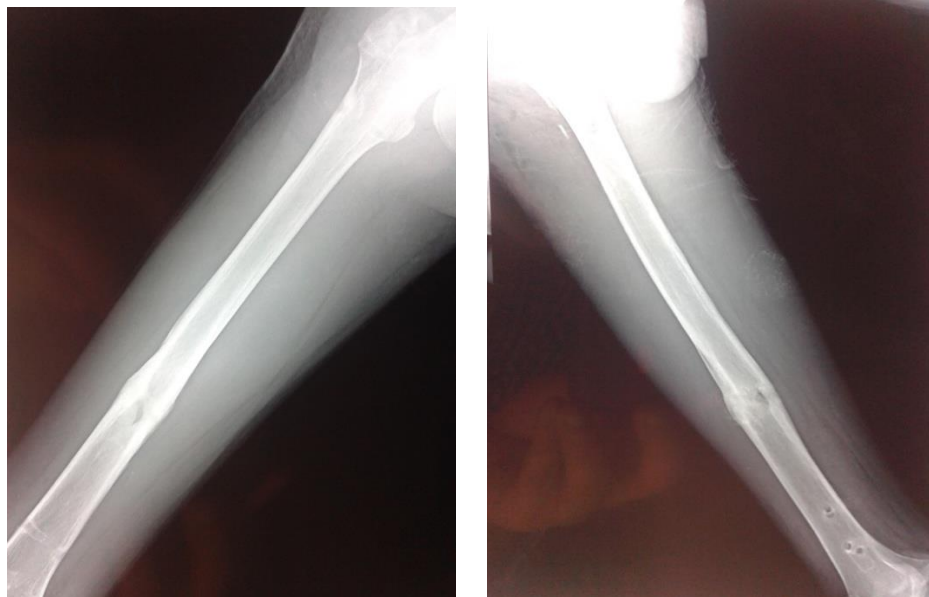
Pre Operative X –ray

Post operative X -ray



Fracture Healing in progress

Fracture healed



Nail Removed

CLOSED NAILING (CASE 4) : ROM Terminally Restriction



Pre operative X-ray



Post operative X-ray



Fracture Healing in progress



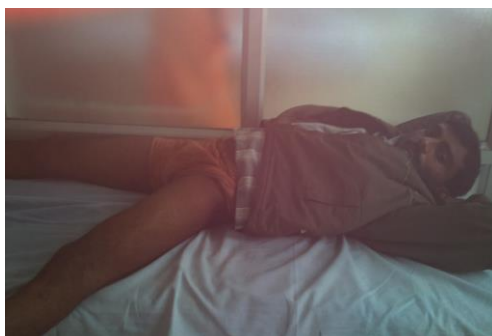
Fracture Healed



Hip Flexion



Hip Extension



Abduction of Hip



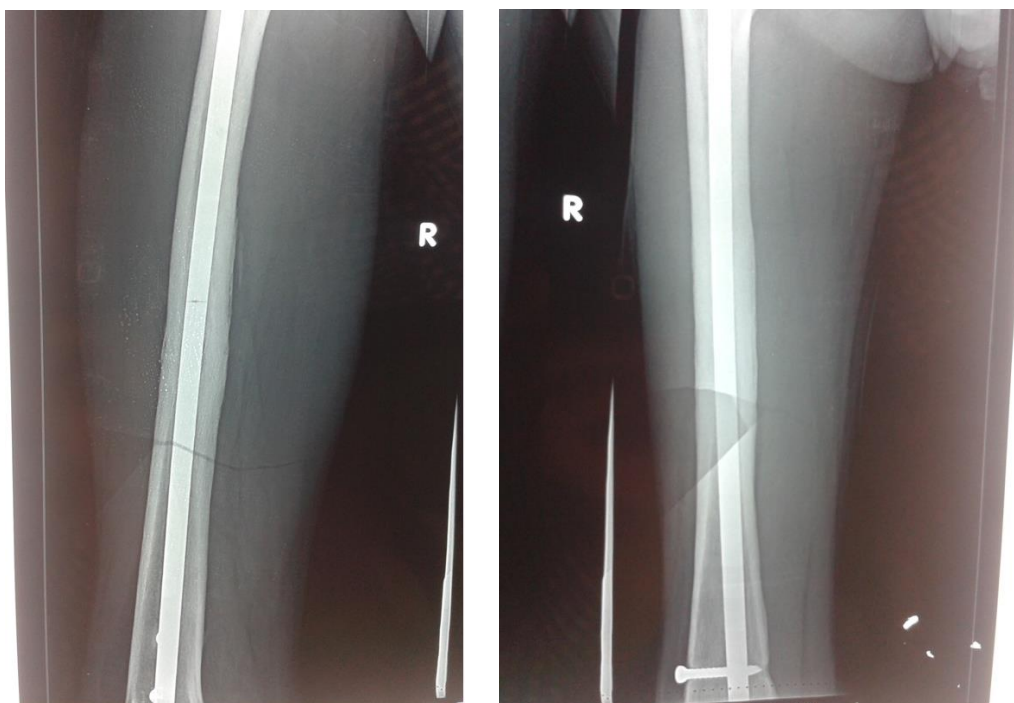
Adduction of Hip

OPEN NAILING (CASE 16)



Pre operative X-ray

Post operative X-ray



Fracture Healed

CASE 16 (GROUP B)



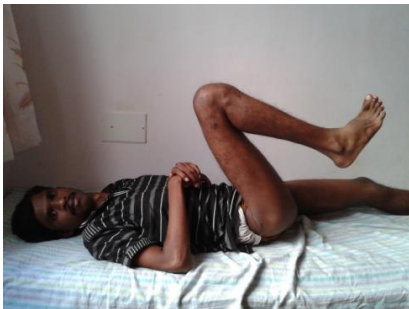
Full Weight Bearing



Sitting Crossed Leg



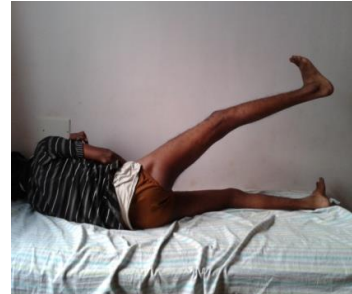
Squatting



Flexion of hip and knee



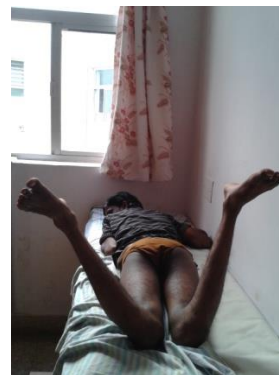
Extension of Knee



Hip Abduction



External Rotation of Hip

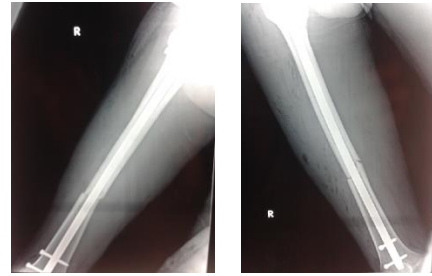


Internal Rotation of Hip

CLOSED NAILING (INFECTED NAIL)



Pre Operative X- ray



Post Operative X-ray



Fracture healed in 3 cortices

COMPLICATIONS



Post operative fracture hematoma



Superficial infection

WOUND HEALING



Sutured wound



Healed wound



Open nailing site



Closed nailing proximal entry site

DISCUSSION

Femoral shaft fractures are the most challenging fractures to fix for an Orthopaedic Surgeon. Interlocking nailing is the treatment of choice for all femoral fractures from 5 cm below lesser trochanter to 15 cm above the knee joint¹⁰⁹ The invention of Intramedullary Interlocking Nail made a revolution in the management of femur fractures.⁴

The use of motorbike in our population is increasing day by day especially by young persons. The motorbike is the most common cause of road traffic accidents in our society and the reflection of it was seen in our study.⁴ In rural India, workplace injury such as fall from height is also common.⁵⁰

Closed interlocking nailing was introduced after the advent of C- arm. In India there are few centres having facility of C-arm control, at the basic level of health infrastructure particularly at rural centres where no facility of C-arm and high surgical expertise are available, open interlocking nailing is the modality to treat femur shaft fractures.⁴⁷

The open Interlocking nailing with a predictable surgical time is less expensive, easy and more convenient for less experienced newly qualified orthopaedic surgeon and only fewer instruments are required. Due to the direct observation of bone anatomic reduction can be done which is not possible with close interlocking procedure particularly in comminuted and segmental fractures. In comparison to the closed method, rotational mal alignment is rare after open reduction. In non unions opening of the medullary canals of the sclerotic bone is easier, and simultaneous bone grafting is possible.⁴⁷

Long surgical skin scar, increased blood loss, loss of fracture hematoma (which is more important in fracture healing) increased infection rate, and

complication rate particularly in comminuted fracture and decreased rate of union has its own demerits in open IL nailing procedure.⁴⁷

Periosteal stripping does not significantly decrease blood flow in middle layer of diaphyseal cortex. Endosteal and periosteal blood vessels are anastamotic and are capable of sustaining adequate circulation to diaphysis.⁵¹ Fracture hematoma has a potential osteogenic factors which is evacuated in open nailing.^{52, 53}

Inspite of evacuation of fracture hematoma and periosteal stripping it is a fact that open nailed fractures unite by callus formation.^{54,55}

Studies also show that reaming and intramedullary nailing reflexesly increase the blood flow in the facultative extra periosteal circulation. Hence exuburent callus forms in open nailed fractures.⁵⁶

In our present study we have 30 cases of fracture shaft of femur treated by closed intramedullary interlocking nail in Group A, 30 cases of open intramedullary interlocking nailing in group B.

The patients were allotted randomly into each group and also based on surgical indication and surgeon compliance

SIZE OF STUDY GROUP

The total number of patients in our study group was smaller as compared to the quoted studies below.

Series	Year	Total no of patients	Open/Closed group (No. of patients)
Leighton RK et al ³⁴	1986	126	61/65
Pati BN et al ⁵⁷	2001	100	20/80
Meena RC et al ⁴⁷	2006	104	62/46
Gharehdaghi M et al ²³	2007	136	55/81
Present study	2012	60	30/30

AGE DISTRUBATION

The mean age in other studies were as quoted below.

Series	Year	Mean age (in years)	
		Open group	Closed group
Rokkanen P et al ³⁰	1969	36	45
Leighton RK et al ³⁴	1986	27	29
Gharehdaghi M et al ²³	2007	36	45
Present Study	2012	33	32

In our study we found mean age in open group was 33 yrs and closed group was 32yrs.

Samples are age matched with p value 0.806.

SEX DISTRIBUTION

Series	Year	Sex %	
		Male	Female
Leighton RK et al ³⁴	1986	75	25
Pati BN et al ⁵⁷	2001	88	12
Razaq MNU et al ²⁶	2009	60	40
Present Study	2012	95	5

In our study we found sex incidence in male was 95 % and female was 5%. Samples are gender matched with p value 1.000.

Thus majority of the patients in our study were males.

COMPOUND FRACTURE TYPE

The number of open fractures included in our study group was higher (18%) as compared to the quoted studies below.

Series	Year	TYPE (No of Cases)					TOTAL (In %)
		I	II	IIIA	IIIB	IIIC	
Pati BN et al ⁵⁷	2001	7	3	-	-	-	10
Meena RC et al ⁴⁷	2006	2	2	-	-	-	3.9
Present study	2012	7	5	1	-	-	18

In our study we found number of compound fractures by GUSTILO ANDERSON's classification to be type I was 7, type II was 5 and type III was 1 with total of 18%. There were 13 cases of compound fracture- I, II,

IIIA (5 in group A and 8 in group B).

MODE OF INJURY

Majority of the fractures in our study were due to RTA (87%) and it correlated with the quoted studies below.

Series	Year	Due to RTA	Others
Rokkanen P et al³⁰	1969	78%	22%
Pati BN et al⁵⁷	2001	86%	14%
Meena RC et al⁴⁷	2006	84%	16%
Present study	2012	87%	13%

Majority of the fractures in our study were due to Road Traffic Accident (RTA) (87%) in our study and mode of injury is statistically similar in two groups with p value 1.000 .

SITE OF FRACTURE

Fractures in the middle third region pre-dominated in our study and it correlated with the quoted studies below.

Series	Year	Middle third	Proximal third	Distal third
Rokkanen P et al³⁰	1969	79%	13%	8%
Leighton RK et al³⁴	1986	100%	-	-
Pati BN et al⁵⁷	2001	65%	25%	15%
Meena RC et al⁴⁷	2006	50%	15%	35%
Razaq MNU et al²⁶	2009	47%	28%	25%
Present study	2012	77%	13%	10 %

In our study percentage of site of fracture in mid third was 77%, proximal third was 13% and distal third was 10%.

Distribution of site is statistically similar in two groups with p value 0.913.

ASSOCIATED INJURIES

The associated injuries in our study was higher as compared to the quoted studies below.

Series	Year	Open group%	Closed group %
Rokkanen P et al³⁰	1969	52	57
Gharehdaghi M et al²³	2007	38	45
Present Study	2012	53	47

In our study percentage of associated injuries in open group was 53% and in closed group was 47 %.

Distribution of associated injuries are statistically similar in two groups with p value 0.606.

Treatment of associated fractures:

Ipsilateral lower extremity fractures (10 in group A; 5 in group B) In group A 6 cases treated by closed nailing of tibial fractures, 2 treated with external fixator. In group B 3 cases treated by closed nailing and other 2 cases by biological fixation with plate and screws.

Associated contralateral femoral fractures in group A were treated by nailing technique , likewise associated patellar fractures in group A and group B were treated by modified tension band wiring.

Associated upper extremity fractures. (3 in group A, 3 in group B) In group A; 1 case of fracture shaft of humerus was treated with open reduction and internal fixation with LC-DCP, 1 case of metacarpal fracture treated with k-wiring, 1 case of chip fracture of right olecranon treated with above elbow

cast. In group B; 1 case of distal end radius treated with below elbow cast and 2 case of metacarpal fracture treated with k-wiring.

2 cases of associated pelvic fractures (1 In each group) was treated by conservative method.

FAT EMBOLISM

The incidence of fat embolism was higher in our study group as compared to the quoted studies below.

Series	Year	No of Cases	Open group	Closed group
Rokkanen P et al³⁰	1969	5 (4%)	2(1.7%)	3 (2.5%)
Leighton RK et al³⁴	1986	4 (3%)	2(1.5%)	2(1.5%)
Pati BN et al⁵⁷	2001	2 (2%)	-	2 (2%)
Present study	2012	4 (6%)	2(3%)	2 (3%)

In our study total number of fat embolism cases were 4(6%) , 2(3%) in open group and 2(3%) in closed group.

There were 4 cases of fat embolism in our study.(2 in each group) all 4 had associated ipsilateral tibial fractures. All cases were managed symptomatically and with low molecular wt. heparin in Intensive care unit. Once pt was fit for surgery nailing of the fracture was done.

DURATION FOR SURGICAL INTERVENTION

Majority of the fractures were treated within 7 days in our study and it co-related with the quoted studies below.

Series	Year	Duration		
		< 7 days	7 -14 days	> 14 days
Pati BN et al⁵⁷	2001	30 (30%)	40 (40%)	30 (30%)
Meena R C et al⁴⁷	2006	100 (100%)	-	-
Gharehdaghi M et al²³	2007	129(95%)	7 (5%)	-
Present study	2012	41 (69%)	14 (23%)	5 (8%)

In our study number of cases operated within 7 days were 21 (70%) between 7-14 days were 6(20%) and after 14 days were 1 (3%) respectively.

Duration between Injury and surgery is statistically similar in two groups with p value 0.361.

MODE OF LOCKING

The static mode of interlocking pre-dominated (88%) in our study and it co-related with the quoted studies below.

Series	Year	Static locking	Dynamic locking
Pati BN et al⁵⁷	2001	70 (70%)	30 (30%)
Gharehdaghi M et al²³	2007	124 (91%)	24 (19%)
Present study	2012	57 (95%)	0(0%)

In our study mode of locking by static locking in 57 cases(95%) and primary dynamization in 3 cases (10%).

COMPLICATION'S ENCOUNTERED DURING SURGERY

Series	COMPLICATIONS	% OF CASES
Harper MC et al ³¹ 1985	Intra-operative shattering of cortices	8%
	Difficult in closed reduction	5%
Thoresen BO et al ³³ 1985	Comminution at entry point	6.2%
	Poor reduction	6.2%
Meena RC et al ⁴⁷ 2006	Upper cortex shattered	4.34%
Present study 2012	Difficulty in entry point	10%
	Difficulty in fracture reduction	17%
	Difficulty in guide wire insertion	10%

In our study in closed group we had difficulty in entry point in 10% of cases, difficulty in fracture reduction in 17 % of cases and difficulty in guide wire insertion in 10% of cases. Difficulty in distal locking was encountered in 3 (12%)cases in group A and 2(8%) cases in group B.

OPERATIVE TIME

The range of operative time in our study groups compared to the quoted studies below.

Series	Year	Operative time Range (Hrs)	
		Open	Closed
Leighton RK et al ³⁴	1986	1.30-3.15	2.15-4.15
Pati BN et al ⁵⁷	2001	1.20-3.05	1.30-3.45
Present study	2012	0.45-2.30	1.30-5.20

The range of operative time in our study groups A and B were 1.30 - 3.30 hours and 45 minutes - 2.30 hours respectively.

OT in hours is significantly less in Group B compared to Group A with $p < 0.001^{**}$.

C-arm exposure's were high in closed nailing as compared with open nailing because of multiple exposures starting from fracture reduction, entry point, guide wire placement, and distal locking. It co-related with study reported by Jain RK et al⁴¹.

C-arm exposure is significantly less in Group B with $P < 0.001^{**}$

POST OPERATIVE COMPLICATIONS

The post operative complications encountered in our study co-related with the below quoted studies.

Series	COMPLICATIONS	Open %	Closed %
Leighton RK et al³⁴ 1986	Malunion	-	4.7%
	Shortening	1.5%	-
	Infection	1.5%	3%
Meena R C et al⁴⁷ 2006	Delayed/ Nonunion	19.35%	7.%
	Infection- deep/superficial	3.2%; 16%	4.3%;8.6%
	Shortening	6.4%	30%
	Broken nail	3.2%	.
	Failed distal locking	19.4%	.
Gharehdaghi M et al²³ 2007	External rotation deformity	-	6%
	Nonunion	3%	1.5%
	Shortening	7.2%	2.5%
	Deep infection	1.8%	1.3%
	Implant failure	3.6%	1.3%
Present study 2012	Nonunion	-	-
	External rotation deformity	3%	10%
	Infection- deep/superficial	0%; 10%	3%;7%
	Shortening	3%	7%
	Screw brekage	0%	0%

Group A superficial infection 1 (4%) case, 3 (12 %) cases of external rotation dermoity > 5° and 1 (4%) case deep infection in which fracture united and implant removal done at 7 months and guarded mobilization, patient did well. In group B superficial infection was seen in 2 (8%) cases which subsided

with antibiotics according to culture and sensitivity, I (4%) case of shortening of 1.5 cms presented at final follow up, it was type IIIA open fracture with bone loss, open nailing with iliac crest grafting was done, fracture healed by 25 weeks with no signs of infection. External rotation dermoity $> 5^{\circ}$ 1 (4%) case.

In our study 6 cases of extensor lag, 3 in each group, which improved with quadriceps exercises and knee flexion-extension exercises. The good post-op range of motion was attributed to strict post-op regimen of quadriceps drill and knee flexion extension exercises and continuous passive motion in patients non-compliant with the above mentioned regimen

Post operative complication in our study groups were almost similar and statistically insignificant.

UNION RATES OPEN VERSUS CLOSED NAILING

The rate of union achieved in our study groups was superior to the quoted studies below.

SERIES	Year	Union rate		Duration
		Open %	Closed %	
Meena RC et al⁴⁷	2006	87.87%	93%	12 months
Gharehdaghi M et al²³	2007	93.2%	95.4%	6 months
Present study	2012	100%	100%	8 months

OVERALL UNION RATES

The overall union rates achieved in our study was superior with respect to the quoted studies below.

SERIES	Year	Union %	Duration (in months)
Pati BN et al⁵⁷	2001	98%	15
Meena RC et al⁴⁷	2006	90.43%	12
Gharehdaghi M et al²³	2007	93.2%	6
Razaq MNU et al²⁶	2009	97.83%	8
Present study	2012	100%	8

In our study we got 100 % union rates in both the groups with duration of union by 8 months. The union in our study group A and B were 16 weeks and 20 weeks respectively.

DURATION FOR FULL WEIGHT BEARING

The duration for full weight bearing in our study groups was earlier with respect to the quoted studies below.

SERIES	Year	Duration (Range in weeks)	
		Open	Closed
Leighton RK et al³⁴	1986	12- 14	12-14
Gharehdaghi M et al²³	2007	10-20	5-16
Present study	2012	8-12	8-12

Toe touch weight bearing with walker was used in most of our patients in both groups with in 1ST post-operative week. By the end of 4weeks partial weight bearing was started based on signs of callus on x-ray and fracture stability. By the end of 12 weeks most of our patients were full weight bearing with walker.

FUNCTIONAL GRADING

SERIES	Year	OPEN %				CLOSED %			
		E	G	F	P	E	G	F	P
Rokkanen P et al³⁰	1969	-	79%	21%	-	-	86%	14%	-
Leighton RK et al³⁴	1986	-	97%	3%	-	-	92%	8%	-
Meena RC et al⁴⁷	2006	56%	-	42%	2%	65%	-	35%	-
Present study	2012	77%	23%	-	-	80%	17%	-	3%

In our study results were evaluated based on criteria laid by Razaq MNU et al²⁶ modification of Thoresen et al³³ criteria - 80% excellent, 17% good, 3% poor in group A and 77% excellent, 23% good in group B.

Distribution of results depending on the functional grading are statistically similar in two groups with p value 0.872.

SUMMARY

Interlocking intramedullary nailing is a very effective and successful method of definitive primary treatment, in most of fractures of the shaft of the femur. Interlocking nail is effective in controlling rotational and longitudinal forces that act across the fracture site and provides strong fixation, rotational stability and early return to functional status, as the rate of healing is good with this method.

It allows early weight bearing and early rehabilitation. This is helpful especially in polytrauma patients, for early mobility and to reduce morbidity and mortality.

In our study outcome based on the objective of comparing the functional outcome of closed intramedullary nailing (Group A) versus open intramedullary nailing (Group B) of fracture shaft of femur was studied in 60 patients ,30 in each group.

- Majority were in age group of 21-30 yrs and majority of the patients in our study were males. (57 M, 3 F).
- Right side being the common side of injury 66.65% in both groups.
- Most of the fracture were due to RTA; 86.7% in both groups.
- Majority of the fractures were in the middle third; group A- 70%, group B- 76.7%.
- Most of the fractures were transverse fracture pattern; 43.3% in group A, 53.3% in group B.
- Fracture were classified based on level of fracture, radiological pattern of fracture, and comminution based on Winquist-Hansen's classification.
- Majority of the fractures were closed fractures; 83.3% in group A , 76.7% in group B.

- The most common associated injury was ipsilateral fracture of lower extremity; 62.5% in group A and 17.9% in group B .
- Duration between injury and surgery in most of the patients in both groups was within 1 week;70.0% in group A, 66.7% in group B.
- In most of the cases epidural anesthesia was used;46,7% in group A , 23.3% in group B.
- Mode of locking in two groups of patients were predominantly static mode; 93.3% in group A , 96.7% in group B.
- C-arm exposure high in group A as compared to group B.
- The operative time was 2-3hrs in majority of the patients (56.7%) in group A and was 1-2hrs (53.3%) in group B.
- Range of motion (ROM) of hip and knee joint in two groups of patients studied were almost same in both groups ; 96,7% in group A , 86.7% in group B.
- Post-operative complications were almost similar in both the groups; 30% in group A, 16.7% in group B.
- Late complications encountered were 23.3% in group A; and 6.7% in group B.
- Time to radiological union (range) was almost similar in both the groups; 16- 20 weeks in both groups.
- The results were evaluated based on criteria laid by Razaq MNU et al¹¹⁵ modification of Thorsen et al⁴⁹. In group A- 80% Excellent, 16.7% good and 3.3 % poor. In group B- 76.7% Excellent and 23.3% good.

CONCLUSION

Interlocking intramedullary nailing is a very effective and successful method of definitive primary treatment, in most types of fractures of the shaft of the femur. It is effective in providing strong fixation controlling rotational and longitudinal deforming forces . It allows early weight bearing ,early rehabilitation and early return to normal status.

Both closed and open methods of nailing do not differ much with respect to the post operative complication, time of fracture union and the functional outcome. Closed nailing requires more surgical expertise, sophisticated instruments and more time consuming and increased exposure to radiation to patient and surgeon.

Open method of nailing on other hand is less time consuming and less radiation to patient and surgeon with an advantage of accurate anatomical reduction and primary bone grafting. Though risk of infection is high in open method in our study the infection rate was similar in both groups.

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ANNEXURE – I
PROFORMA OF THE CASE SHEET

NAME:

I.P. NO.:

AGE:

DATE OF ADMISSION:

SEX:

DATE OF SURGERY:

DATE OF DISCHARGE:

ADDRESS:

I) PRESENTING COMPLAINTS:

II) H/O OF PRESENTING ILLNESS

1. MODE OF INJURY

- MOTOR VEHICLE ACCIDENT
- MOTOR CYCLE ACCIDENT
- FALL FROM HEIGHT
- ASSAULT
- OTHERS

2. MECHANISM OF INJURY

- i) DIRECT ii) INDIRECT**

III) TREATMENT HISTORY:- YES OR NO

IF YES

-OSTEOPATH

-GENERAL PRACTITIONER

-ORTHOPAEDICIAN

IV) PAST H/O INJURY / INJURIES

V) PERSONAL HISTORY

- 1) DIET**
- 2) HABITS**
- 3) SYSTEMIC ILLNESS**

VI) GENERAL PHYSICAL EXAMINATION

- 1) BUILT & NUTRITION**
- 2) PALLOR**
- 3) PULSE**
- 4) RESPIRATORY RATE**
- 5) B.P.**
- 6) CYANOSIS**

VII) SYSTEMIC EXAMINATION

- 1) R.S.**
- 2) C.V.S.**
- 3) P/A**
- 4) C.N.S.**

VIII) LOCAL EXAMINATION

A) INSPECTION

- 1) SIDE INVOLVED- RT/LT**
- 2) OVERLYING SKIN**
- 3) ATTITUDE OF LIMB**
- 4) DEFORMITY**
- 5) SWELLING**
- 6) SHORTENING**

B) PALPATION

- 1) TEMPERATURE
- 2) TENDERNESS
- 3) ABNORMAL MOBILITY
- 4) CREPITUS
- 5) BONY IRREGULARITY
- 6) TRANSMITTED MOVEMENTS
- 7) WOUND EXAMINATION
 - a) PRESENCE OF FOREIGN BODY
 - b) COLOUR OF MUSCLES
- 8) DISTAL NVD

C) MEASUREMENTS

- | | | |
|-----------------|----|----|
| 1) LONGITUDINAL | RT | LT |
| APPARENT | | |
| TRUE | | |
| 2) ASSOCIATED | | |

IX) ASSOCIATED INJURIES

- HIP
- KNEE
- PELVIS
- ANKLE
- OTHERS

CLINICAL DIAGNOSIS

X) INVESTIGATION (PRE-OP ASSESSMENT)

RADIOGRAPHY:

Hb:	PCV:	TC:	DC:	K⁺:
ESR:	RBS:	B.Urea:	S.Creat:	Na⁺:
HIV:	Hbs Ag:	BT:	CT:	BLOO
				D GP:

For patients more than 45 years of age:- CHEST X- RAY

ECG:

XI) MANAGEMENT

1) IMMEDIATE

a) I.V. FLUIDS

**b) PARENTERAL ANTIBIOTICS &
ANALGESICS**

c) BLOOD TRANSFUSION

d) SPLINTING

**i) FIXED SKIN TRACTION IN THOMAS
SPLINT**

ii) UPPER TIBIAL SKELETAL TRACTION

2) SURGICAL TREATMENT

- DOS:

- TYPE OF ANAESTHESIA:

- POSITION OF PT.

- APPROACH:

- METHOD a) OPEN b) CLOSED

- NAIL LENGTH: DIAMETER:

INTERLOCKING SCREWS- LENGTH:

- IMMOBILIZATION AFTER SURGERY

XI) POST OP PERIOD & FOLLOW UP

1. 1ST TO 10TH POST OP DAY

- ANTIBIOTICS & ANALGESICS**
- QUADRICEPS EXERCISES**
- RANGE OF MOTION**
- CHECK X-RAY**

2. 10TH -14TH POST OP DAY

- SUTURE REMOVAL**
- TOE TOUCH WT BEARING**

3. 4TH – 6TH WKS

- CHECK X-RAY**
- PROGRESSIVE WT. BEARING**
- ASSESSMENT OF RANGE OF MOTION**

4. 12TH - 16TH WEEKS

- CHECK X- RAY**
- DYNAMIZATION IF NECESSARY**
- CLNICAL ASSESSMENT OF FRACTURE HEALING**
- FULL WT. BEARING**

5. 24 WKS

- CHECK X-RAY**
- FULL WT. BEARING**

INTERLOCKING INTRAMEDULLARY NAILING IN FEMORAL SHAFT FRACTURES

CRITERIA FOR CLASSIFICATION OF RESULTS OF TREATMENT (Razaq MNU et al ²⁶ modification of Thoresen et al ³³ criteria - 2009)

	RESULT			
	EXCELLENT	GOOD	FAIR	POOR
MALALIGNMENT OF THE FEMUR (DEGREES)				
VARUS OR VALGUS	5	5	10	>10
ANTECURVATUM /RECURVATUM	5	10	15	>15
INTERNAL ROTATION	5	10	15	>15
EXTERNAL ROTATION	10	15	20	>20
SHORTENING OF FEMUR(cms)	1	2	3	>3
RANGE OF MOTION-KNEE JOINT				
FLEXION	>120	120	90	<90
EXTENSION DEFICIT	5	10	15	>15
PAIN OR SWELLING	NONE	SPORODIC	significant	SEVERE
NON-UNION/ NAIL BREAKAGE	ABSENT	ABSENT	ABSENT	ABSENT

ANNEXURE – II
MASTER CHART-GROUP A

Sl No	Pt. Name	Side	Age	Sex	I.P No	Nail Size	Site	Type	MOI	Complication	Locking	ROM	# Pattern	Anesthesia	O.T	C-Arm	Grading	Union (wks)	Assoc. Inj
1	Vijay Bhaskar	RT	18	M	639761	90x375	Midl/3rd	Closed	RTA	Nil	Static	Full	Transverse	E.A	2-3hr	41-50	Excellent	17	-
2	Venkatachalapati	RT	21	M	642772	10x420	Midl/3rd	Open-111A	RTA	Sup. Inf	Static	Full	Transverse	EA	1-2hr	21-30	Excellent	15	+
3	Nagrajappa	RT	60	M	643 075	10x390	Mid/3rd	Closed	RTA	Fracture hematoma	Static	Full	Comminuted	Epidural	2-3hr	31-40	Excellent	16	+
4	Sham	LT	25	M	646484	400x10	Midl/3rd	Closed	DT	Nil	Static	Terminal Restricted	Transverse	Epidural	1-2hr	>50	Excellent	17	-
5	Shiva	LT	24	M	648249	10x390	Prox1/3rd	Closed	RTA	Nil	Static	Full .	Comminuted	S.A	>3hr	>50	Excellent	17	+
6	Arif	RT	22	M	651297	9x380	Distal/3rd	Closed	RTA	Nil	Static	Full	Transverse	SA	2-3hr	>50	Excellent	15	+
7	Ramchandrapappa	RT	40	M	653113	9x380	Midl/3rd	Closed	RTA	Mal Algn	Primary Dynamization	Full	Transverse	E.A	1-2hr	21-30	Good	15	+
8	Narayanswamy	RT	30	M	654080	10x375	Midl/3rd	Closed	RTA	Nil	Static	Full	Comminuted	Epidural	>3hr	>50	Excellent	16	+
9	Musif Pasha	LT	24	M	656055	10x405	Midl13rd	Closed	DT	Nil	Static	Full	Transverse	G.A	2-3hr	41-50	Excellent	15	-
10	Srinivas	RT	24	M	663473	10x360	Midl1i3rd	Closed	RTA	Nil	Static	Full	Transverse	S.A	1-2 hr	21-30	Excellent	16	+
11	Subramani	RT	22	M	680428	10x380	Midl/3rd	Open type 1	RTA	Deep. Inf.	Static	Full	Comminuted	S.A	1-2hr	31-40	Poor	18	-
12	Narayanamma	LT	30	F	689956	10x360	Dist l/3rd	Closed	RTA	Nil	Static	Full	Comminuted	Epidural	2-3hr	>50	Excellent	23	-
13	Suresh	LT	27	M	694457	10x440	Proxl/3rd	Closed	RTA	Nil	Static	Full	Transverse	G.A	2-3hr	>50	Excellent	27	-
14	Rammurthy	RT	55	M	708001	10x400	Midl/3rd	Closed	RTA	Shortening	Static	Full	Segmental	Epidural	1-2hr	31-40	Good	18	+

15	Sunderraj	RT	55	M	745106	10x400	Mid1/3rd	Closed	RTA	Nil	Static	Full	Comminuted	Epidural	2-3hr	41-50	Excellent	17	-
16	Karunan	RT	25	M	756389	10x420	Mid1/3rd	Closed	HT	Nil	Static	Full	Transverse.	S.A	2-3hr	41-50	Excellent	20	-
17	Shashi Kumar	LT	17	M	756392	10x400	Mid1/3rd	Closed	RTA	Mal Algn	Static	Full	Long oblique	E.A	>3hr	>50	Good	25	-
18	Mansur Pasha	RT	18	M	758924	10x400	Prox1/3rd	Closed	RTA	Nil	Static	Full	Transverse	S.A	1-2hr	31-40	Excellent	14	+
19	Ramakrishna	RT	40	M	758924	10x400	Prox1/3rd	Closed	RTA	Nil	Static	Full	Comminuted	Epidural	»5hr	>50	Excellent	32	+
20	Ashok	LT	16	M	781146	10x360	Mid1/3rd	Open-i	RTA	Sup. Inf	Static	Full	Transverse	S.A	2-3hr	41-50	Excellent	18	+
21	Muninarayana Gowda	RT	55	M	781821	10x405	Mid1/3rd	Closed	RTA	Nil	Static	Full	Short oblique	S.A	2-3hr	>50	Excellent	25	-
22	Javed Pasha	RT	27	M	785018	9x375	Mid1i3rd	Closed	RTA	Nil	Static	Full	Comminuted	S.A	2-3hr	>50	Excellent	15	+
23	Janardhan Reddy	LT	33	M	796701	11x370	Mid1/3rd	Closed	RTA	Mal Algn	Static	Full	Comminuted	S.A	2-3hr	41-50	Good	21	+
24	Nagrajappa	RT	70	M	806695	10x400	Mid1/3rd	Closed	RTA	Nil	Static	Full	Segmental	Epidural	2-3hr	41-50	Excellent	22	-
25	Malansha	LT	45	M	806749	10x420	Mid1/3rd	Closed	HT	Nil	Primary Dynamization	Full	Comminuted	Epidural	2-3hr	41-50	Excellent	18	+
26	Manjunath	LT	23	M	812916	10x400	Dist1/3rd	Closed	RTA	Nil	Static	Full	Transverse	S.A	1-2hr	31-40	Excellent	17	-
27	Shravanthi	RT	25	F	815794	10x400	Mid1/3 rd	Open type 1	RTA	Nil	Static	Full	Comminuted	S.A.	2-3hr	>50	Excellent	16	-
28	Amarnath	LT	38	M	817231	10x420	Dist.1/3rd	Closed	RTA	Nil	Static	Full	Transverse	S.A.	1-2hr	31-40	Excellent	17	+
29	Venkatarama	RT	35	M	818502	10x400	Mid1/3 rd	Closed	RTA	Nil	Static	Full	Comminuted	S.A.	2-3hr	41-50	Excellent	16	-
30	Narasimha	RT	20	M	835581	10x400	Distal1/3rd	Open 11	RTA	Shortening	Static	Full	Comminuted	E.A.	2-3hr	>50	Good	17	+

MASTER CHART - GROUP B

SL No	Pt. Name	Side	Age	Sex	I.P No	Nail Size	Site	Type	Complications	ROM	MOI	Locking	# Pattern	Anesthesia	O.T	C-Arm	Grading	Union (Wks)	Assoc. Inj
1	Ranganath	RT	22	M	638836	9X380	PROX1/3RD	Closed	Nil	Full	RTA	Static	Comminuted	S.A	1-2hr	10--20	Excellent	15	+
2	Suresh	RT	20	M	639763	9X360	MID1I3RD	Open II	Shortening	Full	RTA	Static	Comminuted	S.A	< 1 hr	10--20	Good	16	+
3	Srinivas C.M.	RT	35	M	644699	10X420	MID1/3RD	Closed	Nil	Full	RTA	Static	Transverse	S.A	2-3hrs	31-40	Excellent	25	-
4	Manju	RT	19	M	649966	11X400	MID1/3RD	Closed	Nil	Full	RTA	Static	Transverse	S.A	2-3hrs	31-40	Excellent	17	-
5	Mokthiyar	RT	25	M	651998	11X420	MID1/3RD	Open II	Sup. Inf.	Full	RTA	Static	Comminuted	Epidural	1-2hr	21-30	Good	17	-
6	Nagai Shetty	RT	45	M	661476	9X375	MID1/3RD	Closed	Nil	Full	RTA	Static	Transverse	S.A	2-3hrs	21-30	Excellent	17	+
7	Manjunatha	LT	30	M	669957	9X400	MID1/3RD	Closed	Nil	Full	RTA	Static	Comminuted	S.A	1-2hr	21-30	Excellent	25	+
8	Narayanswamy	RT	32	M	671544	10X360	MID1/3RD	Closed	Nil	Full	RTA	Static	Comminuted	S.A	1-2hr	31-40	Excellent	17	+
9	Nagraj	RT	30	M	676892	10X420	MID1/3RD	Open-I	Mal Algn	Trmn Rest	RTA	Static	Transverses	S.A	<1 hr	21-30	Good	30	+
10	Srinivas C R	RT	32	M	680681	10X400	Mid1/3RD	Closed	Nil	Full	RTA	Primary Dynamization	Transverse	G.A	1-2hr	31-40	Excellent	18	-
11	Shankar	LT	28	M	694891	10X400	MID1/3RD	Closed	Nil	Full	DT	Static	Comminuted	Epidural	< 1hr	10--20	Excellent	22	-
12	Venkatesh	RT	26	M	697380	10X420	MID1/3RD	Closed	Nil	Full	RTA	Static	Transverse	S.A	1-2hr	21-30	Excellent	15	-
13	Sriramappa	LT	45	M	703876	10X405	MID1/3RD	Closed	Nil	Full	RTA	Static	Comminuted	S.A	1-2hrs	31-40	Excellent	22	+
14	Sriram	RT	40	M	706163	10X400	Prox1/3RD	Closed	Nil	Full	RTA	Static	Transverse.	S.A	1-2hr	21-30	Excellent	20	-
15	Bychappa	RT	63	M	707344	10X405	MID1I3RD	Closed	Nil	Full	RTA	Static	Transverse	S.A	1-2hr	31-40	Excellent	25	-

16	Srinivas TM	RT	70	M	715344	11X380	MID1/3RD	Closed	Nil	Full	RTA	Static	Transverse	SA	< 1hr	< 10	Excellent	20	+
17	Venkataswamy	LT	35	M	718520	10X400	DIST1/3RD	Open-I	Nil	Full	RTA	Static	Comminuted	Epidural	2-3hrs	31-40	Excellent	21	+
18	Tapan	RT	23	M	724948	11X375	MID1/3RD	Closed	Nil	Termin Rest	RTA	Static	Transverse	Epidural	2-3hrs	21-30	Excellent	18	-
19	Ambrish	RT	19	M	736880	10X340	MID1I3RD	Closed	Nil	Full	RTA	Static	Transverse	Epidural	1-2br	10--20	Excellent	19	-
20	Appoji	LT	65	M	745844	10X400	MID1/3RD	Closed	Nil	Full	HT	Static	Short Oblique	S.A	1-2hr	31-40	Excellent	21	-
21	Manjunath	LT	35	M	739051	11X400	DIST1/3RD	Closed	Nil	Full	RTA	Static	Comminuted	Epidural	< 1hr	<10	Excellent	20	-
22	Nazeem	RT	25	M	756451	9X440	MID1/3RD	Closed	Sup. Inf	Full	DT	Static	Transverse.	Epidural	1-2hr	10-20	Good	20	-
23	Partha Sarathi	LT	24	M	758553	10X400	PROX1/3RD	Open 11	Nil	Trmn Rst	RTA	Static	Transverse	S.A	< 1hr	<10	Good	18	+
24	Sowmya Shree	LT	17	F	759865	12X390	MID1I3RD	Closed	Sup. Inf	Full	RTA	Static	Transverse	G.A	1-2hrs	31-40	Good	17	+
25	Karsarappa	RT	45	M	777314	10X400	MID1I3RD	Closed	Nil	Full	RTA	Static	Comminuted	S.A	2-3hrs	31-40	Excellent	16	-
26	Murlidhar	RT	23	M	784391	10X420	MID1I3RD	Closed	Nil	Full	RTA	Static	Transverse	S.A	1-2hr	31-40	Excellent	17	+-
27	Narayanswamy	RT	40	M	790523	10X360	MID1/3RD	Closed	Nil	Full	RTA	Static	Comminuted	S.A.	1hr	10 -20	Excellent	17	-
28	Gopal	RT	35	M	825146	10X420	MID1/3RD	Open I	Nil	Full	HT	Static	Comminuted	S.A.	1 hr	<10	Excellent	18	+
29	Giddapa	LT	19	M	808794	10X405	PROX1/3RD	Closed	Nil	Trmn Rst	RTA	Static	Transverse	SA	1-2HR	10-20	Good	17	-
30	Vishwanath	RT	24	M	822525	9X420	MID1/3RD	Open I	Nil	Full	RTA	Static	Segmental	SA	1-2hr	10-20	Excellent	20	+