"STUDY OF THE SURGICAL MANAGEMENT OF FRACTURE DISTAL ONE THIRD FEMUR BY RETROGRADE INTRAMEDULLARY NAILING"

BY

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IN

ORTHOPEDICS

UNDER THE GUIDANCE OF

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Dr. AVI PRANAY SHAH

LIST OF ABBREVATIONS USED

AO-ASIF	Arbeitsgemainschaft Fur OsteosyntheseFragen Association for Study of Internal Fixation
Asso	Associated
BBS	Bohler Braun Splint
Comm	Comminuted
Comp	Compound
CRIF	Closed reduction and internal fixation
DCS	Dynamic condylar screw
DOA	Date of Admission
DOD	Date of Discharge
DOO	Date of operation
Exer	Exercise
FFH	Fall from height
Gr	Grade
Imm	Immediate
OA	Osteoarthritis
ORIF	Open reduction and internal fixation
Quad	Quadriceps
RIN	Retrograde intramedullary nail
ROM	Range of motion
RSN	Retrograde supracondylar nail
RTA	Road traffic accident
S/C	Supracondylar
Tr	Transverse

ABSTRACT

Background and objectives: Fracture of distal third of femur is encountered because these fractures most often result from high velocity injuries as femur is the largest bone of the body .It is one of the principal load bearing bones in the lower extremity[1]. One must have a high index of suspicion for complications or other injuries as it can cause prolonged morbidity and extensive disability like joint stiffness due to post traumatic arthritis unless treatment is appropriate. Distal femur fractures make up to 6% of all femoral fractures. Most high energy distal femoral fractures occur in males 15-50 years and low energy fractures occur in osteoporotic women more than 50.Most commonly RTA 53% and fall at home 33%.[7] In rural India, workplace injury such as fall from height is also common.

Possible treatment methods for fracture of distal femur include conservative like closed reduction and above knee cast immobilization, skeletal traction and femoral cast bracing and operative like external fixation, internal fixation, intramedullary nailing with open and closed technique, ante-grade interlocking intramedullary nailing with or without reaming, retrograde interlocking intramedullary nailing, distal femoral nailing and locking plate fixation. These fractures are best treated by anatomical reduction and stable internal fixation.[7]

Currently surgery is indicated for femur fractures because of high rate of union, low rate of complication and advantage of early stabilization which decreases morbidity and mortality in patients. Regardless of the method of treatment, the following principles are agreed upon i.e. restoration of alignment, rotation and length, preservation of blood supply to aid union ,prevent infection, rehabilitation of the extremity and there by the patient.[4]

A method closely approaching this perfection is retrograde intramedullary interlocking nailing which improves the torsional and axial stability and offers a more biological method of fixation with less devitalisation of soft tissues.[4,8] It has improved post-operative knee function with decreased operative time, blood loss, bone grafting, and non-union rates.[8] Result is early recovery, lesser hospital stay, early rehabilitation with good results and is economical.[6] Surgical stabilization of osteoporotic bones and pathological fractures has increased due to retrograde nails.[6]

The present study is to understand the functional outcome and to minimize operative mistakes and complications of surgical management of distal femur fractures with retrograde nailing as we see many RTA victims with distal femoral fractures both open and closed type in R.L.Jalappa Hospital because it is situated on the national highway.

Methods: 30 patients with supracondylar femur fracture were studied. RIS nail was inserted through intercondylar notch. These nails have advantage of being load shearing devices, requiring little soft tissue dissection, infrequently needing bone grafting and technically easier. Preserving fracture hematoma, decreased blood loss, less operative time and decreased infection.

Results: In 30 patients, male predominate (93.3%) in this study. RTA was the chief cause of fracture. Surgery was performed within 1.9 days average, there were 5 open type and 25 closed type of fracture .radiological union was seen in 16-24 weeks. Average patient was followed up for 6 months. Average knee flexion was 115°. 1 died, 1 screw breakage and 2 had pulmonary embolism. 3 shortening of limb, 3 stiffness and 7 delayed union. 15(51.7%) excellent results, 6(20.6%) good results, 7(24. %) fair results and 1(3.4%) poor result.

Interpretation and Conclusion: Retrograde intramedullary nailing is a good fixation system for supracondylar femur fractures with less operative time and blood loss. By closed reduction, not disturbing fracture hematoma and even in open reduction less soft tissue dissection and thus reducing complications like infection, stiffness, distal screw related local symptom is a common problem and is related to implant and technique and has a definite learning curve. Utmost aseptic precaution great care required to prevent infection. Non-requirement of bone graft decreases the morbidity. Early surgery, closed reduction, at least two screws in each fragment and early post-operative knee mobilization are essential for good union and good knee range of motion.

Key Words: Distal third femur fracture; retrograde supracondylar nail; closed reduction.

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INTRODUCTION

This is an era of rapid industrialization and fast pace of life which has led to concomitant rise in road traffic accident (RTA), that cripple many lives as well as increased life expectancy, old age population, carrying dangers of osteoporosis and fractures. So these major factors contribute to such complex fractures of distal femur. The incidence of distal femoral fractures is approximately 37/1, 00,000 person years.[8] Distal femur fractures make up to 6% of all femoral fractures. Most high energy distal femoral fractures occur in males 15-50 years and low energy fractures occur in osteoporotic women more than 50 years. Most common mode of injury is RTA (53%) and fall at home (33%).[7] In rural India, workplace injury such as fall from height is also common.

Supracondylar femoral fractures are often difficult to treat and they are notorious for many complications.[10]

In the early 1960s, there was a great reluctance towards operative management of this fracture because of high incidence of infection, non-union, mal-union, inadequate fixation and lack of proper instrumentation. The orthodox management of distal third femur was along the principle of Watson Jones[12] & John Charnley[13]. This comprised of skeletal traction[11], manipulation of fracture and external immobilization in the form of casts and braces. These methods however were associated with complications like deformity, shortening, fracture disease, knee stiffness, joint incongruity, mal-union, muscle wasting, knee instability and early arthritis. [13, 14]

Dissatisfaction with the results of these orthodox treatments were commonly encountered, which lead to the development of newer techniques of fracture managements. It is now recognized that distal femoral fractures are best treated with open/closed reduction and surgical stabilization.[15]

The osteosynthesis in the distal femur could be difficult because of thin cortex, comminution, osteopenia, complex injuries associated soft tissue injuries, a distal wide medullary canal and involvement of the knee joint. Most surgeons agree that distal femoral fractures need to be treated operatively to achieve optimal outcomes.[9]

1970, AO principles, the trend of surgical treatment with internal fixation with various types of implants like Ender‟s pin, Zickel supracondylar device, AO blade plate; Dynamic condylar screw and during the last few decades results of closed intramedullary interlocking ante grade and Retrograde nailing results were encouraging.

The current method of open reduction and internal fixation has become evident in the recent years with good results being obtained with the AO blade plate, dynamic condylar screw and other implant systems like intramedullary supracondylar nails and recently locking compression plate.

The options for surgical treatment are many but after thorough research the technique of retrograde nailing was the most ideal. This load sharing device gave good results with minimal soft tissue dissection and good stability.

Supracondylar fractures tend to collapse into varus. During application of AO blade plate or dynamic condylar screw, the shaft of femur is often pulled laterally displacing the line of weight bearing, lateral to the anatomic axis of condyle. This creates rotational movements at the fracture site that causes pulling off the blade plate or condylar screws leading to fatigue fracture of the plates. Also, the presence of osteoporotic bone leads to fixation failures with screws and plates cutting of the soft bone.

The obvious advantage of an intramedullary device is that it aligns the femoral shaft with condyles reducing the tendency to place varus movement at the fracture site. The reduced bending movement of an intramedullary device has substantially reduced failure of fixation in osteoporotic bone.

Intramedullary nails offer potential biomechanical advantages over plates and screws because their intramedullary location results in less stress on the implant, they have the potential for load sharing, and can be inserted with minimal stripping of soft tissue. Given the appropriate fracture patterns, ante grade IM nailing in the treatment of distal femoral fractures has been associated with angular deformities because of inability of distal interlock of the ante grade nail to achieve control of the small and often osteoporotic distal fracture fragment. [18]

A retrograde intramedullary supracondylar nail has got distinct advantages of preservation of fracture hematoma, reduced blood loss, minimal tissue damage, less operative time and reduced rate of infection.

Controversy still remains regarding the optimum device for distal femur fixation. The type of device depends on variables, fracture personality and soft tissues.

With this study we aim to evaluate the surgical outcome of supracondylar fracture of femur, treated by close/ open reduction and internal fixation using retrograde intramedullary supracondylar nail.

AIMS AND OBJECTIVES

1. TO STUDY FUNCTIONAL OUTCOME AND UNION RATES OF FRACTURES

2. TO STUDY THE COMPLICATIONS RELATED TO RETROGRADE NAILING

REVIEW OF LITERATURE

1. In a comparative study of 60 cases of supracondylar fracture of femur treated with supracondylar nailing versus open dynamic condylar screw it was found that early weight bearing can be started with nailing technique.[7]
2. In a study of patients with distal femoral fractures in osteoporotic bone with distal intramedullary nailing it was concluded that distal locking pattern affects the stabilization of distal femoral fractures that is it gives axial and torsional stability.[8]
3. In a comparative study of conservative versus operative treatment for management of supracondylar fractures in 25 patients in non-ambulatory patients it was concluded that by surgical treatment they attained stable fixation and a pain free limb.[5]
4. In a study of 13 patients with distal femur fracture treated with supracondylar outcome was assessed for a mean duration of 20.2 months and if it was concluded excellent technique in 6 patients, good in 3 patients and fair in 3 patients based on criteria of schatzker and lambert grading. The scoring system was as follows.
    a. An excellent result required anatomical alignment, <5° flexion contracture, <1 cm shortening, Flexion >120°, minimal pain, and no arthritis.
    b. Good results were present when <5° varus, 100-120° flexion, 5-10° flexion contracture, no arthritis, <1.5 cm shortening, and occasional mild discomfort.
    c. Fair results were present when flexion was 90-100°, >5° varus, mild to moderate discomfort, 10° flexion contracture, and degenerative arthritic changes on radiography existed.
    d. Results were considered poor with <90° of flexion, severe discomfort, nonunion or malunion, >2 cm shortening, and need for ambulatory assistive devices.[4]
5. In a study of 35 cases with complex femoral fractures using retrograde femoral nailing especially for people with polytrauma (multiple trauma) like femoral fractures with tibia shaft fracture, pathological fracture, operated with undreamed nail followed up for 3 years and average union found by 12-18 weeks ,31 patients got full range of movements. They concluded in early recovery, lesser hospital stay and early rehabilitation of patient with good results and it is economical too with the above procedure.[3]

6. The major advance in treatment of all types of femoral fracture was in 1870 when Huge Owen Thomas derived the Thomas splint.[73] Then Sir Arbathrot Lane did the first internal fixation of closed fracture with plating in 1894.
7. In 1907, Lambotte introduced term osteosynthesis and firmly believed in early return of function after surgical fixation.
8. For 1909, Stiem frtiz used Steinmann pin for skeletal traction replacing old skin traction.[38]
9. In 1936, Weil et al in a review of 278 femoral fractures, 58 out of which are distal third stressed the high percentage of poor results in this region.[10]
10. 1937, Tees advocated treatment of distal femoral fractures by skin traction, as a means of reduction and immobilization of these fractures.[32]
11. In 1945, Modlin reported 23 fractures of distal femur treated by skeletal traction with a K-wire in distal femur and one in proximal tibia with good results.[11]
12. In 1955, Sir.Reginald Watson Jones warned the surgeon against any attempt at knee motion less than 6 weeks and even quadriceps exercises were contraindicated, lest the fragment redisplaced.[12]
13. In 1961, John Charnley in his monograph, devoted a chapter on fracture of femoral condyles "the closed treatment of fracture" he described the detail technique of applying skin traction under anesthesia to the leg and immobilization in Thomas Splint. He also advocated the principle of controlled collapse at the fracture site, operative treatment for fractures in athletic individuals and where fragments are held apart.[13]
14. In 1967, Neer et al.[27] analyzed the results of IF in cases of supracondylar fractures of femur. They classified the fractures anatomically as well as formulated rating system based on point for functional and anatomical criteria. This criteria is still used by many and is recommended in evaluating distal third femur fracture; they studied 110 supracondylar fractures of femur out of which 29 were treated with ORIF and rest by closed methods. They reported 52% satisfactory results with ORIF while 90% satisfactory results with closed methods, 84% satisfactory results in displaced supracondylar fractures of femur.
15. In 1967, Randoloph and Anderson reported a series of 56 cases of femoral fractures, 20 out of which were in distal third, showing good results with Russell"s traction.

16. In 1970, Wert Mooney et al.[34] described advantages of cast bracing, early ambulation and weight bearing in treatment of these fractures. They concluded that cast bracing allowed early joint mobilization. At the same time fracture is protected from disruptive forces.
17. In 1970, AO published review of 112 patients with supracondylar fractures femur treated with ORIF according AO principles. They had 73.5% good to excellent results.
18. In 1970, Zickel et al.[57] developed a nail for use in distal femur. The nail had screws in femoral condyles. This nail could be inserted by open or closed method. As the nail alone could not prevent shortening in communited fractures its use was restricted to non-comminuted and minimally comminuted fractures.
19. Riggins et al.[31] conducted study in 1972 and showed that 61% of the then orthopedic favored conservative line of treatment for these fractures because of complication of ORIF like infection, delayed union and knee stiffness.
20. In 1972, Enneking et al.[14] reported that long term immobilization of knee caused capsules and pericapsular contractures, an important role in knee stiffness.
21. In 1972, Connoley JF et al.[33] in their vivo quantitative analysis measured axial rotation and translation of fragments in 30 cases of the fractures, with traction in bed and walking in cast brace. They described the advantage of cast bracing was its effect on the patient and not just fracture, by their observation, rotation and translation was reduced in cast bracing than traction.
22. In 1974, Schatzker et al.[55] published review of Toronto experience with supracondylar fractures from 1966-1972. They treated according to AO principles and had 75% good result.
23. In 1979, Schatzer and Lambert[15] reported on 17 supracondylar fractures of femur treated AO blade plate with 71% good to excellent results. Their study proved that accurate reduction, stable IF, and early joint mobilization gave excellent results.
24. In 1982, R.D.Mize et al.[39] studied 30 cases of SC fractures and IC fracture of femur reported good results in 24 cases with AO blade plate and advocated that advanced age is not contraindication for IF.

25. In 1989, J.M Siliski et al.[40] managed 52 SC and IC femoral fractures following AO classification and fixation principles and obtained 92% good to excellent in C, 72% in C2 and 85% type C2 fractures with different types of implants.
26. In 1991, Roy Saunders et al described treatment of comminuted and unstable femoral fracture with double plating method. But post-operative knee ROM was unsatisfactory.[46]
27. In 1991, Leung et al.[37] stated that conventional surgical methods of Distal femoral fracture required extensive soft tissue trauma and increased NU and infection. They advocated use of closed intramedullary nailing in SC and IC fracture. They showed 94% good to excellent results.
28. In 1993, Emmett Lucas et al.[41] reported a preliminary study with GSH supracondylar nail, the results of 34 supracondylar fractures in 33 patients. In short term follow up of 5 months in 25 patients, all fractures healed with an average arc of motion of 100°. Four AO/ASIF type C fractures required bone grafts at 3 months: there was one bent and one broken nail and one late infection with a septic knee.
29. In 1994, David S.Marks et al. reported 33 cases of supracondylar fractures femoral fractures in elderly patients using Zickel supracondylar fractures nail system with good result. J.R.Lovelle et al discussed role of DCS for supracondylar fractures with their study results were unsatisfactory in elderly patients.
30. In 1994, Iannacore WM et al.[36] reported 41 distal femoral fractures treated by RIN. 35 of 41 cases achieved 90° flexion, no infection. Modification of the design of the nail was made due to fatigue fractures. They concluded that supracondylar nail would contribute to management of these fractures after further clinical trial and additional biomechanical testing.
31. In 1995, Danziger MB et al.[50] reported 94% excellent to good result with average ROM of knee joint in 23 cases supracondylar fractures treated with GSH SC nail and open reduction. They concluded that GSH SC nail is an excellent alternative for treatment of these distal femoral fractures.
32. In 1995, Henry SL discussed using RIN for treatment of supracondylar fractures of femur above total knee arthroplasty. He reported excellent biochemical stability resulting in minimal complication allowing early ROM of knee joint.

33. Firoz Baksh K et al.[64] study in 1995 concluded that a RIN had a rigidity versus plate fixation in varus loading which is the most common and important cause of implant failure in their cadaveric study to compare mechanical properties of RIN and plate and screws.
34. Richard E. Gellman et al.[51] (1996) studied 26 SC fractures in 24 patients who were treated with RIN. Follow-up interval was 18 months (range, 4-36 months). All fractures healed by 4 months (average, 3 months). Only one patient required bone grafting. There were no implant failures or infections. There was one malunion. Average knee range of motion was 104°. There were 4 excellent, 16 good, 2 fair and 2 poor results out of 24 supracondylar fractures available for follow up.
35. In 1996, Ostermann PA[49] and Halin MP treated 18 distal femoral fractures using RIN with 16 cases achieving pretraumatic ROM of knee, only one patient developed varus misalignment requiring corrective osteotomy.
36. In 1998, Scheerlinck reported 16 cases treated with Green-Seligson Henry RIN. They concluded that compared to plate osteosynthesis RIN requires less extensive dissection and is biomechanically favorable.
37. Jan Zing used RIN in 26 distal femoral fractures 6 were AO type C, 25 of 26 healed and 72% had Neer score of 85 or more points.
38. In 1998, Ito K, Gass R and Zwipp H reported a frozen cadaveric femur. The result of study was varus angle and failure under axial load was significantly greater for condylar blade plates than GSH nail or a new retrograde unreamed SC nail.
39. Helfet DL, Lorich DG[52] in 1998 reviewed RIN of supracondylar fractures as an alternative to AO P&S techniques. Which included technique after knee arthrotomy, fracture reduction, nail insertion and reported clinical and biomechanical results, the RIN is viable alternative for AO P&S for type 3A and some 3C supracondylar fractures.
40. Kumar et al.[19] in 2000 studied 18 cases of distal femoral fracture in elderly patients. With Retrograde titanium supracondylar nail, 15 fractures united in an average of 3.6 months, ROM was 100.6°. There was no implant failure/sepsis/wound healing problem. One NU and 2 stress fracture above nail were noted.

41. In 2001, Leggon RE, Feldmann DD[67] studied RIN of 23 patients with reamed intramedullary nails 19 patients were followed up for average 19.3 months, union rate was 100% with no infection/MU. Mild knee pain was common.
42. In 2002, Watonabe Y et al.[56] reviewed 24 fractures treated with RIN. All fracture healed clinically/radio logically, knee ROM was 102±8 there was 3 varus/valgus MU, with 2 cases of distal screw loosening and breakage each. They concluded that RIN was satisfactory is younger patient than 60 years age.
43. Armstrong R et al. (2003) treated distal femoral fractures with RIN. Post operatively early mobilization began immediately, but wt. bearing after clinical union achieved. They concluded that this treatment provides an excellent technique.
44. In 2004, Patel K Kapoor et al.[54] presented a prospective study of 25 patients with SC and IC fracture of the femur carried out from January 1999 to June 2003 at SSG Hospital, Baroda, India. 28% fractures were open and 72% were closed. AO classification was used to classify the fractures. 84% of the fractures were due to high velocity trauma. All the cases were operated by percutaneous RIN. Rating scale developed by Hospital for Special surgery was used to quantify the results. 84% showed excellent, 8% showed good and 8% showed fair results. Percutaneous RIN is thus, an excellent method of treating fractures of distal femur.
45. In 2005, Pao JL, Jian CC[59] studied RIN for NU supracondylar fractures of osteoporotic bones in 3 elderly patients treated with various plate and screws. Two was traumatic NU supracondylar fractures, one per prosthetic fracture after total knee replacement. All structures healed, united with indirect reduction, provided superior biochemical properties, and reduce the need for soft tissue dissection.
46. In 2005, Chistodoubu A et al.[43] did a comparative study of treating supracondylar fractures with DCS and supracondylar nailing methods. 80 patients selected type A and C of AO classification RIN in 35 and DCS in 37cases.In DCS mean operative time was 145 minutes, estimated blood loss was 310 cc, results (19); excellent 11, moderate 4, poor 3,complications knee stiffness 4. In RIN mean operative time was 92 minutes, estimated blood loss was 118 cc, results (18); excellent 11,moderate 3,poor 3,complications knee stiffness 2,nonunion 2,varus mild 2. Using criteria set by

Schatzker and Lambert they concluded that RIN is preferable to DCS in terms of blood loss and shorter operative time and soft tissue dissection.

47. In 2007, ***S El-Kawyet al***[74] made a retrospective study in which 23 elderly patients with supracondylar fractures of femur treated by retrograde femoral nailing. Patients had an average age of 75 years. All patients were assessed with regard to operative time, blood loss, hospital stay, and postoperative complications. All patients were assessed clinically and radio logically every 6weeks for average period of 14 months. Of these two patients died a few weeks postoperatively. Average operative time 70minutes, average blood loss 350ml. Radio logically all cases united, 39.2% had angular misalignment. There were no cases of implant or fixation failure. He concluded that retrograde femoral nailing is a surgically limited and reliable procedure for elderly patients with supracondylar fractures of femur without intraarticular extension.
48. In 2008, ***T NEUBAUER et al***[75]made retrospective study of retrograde nailing for fixation method of fractures of distal femur and in femoral shaft fractures as an alternative to the existing technique of ante grade nailing. In 40 patients with average age 63.7years the treatment of distal femoral (AO/ASIF –type 33) and femoral shaft fractures (AO/ASIF-32) in 40 patients with 41 fractures. Patients were followed till fracture healing occurred. Osseous healing occurred in shaft fractures in 18.1weeks .On an average compared to 16.5 w weeks in supracondylar fractures. Thus retrograde nailing resulted in the majority (95.1%) in reliable osseous healing. He concluded that retrograde nailing represents a reliable fixation method for extra articular (33-A1-3) and simple intraarticular (33-C1-2) fractures of supracondylar area. In femoral shaft fractures retrograde inserted nails offer a valuable alternative, especially when the proximal femoral approach is obstructed.
49. In 2010 ***POYANLI et al***[76] a study of 15 patients with mean age of 27.8years with supracondylar fractures of femur due to gunshot wounds and without skin defects, retrograde intramedullary nailing was done. They were assessed whether osteomyelitis of the femur or septic arthritis of knee develops after retrograde intramedullary nailing of the femur performed within 7days of supracondylar femur fracture. They were followed up for a mean period of 11.7months and showed no evidence of ipsilateral septic arthritis of knee or osteomyelitis of the femur. Thus retrograde nailing can be performed in patients with supracondylar fractures of femur due to gunshot wounds, and without skin defects in first 7days after the trauma.
50. In 2013 ***SKV Gupta et a***l[77] a study of 57 cases operated with retrograde intramedullary nail showed radiological and clinical union with an average time of 7.4 months for union. 5 cases (9%) developed nonunion.

Various implants for fixation of supracondylar and intercondylar fractures of femur

Sl. No.	Surgeons	Year	Technique
1.	Umansky et al	1949	Blountblade plate
2.	White and Russin	1956	Reverse Blount Plate
3.	Neer et al	1967	Blade plate, plates and bolts
4.	Austin Brown & D"Arcy JC	1971	Trifin Nail Plate with Medial
5.	Sven Olerud	1972	AO Blade Plate
6.	Schatzker et al	1979	AO Blade Plate
7.	Mize RD et al	1982	AO Blade Plate
8.	Siliski JM et al	1989	AO Blade Plate
9.	Zickel et al	1976	Zickel nailing technique
10.	Kolmert et al	1983	Enders nails
11.	Leung KS et al	1991	Interlocking nail
12.	Zimmermann AJ	1979	DCS & 95° plate
13.	Giles JB et al	1982	DCS & 95° plate
14.	Shewring DJ et al	1992	DCS & 95° plate
15.	Lucas SE et al	1993	Supracondylar femoral nail

ANATOMY

The cylindrical shaft of the femur expands at the lower end into two curved condyles as a weight bearing surface for transmission of weight to the tibia.

Definition of supracondylar area: [2, 21]

Area or zone between the distal femoral articular surface and the junction of the metaphysis with the femoral diaphysis. This is approximately the distal 15 cm of femur as measured from femoral distal articular surface. This area includes the two medial and lateral condyles which are partially articular. The distal femur is trapezoidal (narrower anteriorly and broader posteriorly) with an angle of inclination of the medial surface of about 25° and lateral condyle about 10°. The lateral condyle is broader and extends further proximally. The medial condyle is longer than lateral and extends further distally. These two condyles are continuous anteriorly and continue with the shaft. They are separated posteriorly by the inter-condylar notch.

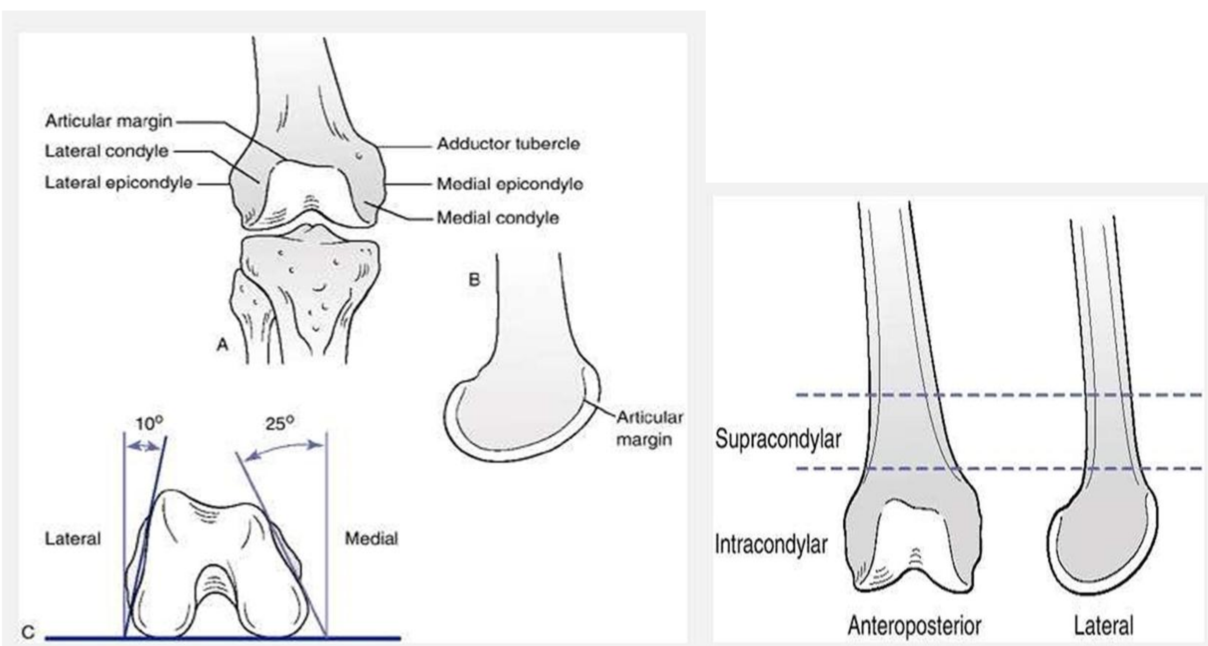


Fig-1 anatomy of distal femur[2]

Anteriorly there is an inverted U shaped broad area for patella. This patellar surface is grooved to articulate with the patella. A large part of this surface is formed by the lateral condyle.

The inter-condylar fossa is intra-articular but extra synovial, gives attachment to cruciate ligament. Posteriorly the medial and lateral head of gastrocnemius arise from popliteal surface. Anteriorly the supracondylar femur area is covered by quadriceps tendon and suprapatellar pouch.

The tibial surface is convex in all directions, medial surface is longer on anterior-posterior projection. The lateral condyle is less prominent than its counterpart and is flat laterally and more directly in line with shaft femur. It transmits more weight to the tibia. The fibular collateral ligament is attached to its summit i.e. lateral epicondyle.[21]

The medial condyle is longer than lateral condyle and extends further distally, so that despite the obliquity of the shaft, the profile of the distal end of femur is horizontal. Proximally adductor tubercle provides insertion to adductor Magnus muscles. The medial epicondyle gives attachment for tibial collateral ligaments. [21]

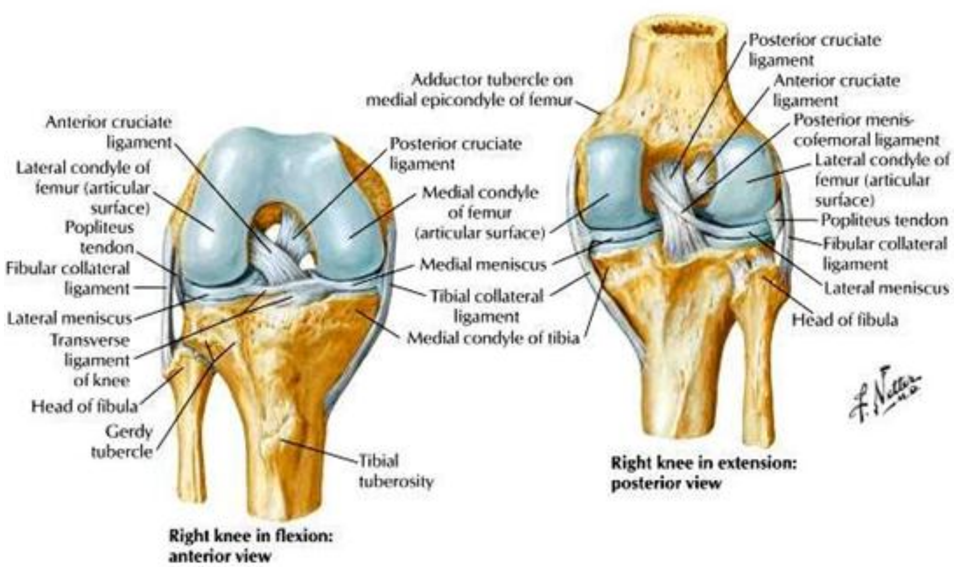


Fig-2 anatomy of knee joint in flexion and extension[21]

Bone structure of femur in distal third[21]

Here the trabecular spring from the entire external surface of compact bone descending perpendicular to the articular surface. These trabecular are strongest proximal to the condyles and are accurately perpendicular to the articular surface.

Blood supply to the distal femur: [22]

The lower half of the femur is supplied by a long descending branch of nutrient artery, which is derived from the first and second perforating branch of profonda femoris. The nutrient vessels arborizes distally to provide endosteal bone circulation, periosteal vessels enter at the linea aspera and are aligned perpendicularly to the cortex extensive stripping results in delayed union.

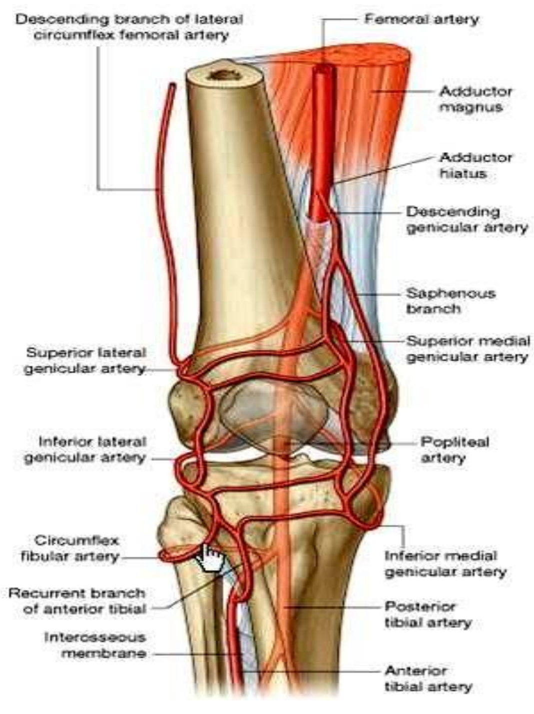


Fig-3 blood supply of distal femur[22]

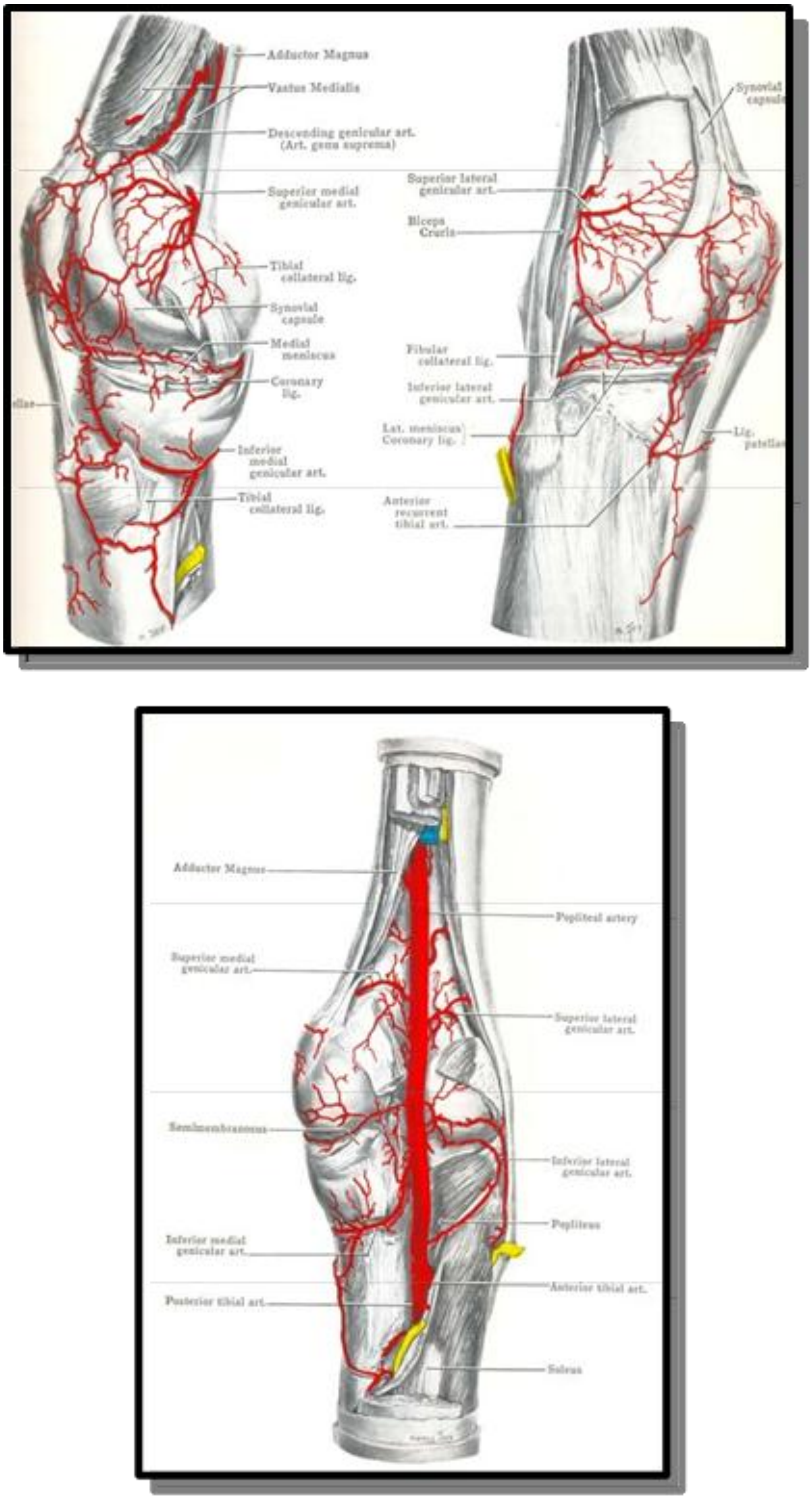


Fig-4 blood supply of knee [24]

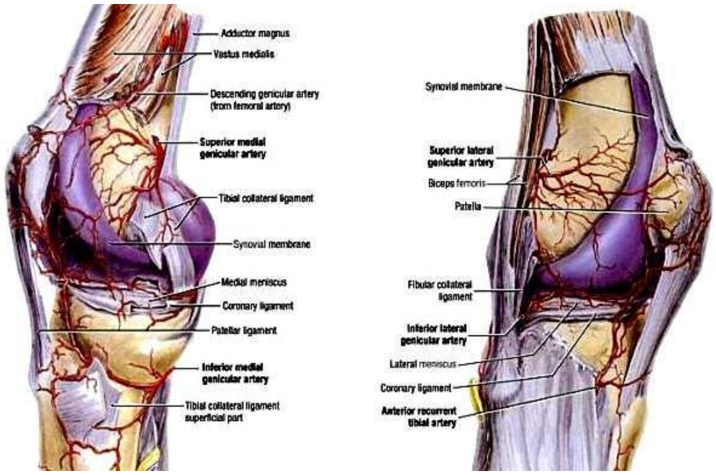


Fig- 5 anastomosis around knee joint[22]

<u>Applied anatomy of distal femur</u>:

The anatomical axis of the knee joint and mechanical weight bearing axis does not coincide. The weight bearing axis passes through center of femoral head and center of knee. The anatomical axis is in valgus and subtends an angle of 6 degrees with knee joint axis.[1]

In the lateral view of the distal femur the posterior position of the condyles appears as if they are projecting out of posterior aspect of shaft of femur, while the anterior position of the condyles appear as a continuation of the shaft.

The distal femur is trapezoidal in shape the medial condyle has a slope of 25° and lateral condyle 10° to the vertical. [2]

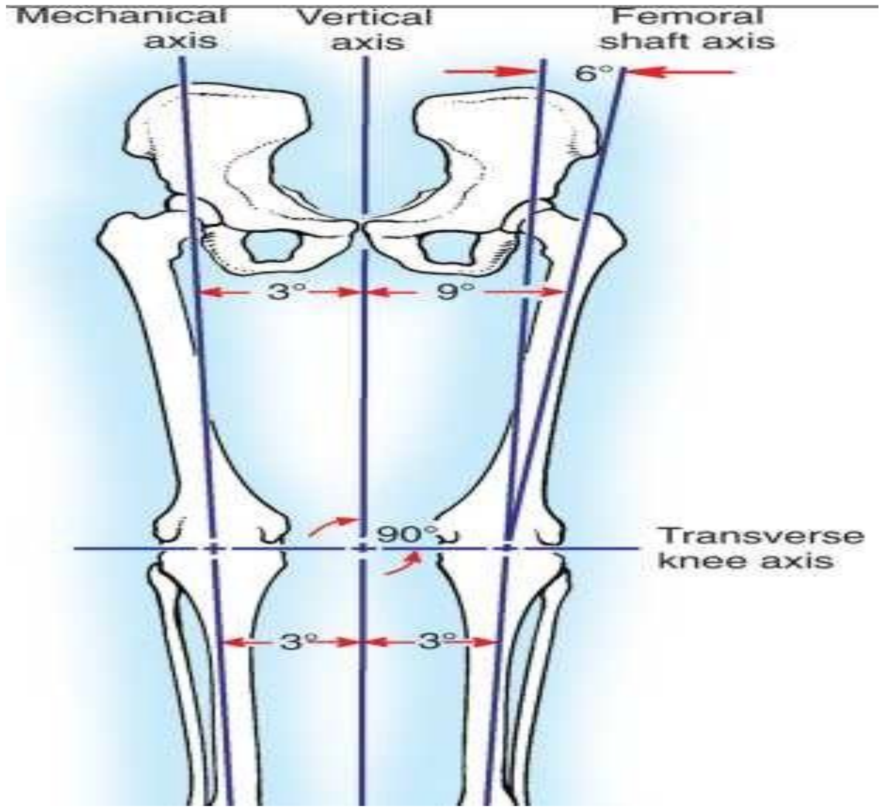


Fig-6 mechanical axis of knee joint[1]

Surgical anatomy of distal femur; [25]

The proximal and middle third shaft femur, being tubular have maximum resistance to angular stresses. But the distal third shaft of the femur, which gradually widens is quite resistant to angular stresses. However, with ageing, slow bone turnover, this part is more liable to shatter than the proximal and middle third shaft femur. In distal femoral fractures the distal fragment is flexed by the origins of the powerful gastrocnemius muscle. In this position the popliteal vessels are in great danger of injury by the flexed distal fragment.

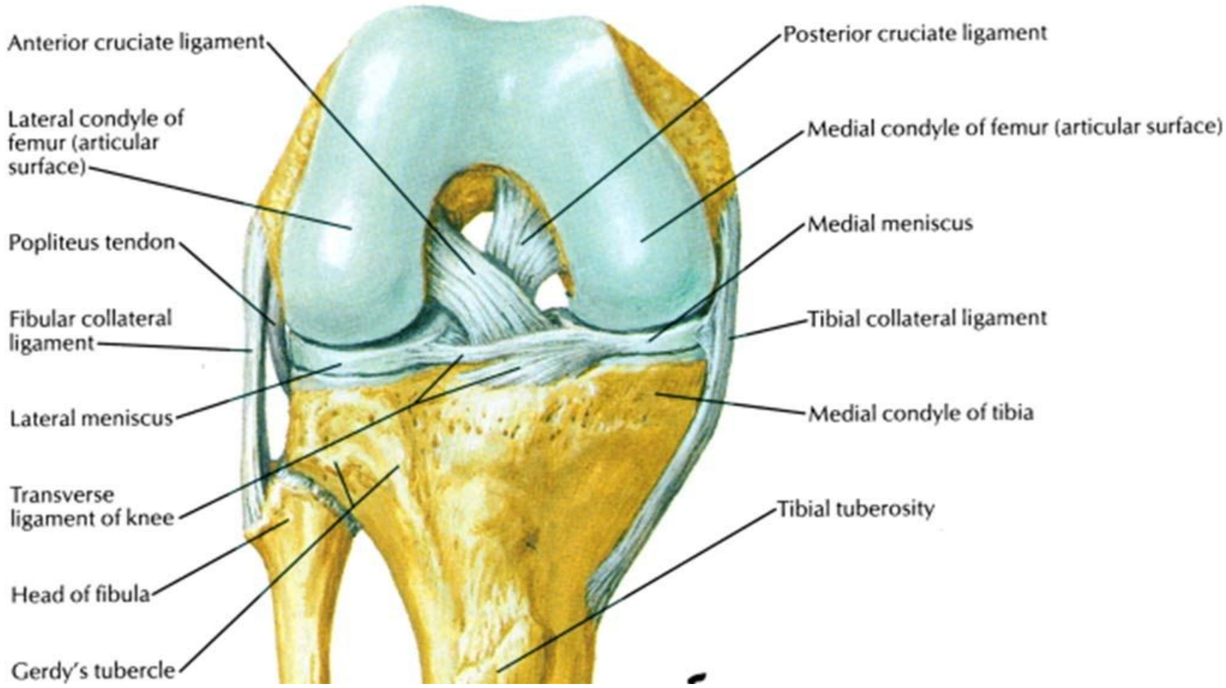


Fig-7 knee joint, opened from the front[23]

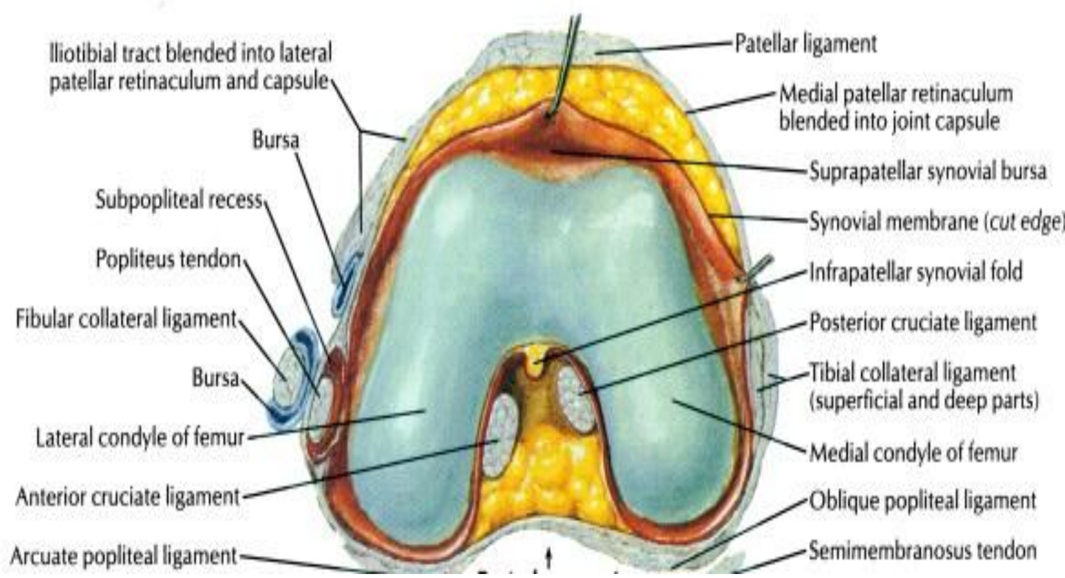


Fig -8 knee joint front

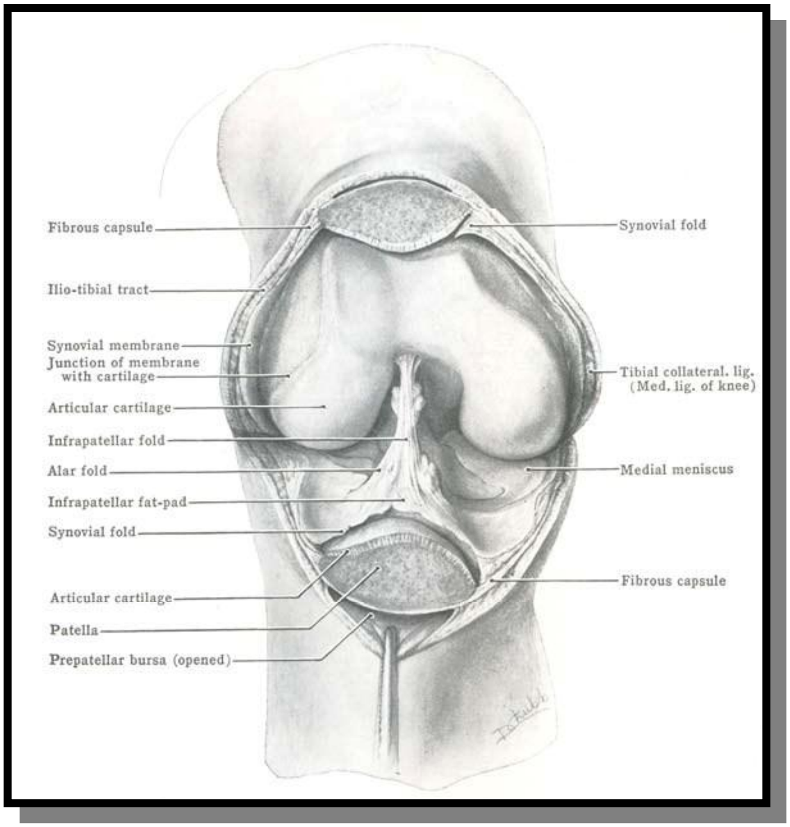


Fig-9: Knee Joint, Opened from the Front [24]

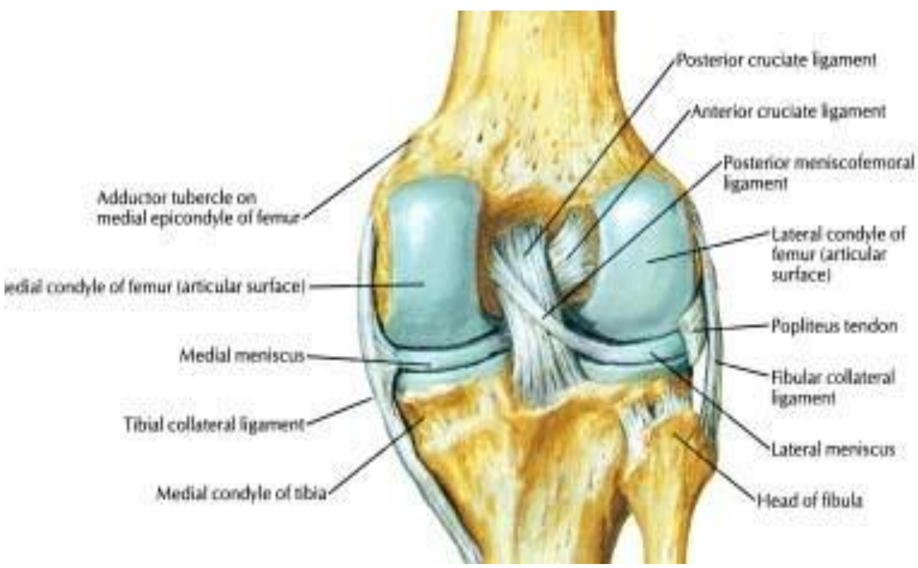


Fig-10 Femoral attachment of ligaments and Ligaments of the Knee Joint, from behind[24]

Mechanism of injury: [26]

The mechanism of injury of supracondylar fracture is axial loading with varus and valgus rotational forces. High velocity trauma is the main cause in young generation where considerable fracture displacement, comminution and open wound may be seen. In elderly with osteoporotic bones, trivial trauma on flexed knee can cause this fracture.

The deformity resulting from supracondylar fracture is produced by:

1. Initial trauma
2. Muscle imbalance

The initial trauma causes the primary effect at the time of impact. However the muscular forces to continue to act till the fracture consolidate. The major muscles involved are quadriceps, adductors, hamstrings, and gastrocnemius. In supra and inter condylar fractures the gastrocnemius causes posterior angulation or displacement of distal fragment, thereby causing misalignment. They also exert rotational forces and draw condyles apart. This posterior angulation results in hazards associated with this fracture essentially due to the closeness of popliteal artery to the supracondylar posterior surface area. The artery may be damaged at the time of trauma or compressed by sharp margins of the distal fragment of the femur.[25]

The posteriorly fitted distal fragment if not corrected will cause genu recurvatum, quadriceps and hamstrings produce longitudinal tension causing overriding and angulation. The proximal fragment may be driven into suprapatellar pouch, causing increased damage. Varus deformity is caused by adductors pull on distal fragment.

T and Y fractures of the lower end of femur: [26]

The T & Y type C condylar fractures are produced by wedging of proximal fragment on the distal condyles at the time of trauma. It is a combination of transverse fracture and longitudinal fracture which splits the condyles. [26] Most of the times it will be displaced (Rarely undisplaced) with complete separation of the fractured end and distal fragment pulled by two heads of gastrocnemius muscle.

Neurological damage is rare and common peroneal nerve is rarely involved in the fracture. Another injury seldom recognized is that of quadriceps mechanism and concomitant ligament injuries to the knee causing extra articular adhesions, knee stiffness and knee instability.

Common deformities in distal femoral fractures: [2]

Produced by the pull of quadriceps, hamstrings and gastrocnemius muscles

1) Femoral shortening
2) Anterior angulation of distal fragment
3) Posterior displacement of distal fragment

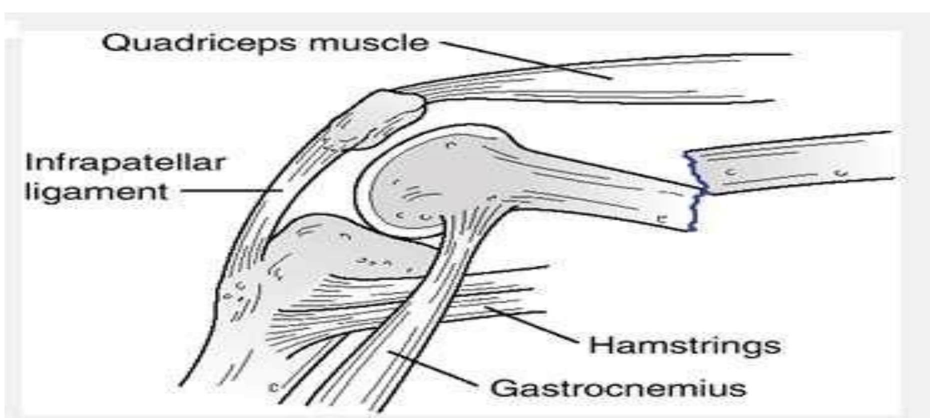


Fig-11 Common deformity in distal femoral fracture (posterior angulation) [2]

CLASSIFICATION OF FRACTURE: [27,28,29,30]

The classification of fractures serves to organize planning different modalities of treatment and avoid complications and serves for better functional outcome.

There is no universally accepted method of classification for supracondylar and intercondylar fracture of distal femur. Essentially all classifications distinguish between extra articular, intraarticular and isolated condylar fracture. Fractures are further divided based on degree of displacement, comminution and involvement of joint surfaces. Unfortunately, anatomical classifications fail to address the conditions commonly associated with supracondylar femur fractures, which affect the influence of treatment or outcome. These factors, which play dynamic role in management, determine the personality of the fracture.

Here are some of classification systems for supracondylar and intercondylar fracture of distal femur.

1. Neer and associates[27]
2. Stewart and co-workers[28]
3. Schatzker and tile[29]
4. Seinsheimer
5. AO classification[30]

Muller and colleagues devised the AO classification for the supracondylar and intracondylar fractures of femur, which is based on radiographic appearances. This classification system widely accepted, easy to use and understand, equally accurate in predicting the outcome as with other complicated classification systems. The AOASIF classification co-relates well with the complexity of the fractures and surgical techniques, which are need for adequate stabilization. The AO-ASIF classification has been used in the present study.

<u>AO CLASSIFICATION</u>:

<u>TYPE A: EXTRAARTICULAR FRACTURES</u>

<u>A1: Simple fractures</u>

A1.1: Avulsion fracture of medical or lateral epicondyle.

A1.2 Fracture of metaphysis oblique or spiral

A1.3 Fracture of metaphysis transverse

<u>A2 Metaphyseal wedge fracture</u>

A2.1 Wedge intact

A2.2 Lateral comminuted wedge

A2.3 Medical comminuted wedge

<u>A3 complex metaphyseal fracture</u>

A3.1 With a split intermediate segment

A3.2 Irregular but limited to the metaphysis

A3.3 Irregular and extending into the diaphysis

TYPE B: FRACTURES ARE PARTIAL ARTICULAR

B 1: Lateral condylar fracture in the sagittal plane

B1.1: Simple through intercondylar notch

B1.2: Simple through weight bearing surface

B1.3 Comminuted

B2: Medial condylar fracture in sagittal plane

B2.1: Simple through intercondylar notch

B2.2: Simple through weight bearing surface

B2.3: Comminuted

B3: Condylar fracture in coronal pane (Hoffa's fracture)

TYPE C: INTRA ARTICULAR FRACTURES

C1: Simple fracture of both articular and metaphysis

C1.1: Slightly displaced T or Y shaped fracture

C1.2: Markedly displaced T or Y shaped fracture

C1.3: Distally situated Fractures with horizontal element involving the epiphysis

C2: Simple fractures of articular surface and communition of metaphysis

C 2.1: With intact wedge

C 2.2: comminuted wedge

C 2.3: Complex

C 3: comminuted articular surface

C 3.1: Metaphyseal simple

C 3.2: Metaphyseal comminuted

C 3.3: Metaphyseal & Intraarticular commination.

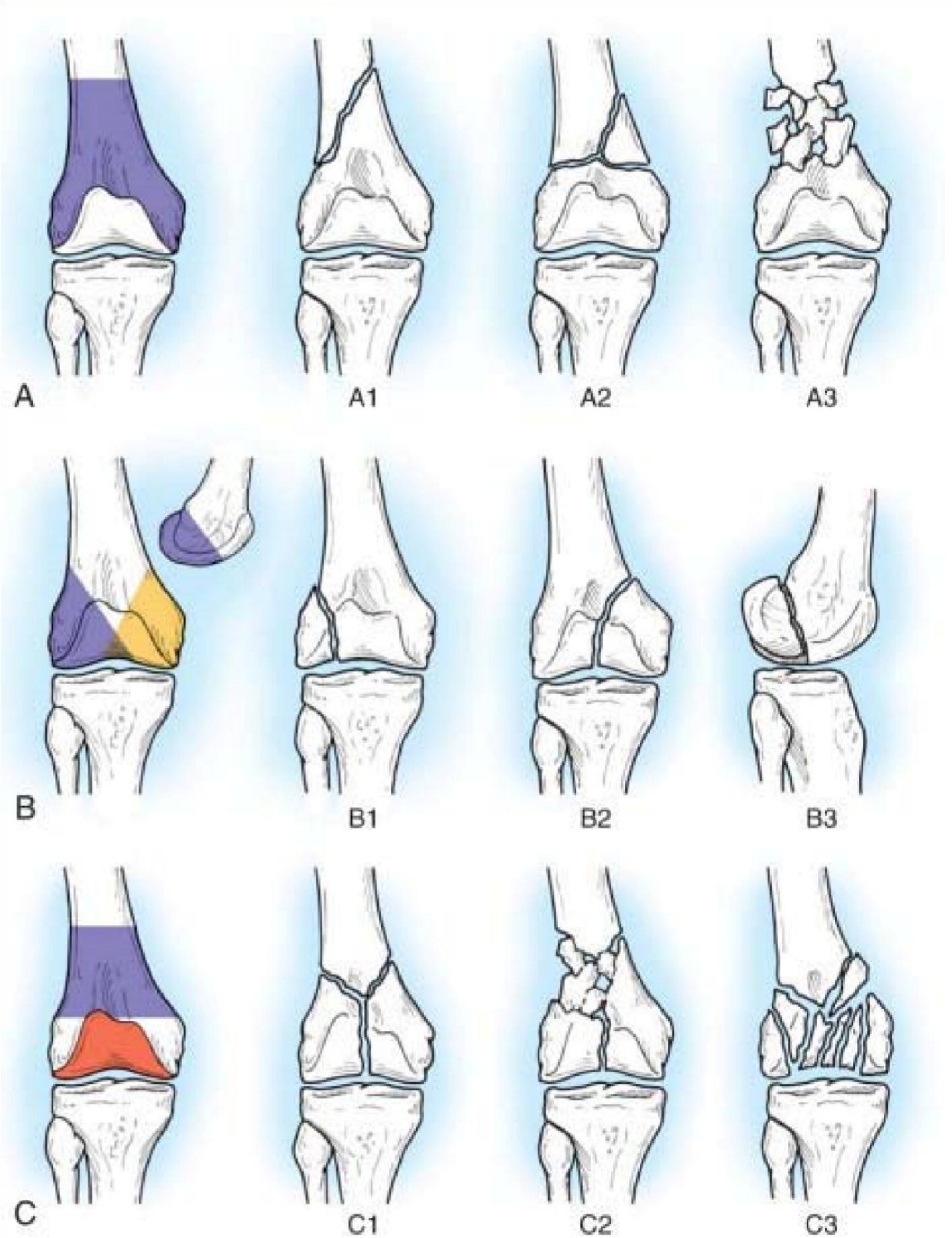


Fig-12 MULLER (AO-ASIF) CLASSIFICATION FOR DISTAL FEMORAL FRACTURES[2, 30]

METHODS OF TREATMENT OF DISTAL FEMORAL FRACTURES:

CONSERVATIVE TREATMENT: [11,15,31,32,33,34,38]

Indications for conservative treatment are:-

1. Non displaced or incomplete fractures.
2. Impacted stable fractures in elderly osteoporotic patients.
3. Significant medical diseases.
4. Severe osteoporosis.
5. Severely contaminated open fractures.
6. Infected fractures.

Methods of conservative treatment:-

a. Skin traction.[32]

b. Skeletal traction for 6-12 weeks with a pin in proximal tibia.[38]

c. Two pin skeletal traction – one pin in distal femur and the other in proximal tibia. This is a combination of longitudinal tibial traction and vertical pin traction to supra condylar fragment.[11]

d. Cast brace[33, 34] – in non-displaced impacted and well-aligned fractures cast bracing can be applied after 1-2 weeks of pop slab immobilization. In general, however non-operative treatment does not work well for displaced fractures.

SURGICAL TREATMENT: [9, 34,35,36,39,40,41,42]

Indications for surgical treatments are-

1. Displaced intra articular fractures.
2. Patients with multiple injuries to permit early mobilization.
3. Associated vascular injuries requiring repair.
4. Most open fractures.

Contraindications for surgical treatment:-

1. Active infection.
2. Severely contaminated open fractures (type III B).

Treatment goals include anatomical reduction of articular surface, restoration of limb alignment, early post-operative mobilization of knee joint(important for articular cartilage nutrition) and early patient mobilization.[40,41] .Initial treatment includes a well-padded long leg splint to improve patient comfort and to prevent further soft tissue injuries and skeletal traction through proximal tibia for temporary stabilization.

There are two major internal fixation devices used widely in management of distal femoral fractures.

1. Distal femur LCP/ Condylar plate and screws/dynamic condylar screws/condylar buttress plate

2. Intra medullary nails.

1. LCP/CONDYLAR PLATE AND SCREWS/DYNAMIC CONDYLAR SCREW: 2,42,43,44,45,47,46

These devices provide stable internal fixation and restores limb alignment.

Disadvantage:

1. Extensive exposure needed.[45]

2. May not give good purchase for the screws in osteoporotic bone.

3. Varus/valgus mal-alignment.[44]

4. Occurrence of fractures proximal to plate or refracture after plate removal[16,17]

2. CONDYLAR BUTTRESS PLATE:-

This cloverleaf shaped device specially designed for lateral distal femur can accommodate six cancellous screws mechanically. However, the implant is not as strong as blade plate condylar screw and side plate.

3. INTRAMEDULLARY NAILING [48]

The use of Intramedullary nailing have advantages over plate fixation devices because they are load sharing devices and there is less soft tissue dissection, less operative time, less blood loss, less infection, early mobilization and good functional outcome.

a. Ante grade interlocking IM nailing[48,49]

b. Retrograde interlocking IM nailing[50,51,52,53,54,55,56,57]

Both ante grade and Retrograde nailing are used, Given the appropriate fracture patterns, ante grade IM nailing in the treatment of distal femoral fractures has been associated with angular deformities because of inability of distal interlock of the ante grade nail to achieve control of the small and often osteoporotic distal fracture fragment and as Retrograde nailing technique is evolved, due to greater number of distal fixation options available with Retrograde interlocking nailing. It is currently used for distal femoral fractures than anterograde interlocking nailing.

Intramedullary Nailing

Intramedullary nail fixation is reserved for fractures with enough intact distal femur to allow for interlock fixation. The main indication for using an intramedullary nail is an AO/OTA type a fracture. However, both nailing techniques have been used successfully in the management of high-energy AO/OTA type C 1 and 2 fractures.[10, 26, 29]

As the retrograde intramedullary nailing technique has evolved, it has become more used for this fracture type than ante grade nailing. This is due to the increased number of distal fixation options present with retrograde nailing. As with plating distal femur fractures, indirect fracture reduction and minimally invasive nailing techniques have also been developed.

The Evolution of Intramedullary nailing

Historical overview[63]

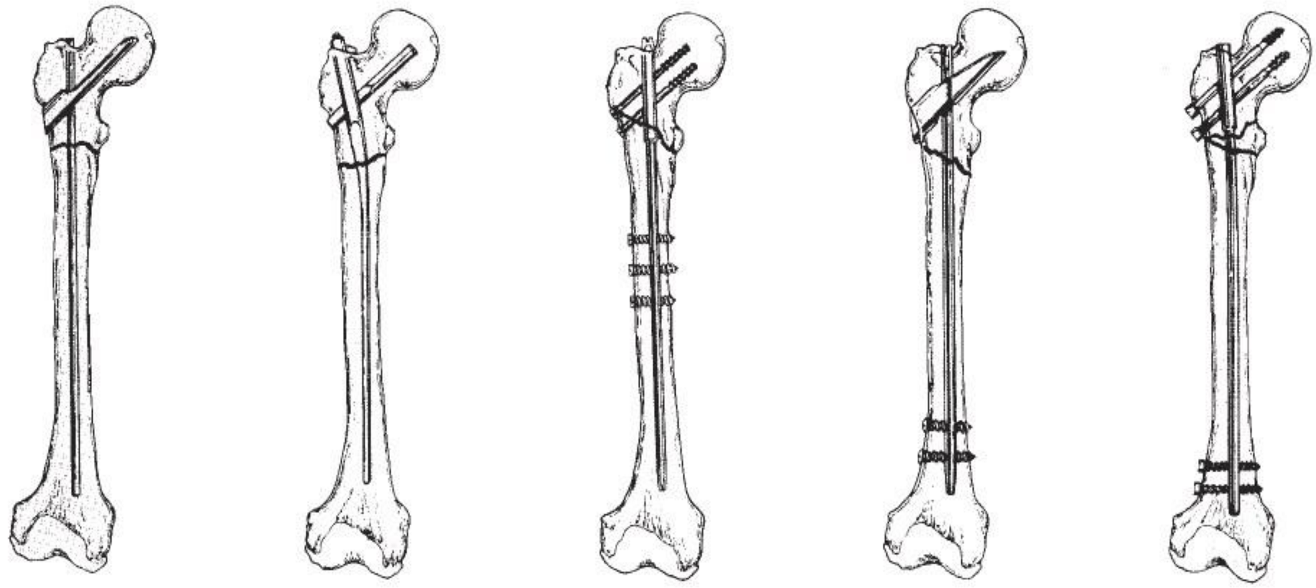
The "beginnings" of intramedullary fixation go back into the 16th century. The conquistadors in America described how the Indians used wooden wedges to treat bone fractures. By the end of the 19th century, first experimental intramedullary fixations were performed in Europe. The pioneers were Bircher, König, von Langenbeck, Cheyne and Lane. Several methods of fixation of proximal femoral fractures were introduced that included the use of bony, ivory or metal (silver) screws and wedges. In the beginning of the 20th century, Ernest Hey Groves (England) already used specially designed three- or four-edged intramedullary nails for the fixation of diaphyseal long bone fractures. But due to the common infections which associated the operation, Groves was eventually nick-named "septic Ernie" and his method did not spread.

Smith-Petersen made a huge step forward regarding fracture treatment when he introduced a nail to fixate sub capital femoral fractures in the 1920‟s. In 1940, Lambrinudi suggested the placement of strong wires and thin metal sticks through the medullary canal. This method was later upgraded by the Rush brothers[24]. After the greatest work of Gerhard Küntscher in the 1940‟s the use of intramedullary fixation of long bone fractures spread again in the second half of the 20th century, with the works of Madny, Kemm, Schelman, Grosse, Kempf, and of the AO group (Arbeitsgemeinschaft für Osteosynthesefragen). The introduction of locking screws spread the indications widely[24]

The principles of intramedullary fixation

The basic principle of intramedullary nailing is "**dynamic osteosynthesis**".

If we nail an object (nail, stick) along-side a structure, certain pressure is applied to the structure, which provokes reverse pressure, and that brings to elastic „‟binding‟‟ between the object and the structure.it can be best likened to a tube within a tube. Küntscher used this basic idea when he placed nails into the medullary canal. [63]



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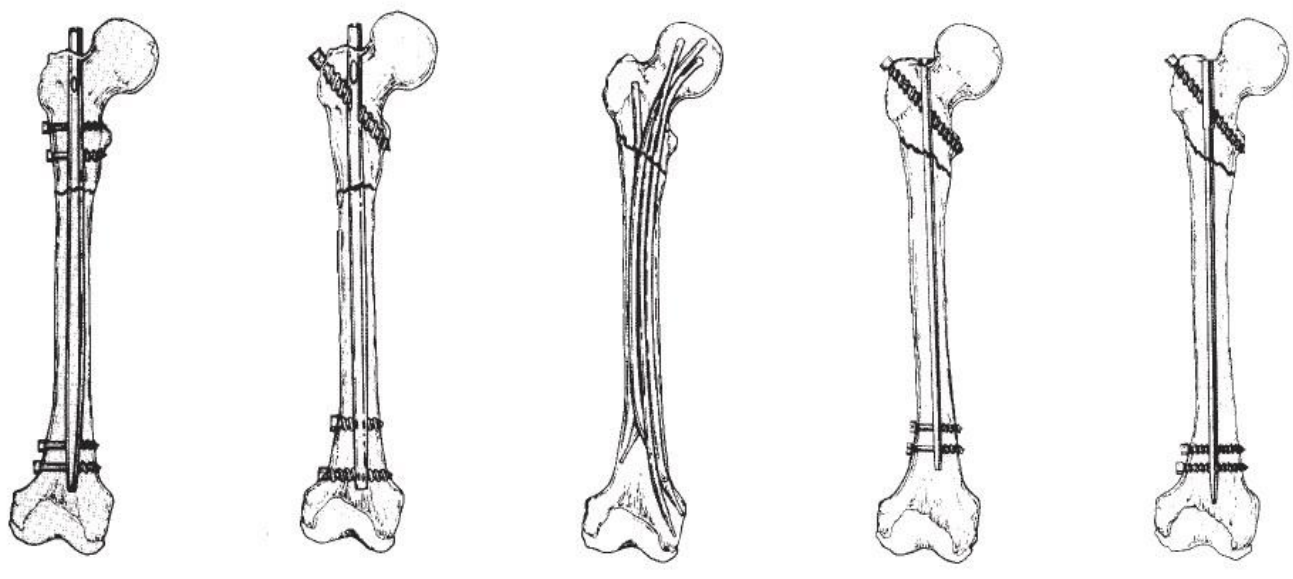


Fig -13: development of intramedullary nails. Upper row – first generation, lower row – second generation.[63]

Concept of Reaming[24, 63]

The nail is dependent upon the length of contact with cortical bone for its resistance to bending and upon friction between the nail and bone and the inter-digitation of fracture fragments for rotational stability. It is the contact with cortical bone that allows a nail to control angulation and translation. Intramedullary reaming is frequently employed to enlarge the area of contact between the endosteum and the nail. This enlarges the medullary canal sufficiently to permit the insertion of a nail which is not only large enough to provide stability but also strong enough to take over the function of the bone.

Concept of locking[24, 63]

Intramedullary nailing prior to the introduction of locking, because of the mode of application and the manner in which the nail rendered stability, was best suited for fractures in the middle one-third of the femur and of the tibia. The proximal and distal ends of tubular bones widen into broad segments of cancellous bone. In these areas the nail can provide neither angular nor rotational stability. Axial stability of a nailed fracture depends on cortical stability and on the ability of the cortex to withstand axial loads. Thus, certain fracture patterns were not ideally suited for intramedullary nailing. These were: long oblique and long spiral fractures, and comminuted fractures in which the cortex in contact was less than 50% of the diameter of the bone at that level.

Advantages of locking are

- It provides stability.

- Locking screws provide the comfort of using loose fitting nail in the medullary canal without losing limb length and (vertical alignment) and rotational alignment.

- Early mobilization and early ambulation.

Another important characteristic of a nail is its **working length** (WL), the length of the unsupported part of the nail between the proximal and the distal firm grip of the nail and the bone[24]. In comminuted fractures, this length can be very large, which means the along-side support is small. As stability of fixation against the forces of bending is inversely proportional with working length square ($1/WL^2$), stability is very small if we use regular intramedullary nails in long comminuted fracture.

Indications for RIN:-

1. Supracondylar and inter condylar fractures
2. Severely comminuted fractures with intra articular extension
3. Associated with other injuries such as Floating knee injury, pelvic injuries, acetabular fractures, bilateral distal femoral fractures, head injuries, spine injuries.
4. Supra condylar fractures of femur proximal to TKR.
5. Supra condylar fractures of femur in patients with THR.[64]
6. Obese patients.
7. Nonunion of supra-condylar fractures.[64]

Contraindications:-

1. Active infection.
2. Severely comminuted extra articular and intra articular distal femoral Fractures.
3. Osteoporosis.

Advantages:

1. Stabilizes fractures below the isthmus and gives rigid internal fixation
2. Prevents rotational instability and shortening
3. Early mobilization and good knee function
4. Minimal skin incision and minimal blood loss in closed technique
5. No chances of refracture after removal
6. Is used for fixing supra condylar fractures of femur proximal to a total knee arthroplasty.[53]

Disadvantages:

1. Knee sepsis
2. Patello femoral degeneration and stiffness
3. Synovial metallosis
4. Exposure to radiation
5. Needs experience
6. Instruments and implants are costly

EXTERNAL FIXATION[65, 66]

1. This is typically reserved for patients with open fractures with bone loss, significant soft tissue injury, severe comminution and vascular injury. The most common indication for its use is severe open fractures particularly type 3B injuries and temporary stabilization for soft tissue injuries and fracture management.

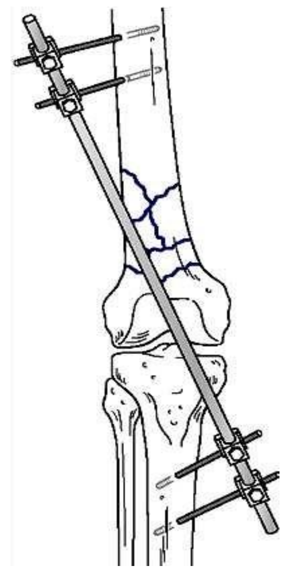


Fig.14 a spanning external fixator with half-pins placed percutaneously[2]

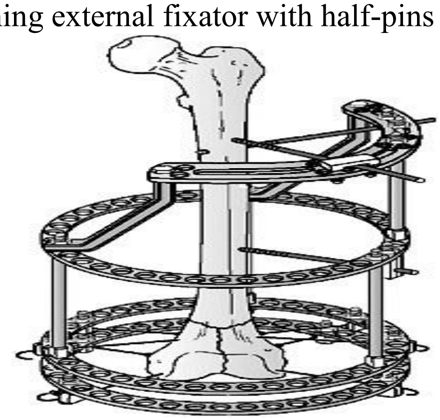


Fig.15 hybrid external fixation of a distal femur fracture[2]

COMPLICATIONS OF DISTAL FEMORAL FRACTURES:

Early complications:

1. **Infection**: It is not common except in open fractures in which rate of infection is 20%. In closed clean fractures it is less than 10%. Chronic osteomyelitis, septic arthritis, infective nonunion can occur as a result of infection.

2. **Failure of reduction**: Attaining reduction of distal femoral fractures is difficult even with full open reduction technique, if the fracture is comminuted reduction of the fragments, articular congruity is the major concern, if not obtained leads to painful secondary osteoarthritis.

3. **Failure of fixation:**

   It is usually as a result of:

   a) Poor bone stock.

   b) Poor patient compliance with post-operative care.

   c) Poor surgical planning and execution, inexperienced surgeons and technique and Skills.

4. **Vascular complications:** [22]

   In 2% of distal femoral fractures vascular complications occurs, usually popliteal artery is likely to be damaged, as it winds from medial to posterior close to the bone.

Treatment: vascular reconstruction

LATE COMPLICATIONS:

1. **Late infections:** in the form of chronic osteomyelitis, septic arthritis, infected nonunion.

2. **Nonunion:** [60, 61, and 63] it is common in partial articular type B fractures because of high shearing forces and poorly vascularized.

   Treatment: Use of compression to buttress against sheer force to gain rigid fixation.

3. **Mal union:** [49] Mal union occurs as a result of failure of fixation. Most commonly occurs with distal fragment in varus.

   MU in valgus occurs in IM fixation when patient is placed in lateral position.

   Rotational deformity also occurs and can be managed by minimally invasive osteotomy with an IM saw followed by fixation with locked nail.

   The more commonly malunion are angular deformities at the fracture site in either AP or mediolateral view.

   Treatment: These can be corrected by either closed or open wedge osteotomies.[49]

4. **Painful internal fixation:** [67] occurs if the screws are too long and protrude out of medial cortex.

   Treatment: Removed and replaced with appropriate length screws.

5. **Knee stiffness:** [67] it is not an uncommon sequel of distal femoral fractures. The patient may have fixed flexion deformity or limited range of mobility.

Treatment: To prevent knee stiffness one needs to move knee in the early stages after fracture fixation, pain relief for mobility of knee joint by stable fixation. In post-operative period continuous passive motion, and epidural analgesia post hospital physical therapy and constant follow up will help.

6. **Post traumatic osteoarthritis:**[67]

Most commonly occurs in any intra articular fractures type C and if extra articular fractures fixed in varus misalignment.

Prevention is by anatomic reduction of distal femoral joint surface.

Treatment: Symptomatic patients are treated with either intraarticular or extra articular osteotomies, or stage arthritis by arthralgia or arthroplasty.

COMMON SURGICAL APPROACHES FOR RIN OF DISTAL FEMORAL FRACTURES:

Surgical approaches of distal femoral nailing procedure

1. Anterior approach; a straight midline anterior incision used.

2. Anterolateral approach: This is used as an alternative i.e. better exposure of articular surface indicated in complex intraarticular fracture.[29]
3. Swash Buckler technique: It is a modified anterior approach, spares quadriceps muscle bellies and surgical scar does not interfere with subsequent TKR.

4. Closed reduction and internal fixation through 5-6 cm midline incision over patellar tendon -- Tran‟s patellar tendon approach.

METHODOLGY

In this study 30 patients with distal third fracture of femur were studied.

All patients from OCT 2012 to JULY 2014 attending the outpatient department &/or admitted patients in R.L.JALAPPA HOSPITAL & RESEARCH CENTER and attached hospitals, attached to Sri Deva raj Urs Medical College, Tamaka, kolar, diagnosed clinically and radio logically with fracture distal one third femur will be included in the study and follow up from the time of admission to a minimum of 6 months of postoperative period will be done

All the fractures in this series were post-traumatic.

Inclusion criteria: patients above 18 years

Fracture distal one third femur shaft (15cms)

Extra articular supracondylar fractures

Exclusion criteria:

1. Distal femur fractures AO type B and C
2. Gustillo Anderson open type III C

Implant Used:

2. The implant used was supracondylar nail system with instrumentation set.
3. The nails are available with outer diameter of 9, 10, 11 and 12 mm
4. The distal end is expanded to outer diameter of 13 mm.
5. The nails are available in lengths of 150, 200, 250 and 300 mm.
6. There is 5 degree anterior bend and an anterior bow for anatomic fit.

All sized nails have interlocking holes in all lengths two proximal holes and two distal holes, which accept interlocking screws of 4.9mm thread diameter.

INTRAMEDULLARY SUPRACONDYLAR NAIL WITH INSTRUMENTATION SET

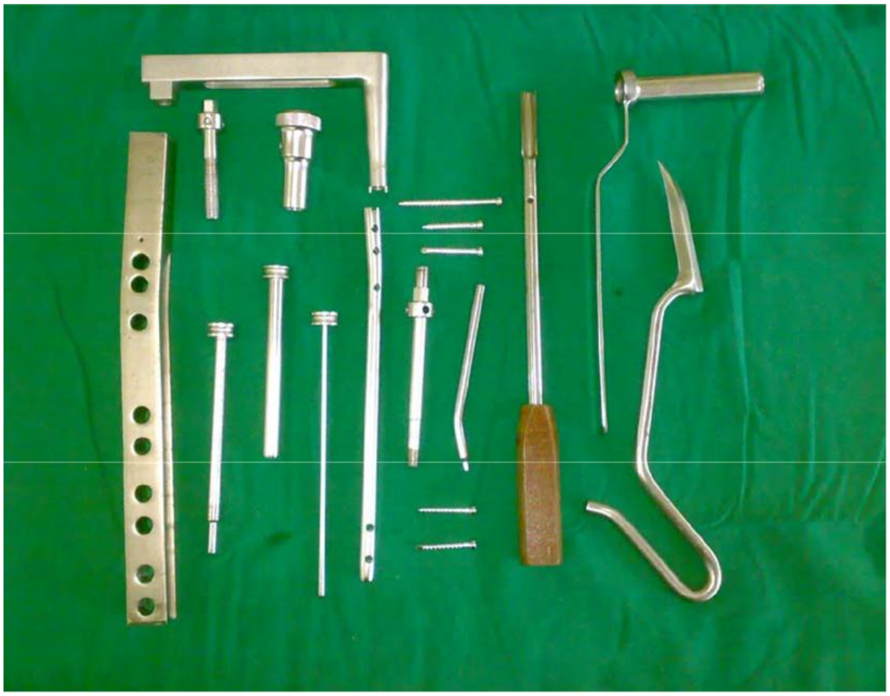


Figure-16: Intramedullary Supracondylar Nail with Instrumentation

FROM LEFT TO RIGHT

1	SUPRACONDYLAR GUIDE BAR
2	NAIL WITH INTERLOCKING BOLTS
3	SOLAPUR SLEEVE
4	SUPRACONDYLAR REPLACE BOLT
5	TOMMY BAR
6	SCREW DRIVER
7	OUTER SLEEVE
8	ATTACHMENT BOLT
9	ENTRY AWL

Preoperative Planning and Preparation:

Fractures were classified with the help of radiographs according to the AO- ASIF classification. Preoperative calculation was done on radiographs to ascertain the length of supracondylar nail, maximum possible diameter and lengths of interlocking bolts after subtraction of the magnification factor.

The length of nail was selected so that the distal locking hole of two proximal holes was at least 2.5 cm proximal to fracture site.

The limb to be operated was shave and prepared a day before scheduled surgery. One gram of second third generation intravenous cephalosporin was injected previous night and early morning on the day of surgery.

Operation Table:

The patient was placed on a radiolucent fracture table. A bolster was placed under the thigh of the limb to be operated.

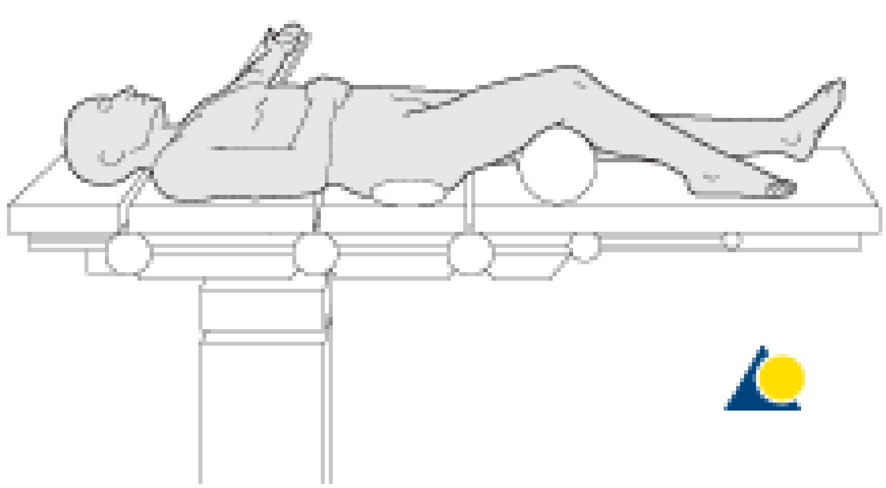


Fig -17 position of patient.

Patient Position:

After induction of patient with regional or general anesthesia. Position the patient supine on a radiolucent table with the knee in 30° flexion. The knee is supported by a cushion, or rolled sheets

Operative Procedure:

The limb was scrubbed for 5 minutes with surgical betadine scrub followed by painting with povidone iodine and medicated spirit and draping with sterile drapes so that the knee joint and distal thigh were in the operative field. A midline incision of 4 cm was taken from inferior pole of patella up to tibial tuberosity. The paratenon over patellar tendon was sharply incised and patellar tendon was split in the midline along the direction of the fibers. Sleeve was then inserted into the joint through the split tendon and positioned against the inter-condylar notch.

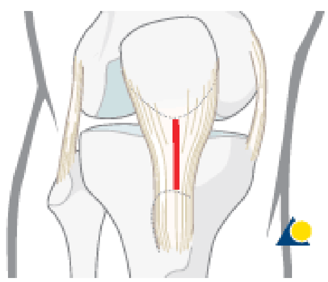


Fig-18-incision for RIN

Its position was checked under image intensifier and the awl was inserted then removed and guide wire passed through the entry point.

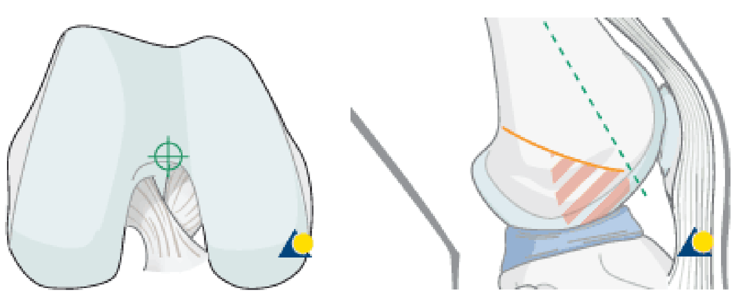


Fig- 19 entry point

The sleeve was then removed and the fracture was reduced under image intensifier control and guide wire passed in proximal fragment. The distal fragment was then reamed with cannulated reamer provided with instrumentation set. The predetermined nail of adequate diameter and length was then loaded over the jig with the help of conical bolt keeping in mind the side to be operated so that jig was placed laterally and the convexity of nail facing anteriorly. The nail was then inserted over the guide wire through the entry point made previously through distal and then proximal fragment. Its position was confirmed on image intensifier and then depending on the length of the nail, the proximal holes were locked with the help of corresponding markings on the jig. After taking stab incision over the corresponding lateral skin, the soft tissues were separated by blunt dissection with the help of hemostat and drill sleeve and drill guide for 4.5 mm drill bit were inserted through the fenestrations provided over the jig, through the stab incision flush with the lateral cortex. The lateral and medial cortex were drilled with 4.5 mm drill bit. Continuity of drill holes in both the cortices with the locking hole of nails was confirmed with sounding (tik-tik) technique.

The required length of locking bolt was measured with the help of depth gauge and interlocking bolt of 4.9mm thread diameter passed from lateral to medial cortex engaging the locking hole in the nail. Either single or both holes were locked proximally. Similarly, the distal holes were locked in one, two or three numbers. The jig was then disengaged, the joint was washed thoroughly to remove the debris. Tourniquet was released, hemostasis achieved and incision closed in layers. Particular attention was paid to repair paratenon of patellar tendon.

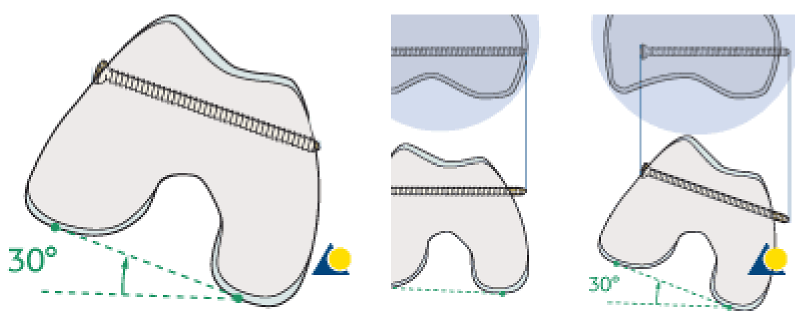


Fig-20 locking screws

Postoperative:

Tight compression bandage was given to patients post operatively. If presence of any concomitant ispilateral injuries were present an above knee posterior slab was applied. In the wards, limb elevation was given along with injectable analgesics and antibiotics for 5-10 days. In closed nailed patients, static quadriceps and active or active assisted bedside knee mobilization was started from second postoperative day. Suture removal was done on 14^{th} postoperative day. Patients were discharged on day 15 or 17^{th} postoperative and were advised to follow-up after 1, 3, and 6 months post-operatively. Since our institute is a teaching institute the patients were kept up till suture removal and sent for regular physiotherapy for the duration of their stay. Patients were given training and made to walk with non-weight bearing ambulation with walker. As the patient gained confidence, toe touch walking was allowed by the **6**th week.

Further, weight bearing was allowed depending on the clinical and radiological picture. The initial fracture geometry, intra articular commination, stability of fixation were the major factors considered while advising progressive weight bearing.

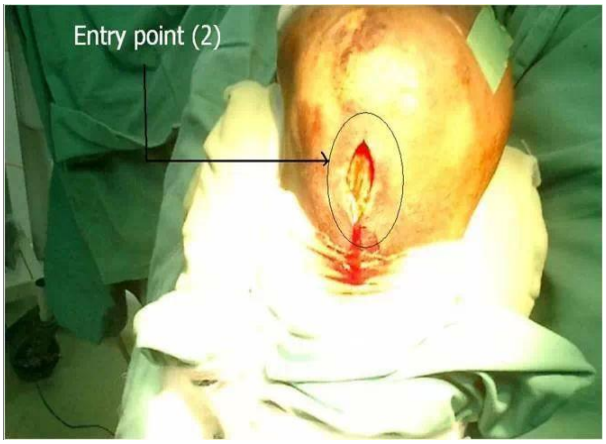
At each follow-up patient was assessed as regards clinico-radiological union in the form of pain at fracture site, thickening at fracture site, warmth at fractures site, radiographic alignment, evidence of callus seen, knee range of motion, extensor lag and shortening.

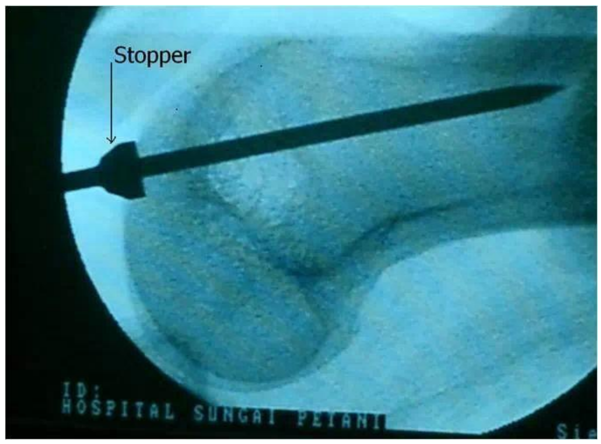
Unprotected weight bearing was not allowed till there was good clinical and radiological evidence of progressive fracture healing. Clinically, fracture was considered to be united when there was no pain on palpation and no discomfort on weight bearing. Radiological evidence of callus and consolidation were analyzed. For each fracture type, the long-term results were evaluated using Neer‟s rating system which assigns points for pain, working and walking capacity, range of movement, radiological appearance, etc.

OPERATIVE PICTURES

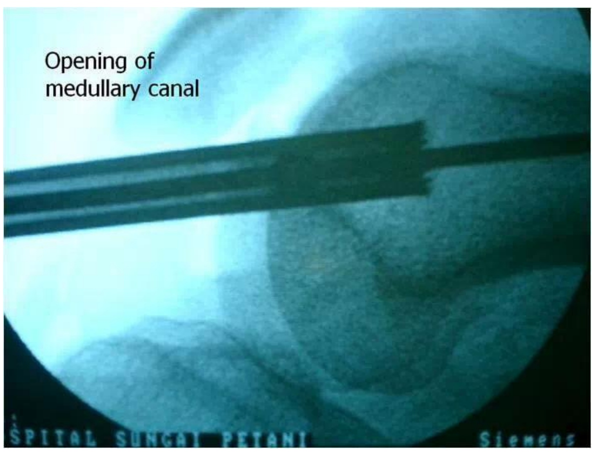
Fig-21

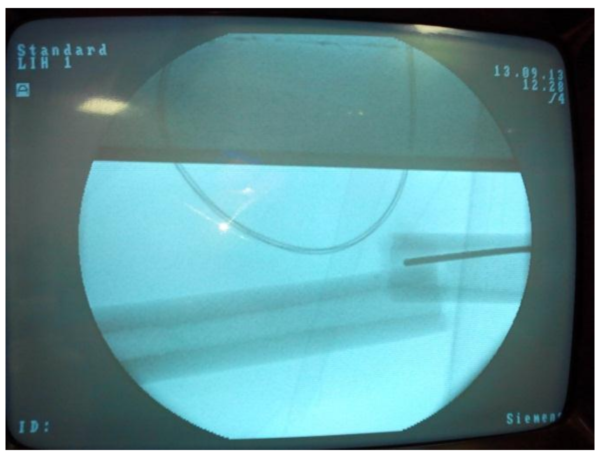

(a) ***Position of patient*** ***(b)***



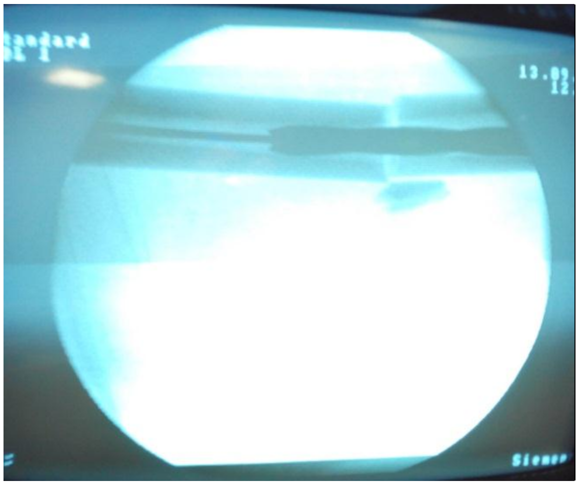


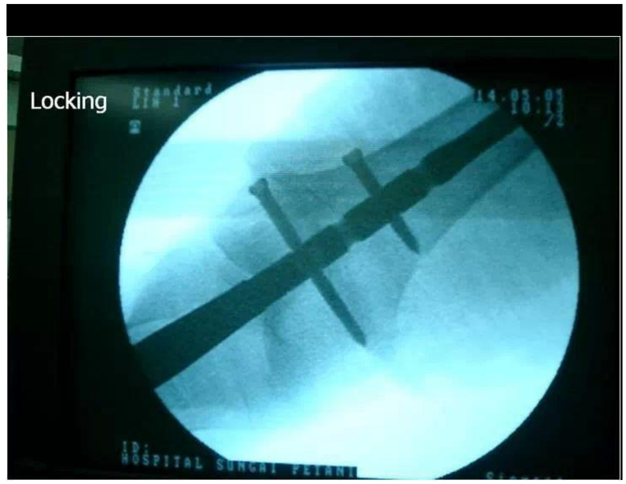
(c) ***Incision and entry point as seen in C-arm*** ***(d)***





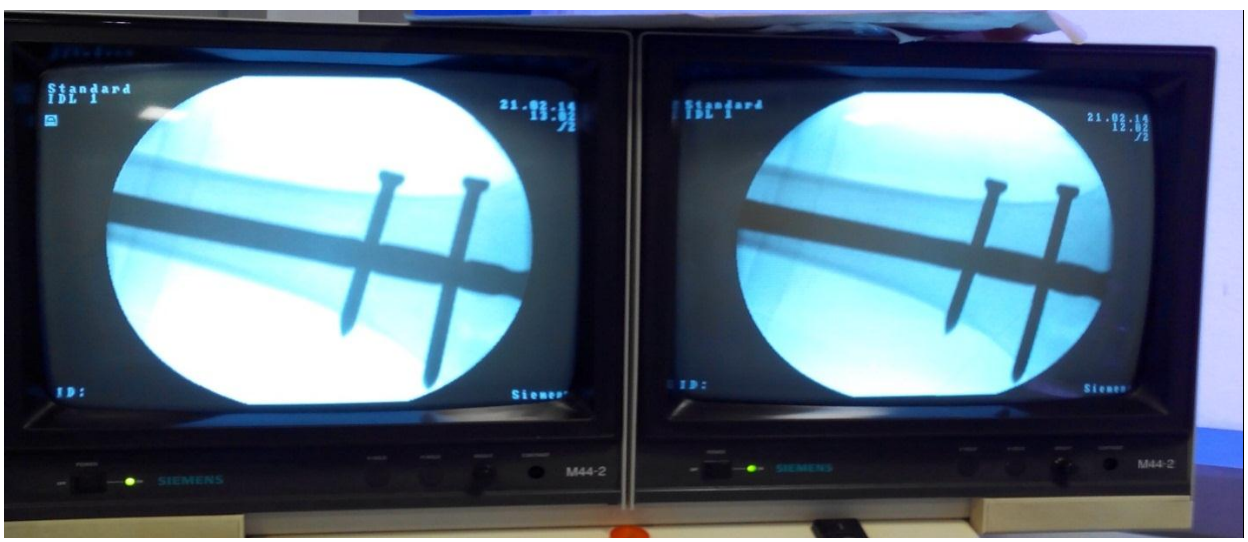
(e) ***C-arm images images of guide wire insertion*** ***(f)***





(g) C-arm images of nail insertion and distal locking (h)

(i)Image showing proximal locking for nail



(j) C-arm images after locking

<u>CASE PHOTOS- </u>CASE NO. 6

PRE-OP X-RAY

POST-OP X-RAY AND X-RAY SHOWING UNION

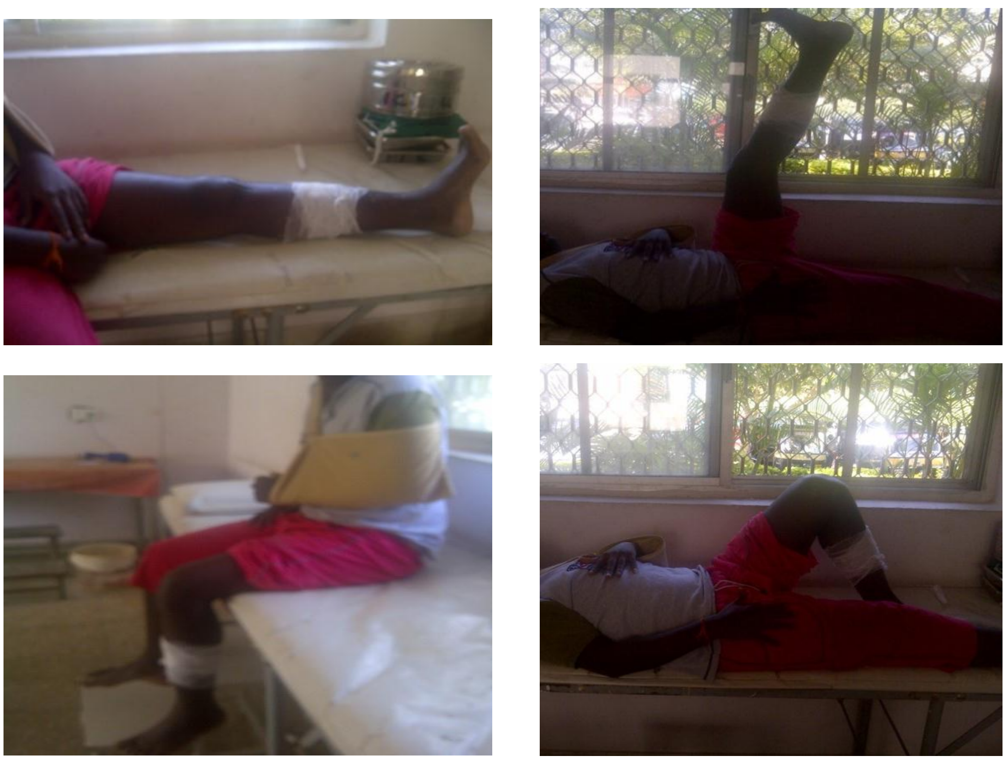
Knee flexion ***knee extension***

ROM AT END OF FOLLOW-UP

<u>CASE PHOTO</u>- CASE N0.4

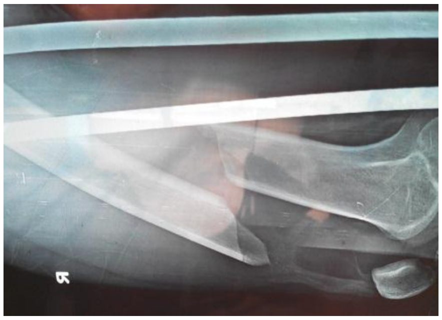
PRE-OP AND POST-OP X-RAYS

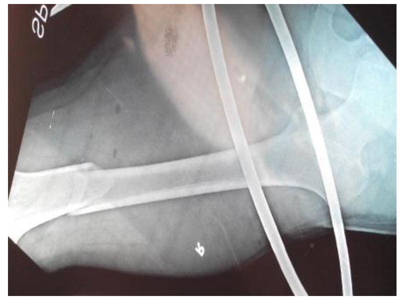
X-RAYS SHOWING UNION



ROM- FLEXION & EXTENSION

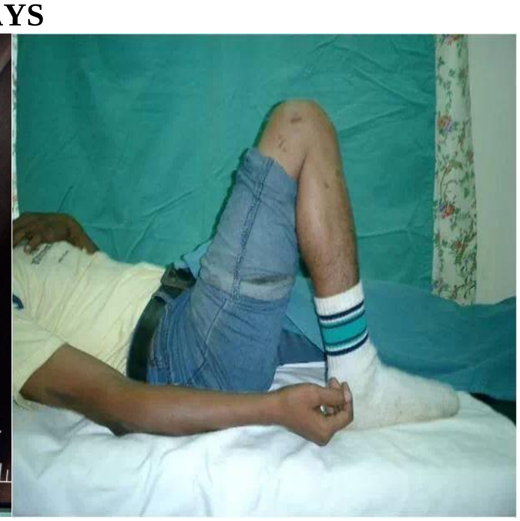
<u>**CASE PHOTO**</u>**- CASE NO.17**





PRE-OP X-RAYS

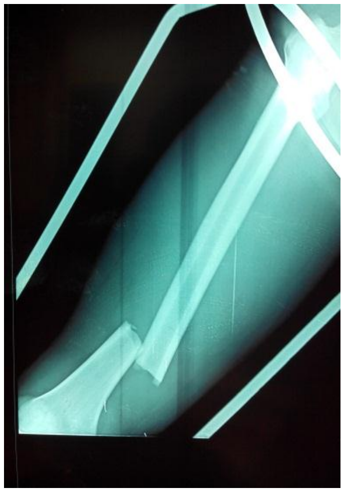
POST-OP X-RAYS

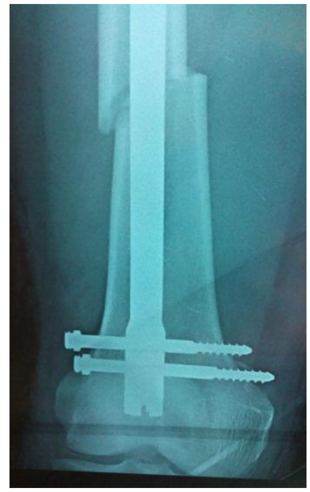


X-RAY SHOWING DELAYED UNION AT 6 MONTHS   KNEE FLEXION

<u>CASE PHOTO</u>- CASE NO.8

PRE-OP X-RAYS **POST-OP XRAY**

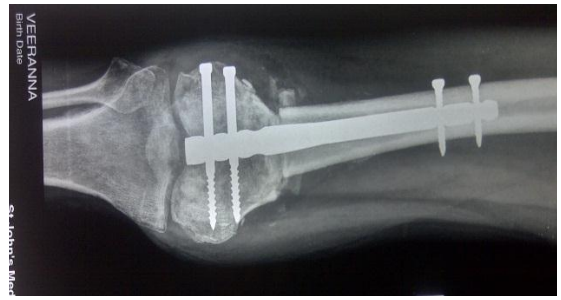



X-RAY SHOWING UNION

RANGE FOR MOVEMENTS

<u>CASE PHOTO</u>- CASE NO.3

PRE-OP



POST OP

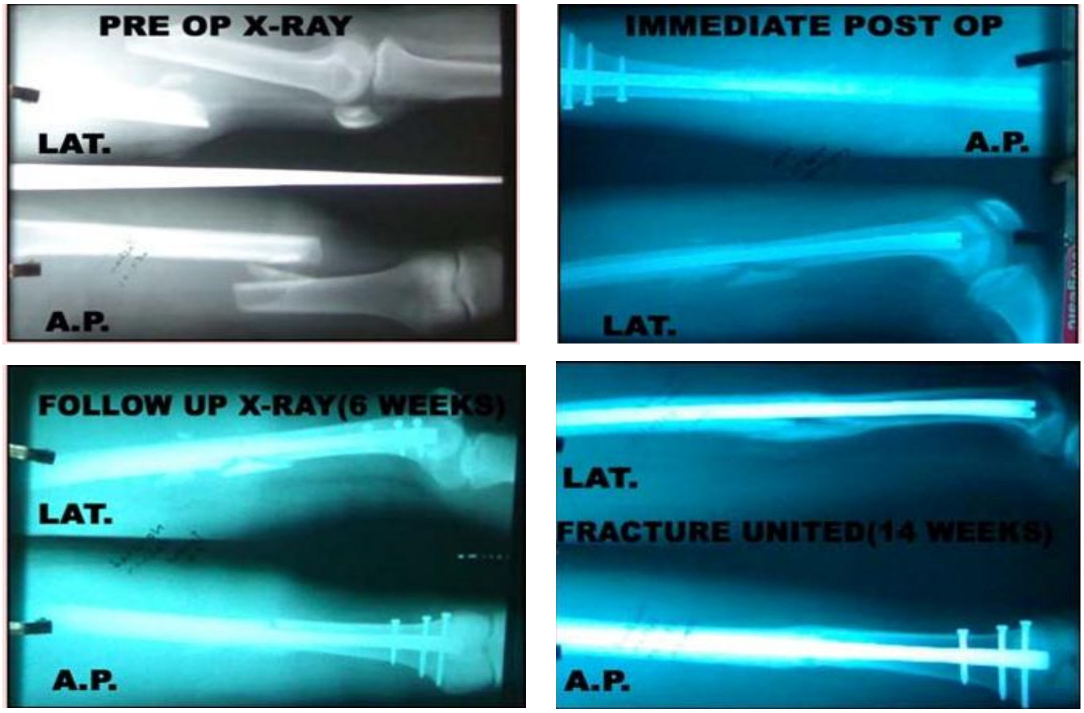
X RAY SHOWING SCREW BREAKAGE

FLEXION

EXTENSION

RANGE OF MOVEMENTS

<u>CASE PHOTO</u>-CASE NO.1



STANDING *SITTING CROSS LEGGED*

RANGE OF MOVEMENTS AT THE END OF FOLLOW –UP

CRITERIA FOR EVALUATION OF THE RESULTS (FROM NEER CS, II GRANTHAN SA, and SHELTON ML) [27]

Functional (70 points)		Anatomical (30 points)	
a) Pain (20 points)		a) Gross anatomy (15 points)	
• No pain	20	• Thickening only	15
Intermittent or during changes in	16	• 5 degree angulation for 0.5 cm shortening	12
• With fatigue	12	• 10 degree angulation or rotation, 2 cm shortening	9
• Limits function	8	• 15 degree angulation or rotation, 3 cm shortening	6
• Constant or at exertion	4-0	• Healed with considerable deformity	3
b) Walking capacity (20 points)		• Non-union or chronic infection	0
• Same as before accident	20	b) Roentgenogram (15 points)	
• Mild restriction	16	• Near normal	15
• Restricted stair side ways	12	• 5 degree angulation or 0.5 cm displacement	12
• Use crutches or other walking aids	4-0	• 10 degree angulation or 1 cm displacement	9
c) Joint movement (20 points)		• 15 degree angulation or 2 cm displacement	6
• Normal or 135 degrees	20	• Union but with greater deformity, spreading of condyles and osteoarthritis	3
• Up to 100 degrees	16	• Non-union or chronic infection	0
• Up to 80 degrees	12		
• up to 60 degrees	8		
• Up to 40 degrees	4		
• Up to 20 degrees	0		
d) Work capacity (10 points)			
• Same as before accident	10		
• Regular but with handicap	8		
• Alter work	6		
• Light work	4		
• No work	2-0		

Excellent	More than 85 points
Good	70 to 85 points
Fair	55 to 69 points
Poor	Less than 55 points

Statistical analysis: Continuous data was represented in the form of Mean and standard deviation. Chi-square was the test of significance. P value <0.05 was considered as statistically significant.

Results:

Table 1: Age distribution of the subjects

		NO. PATIENTS	PERCENTAGE
Age	<30 years	11	36.7
	31 to 40 years	5	16.7
	41 to 50 years	7	23.3
	> 50 years	7	23.3
	Total	30	100.0

Majority i.e. 36.7% were in the age group < 30 years, 23.3% in 41 to 50 years and > 50 years respectively, and 16.7% in the age group 31 to 40 years.

Mean age was 41.27 ± 17.43 yrs.

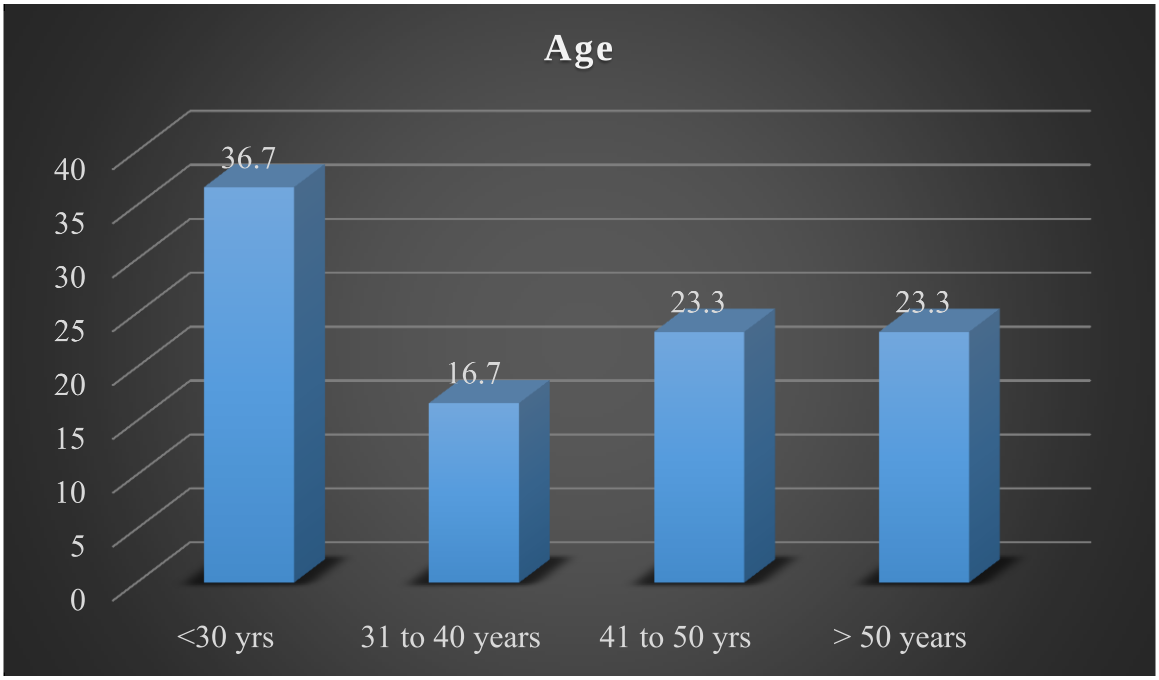


Figure 22: Bar diagram showing age distribution

Table 2: Sex distribution among the subjects

		NO. OF PATIENTS	PERCENTENTAGE
Sex	Female	2	6.7
	Male	28	93.3
	Total	30	100.0

In the study majority of subjects were males i.e. 93.3% and 6.7% were females

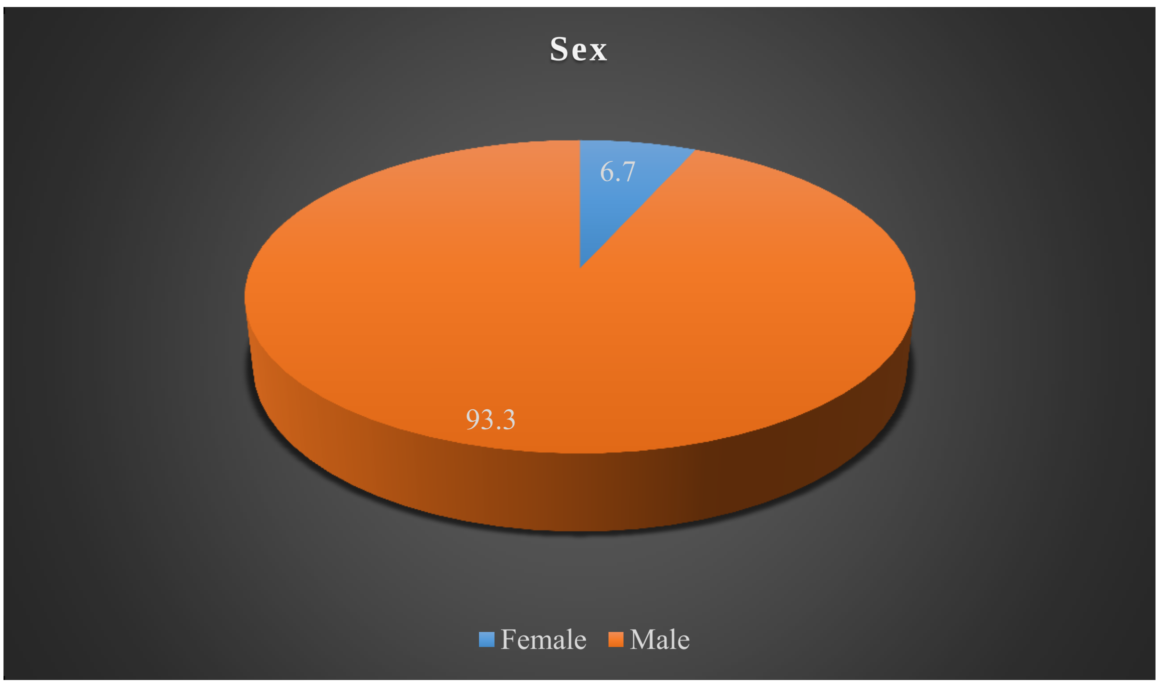


Figure 23: Pie chart showing Sex distribution

Table 3: Side of the Fracture among the subjects

		NO OF PATIENTS	PERCENTAGE
Side	**LEFT**	11	36.7
	RIGHT	19	63.3
	Total	30	100.0

Majority 63.3% of fractures were on right side and 36.7% was on left side.

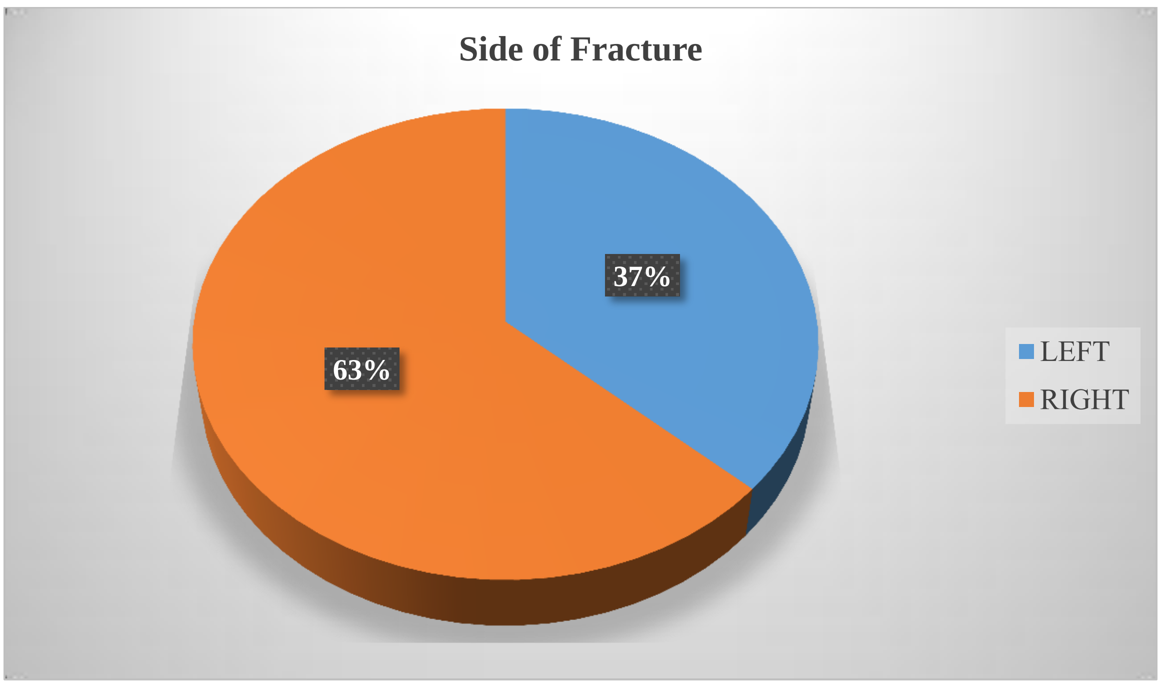


Figure 24: Pie diagram showing side of fracture

Table 4: Duration of days of injury before presentation

	Days	NO OF PATIENTS	PERCENTAGE
Duration of Injury	1	18	60.0
	2	4	13.3
	3	5	16.7
	4	2	6.7
	8	1	3.3
	Total	30	100.0

Majority 60% had reported within one day of injury, 13.3% reported within two days of injury, 16.7% reported after day 3, 6.7% reported after day 4 and 3.3% reported after day 8.

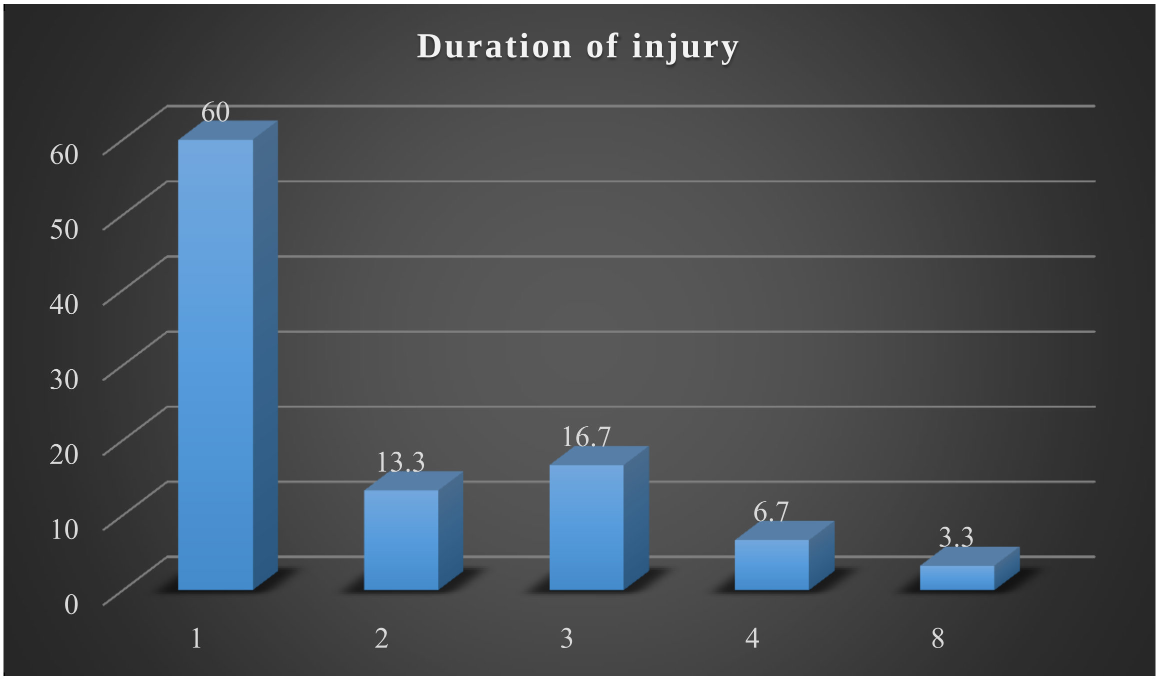


Figure25: Bar diagram showing duration of injury

Mode of Injury

TABLE 5

	NO. OF PATIENTS	PERCENTAGE
RTA	28	93.3
Self-Fall	2	6.7
Total	30	100

93.3% cases occurred due to motor vehicle accidents and 6.7% cases were due to self-fall

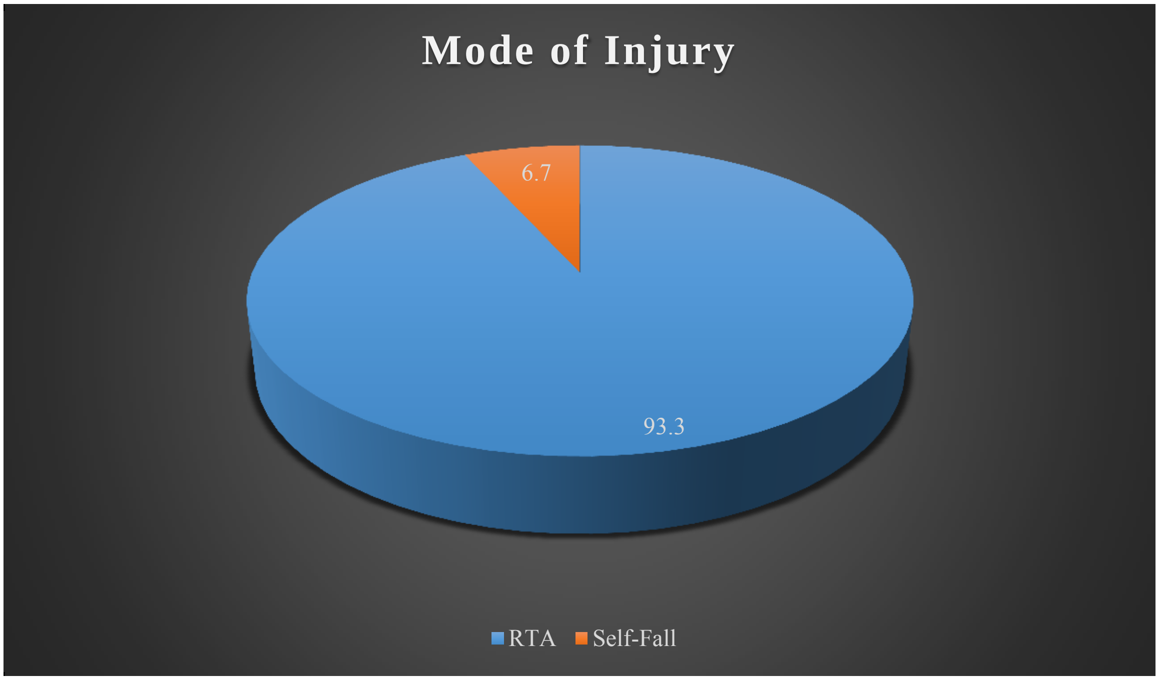


Figure 26: Pie diagram showing Mode of Injury

Association between Mode of Injury and Sex

TABLE 6

		Sex		Total	χ 2, df, p value
		Male	**Female**		
Mode of Injury	**RTA**	28	0	28	30, 1, <0.00001**
	Self-Fall	0	2	2	
	Total	28	2	30	

Significant p value score is present for association of distal femur fractures in males due to RTA and due to self-fall in female patients.

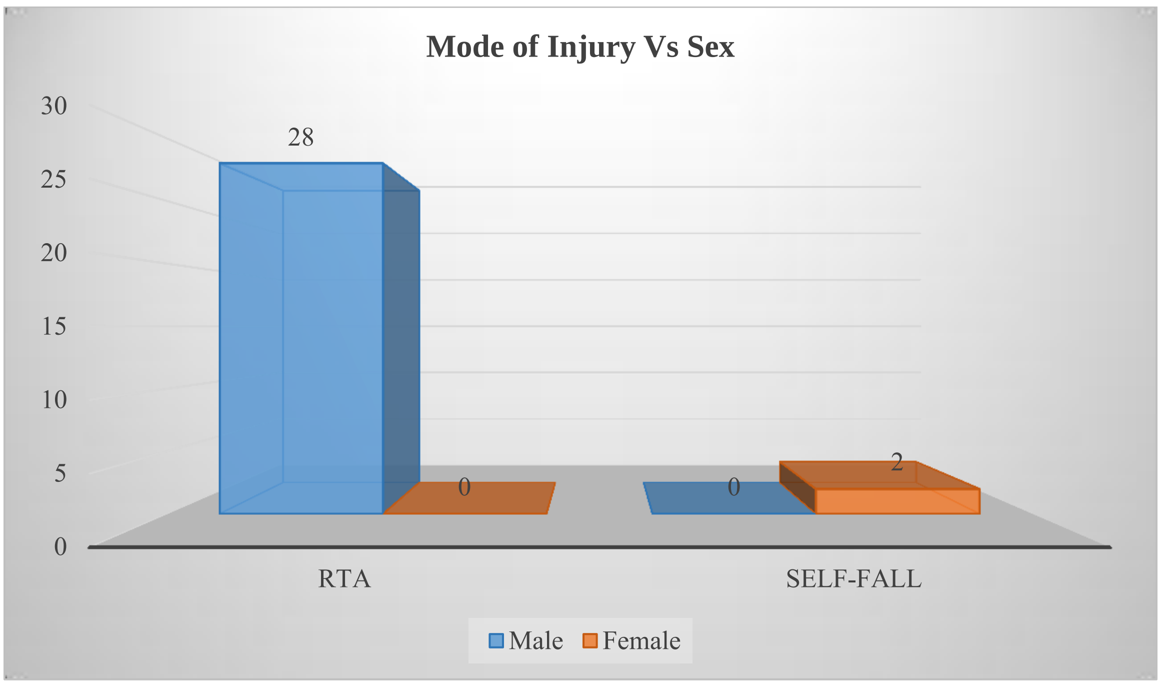


Figure 27: Bar diagram showing association between Mode of injury and sex

Type of Fracture

TABLE 7

		NO. PATIENTS	Percent
Type of Fracture	Closed	25	83.4%
	Open	5	16.6%
	Total	30	100.0

83.4% cases were closed type and 16.6% open type

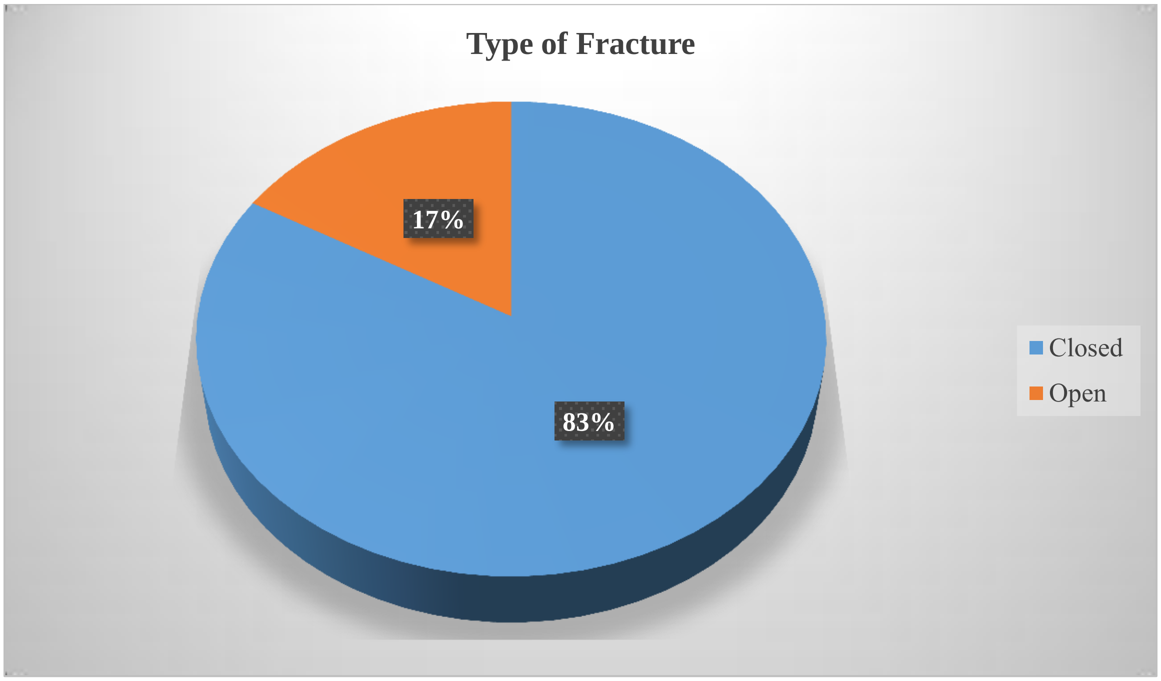


Figure 28: Pie diagram showing Type of Fracture

Table 8: Type of fracture among the subjects

		NO. PATIENTS	Percent
Type of Fracture	Closed Muller Type A1	23	76.7
	Closed Muller Type A2	1	3.3
	Closed Muller Type A3	1	3.3
	Open Muller Type A1	4	13.3
	Open Muller Type A2	1	3.3
	Total	30	100.0

Majority of the subjects i.e. 76.7% had Closed Muller type A1 #, 13.3% had Open Muller type A1 and 3.3% had Closed Muller Type A2, Closed Muller Type A3 and Open Muller Type A2 respectively.

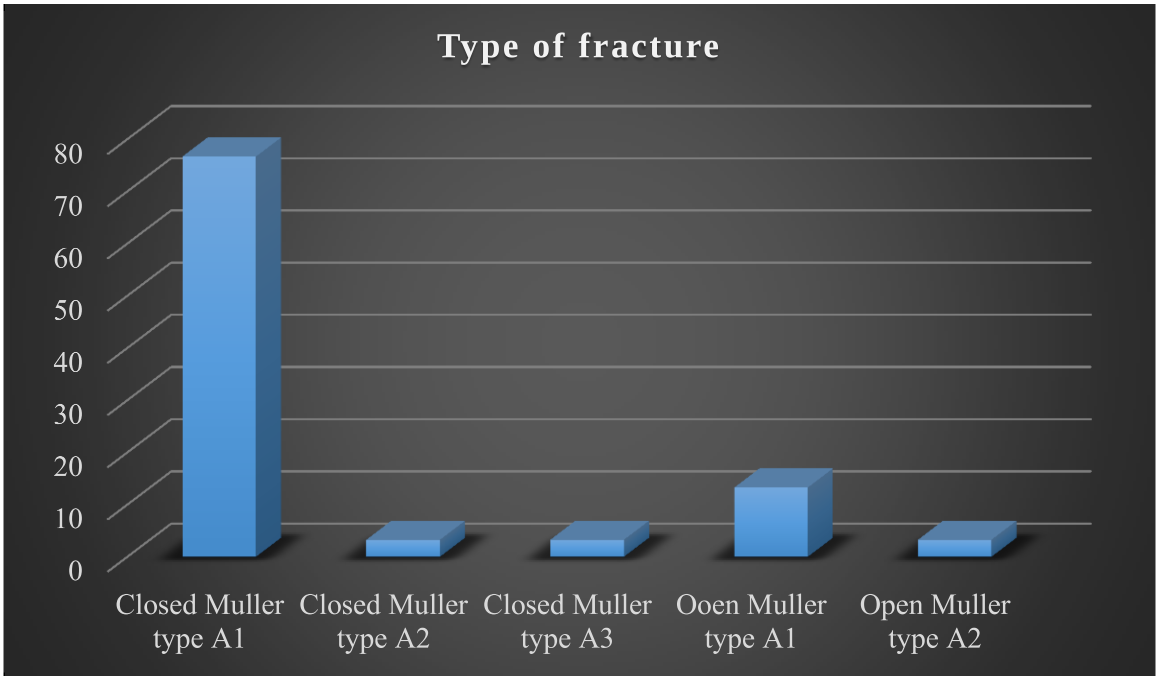


Figure 29: Bar diagram showing type of fracture

Table 9: Type of implant among the subjects

		NUMBER	Percent
Type of Implant	150 X 10 NAIL	1	3.3
	250 X 10 NAIL	11	36.7
	250 X 11 NAIL	8	26.7
	300 X 10 NAIL	4	13.3
	300 X 11 NAIL	6	20.0
	Total	30	100.0

Most common implant used was 250 X 10 NAIL in 36.7% followed by 250 X 11 NAIL in 26.7%, 300 X 11 NAIL in 20%, 300 X 10 NAIL in 13.3% and 150 X 10 NAIL in 3.3%.

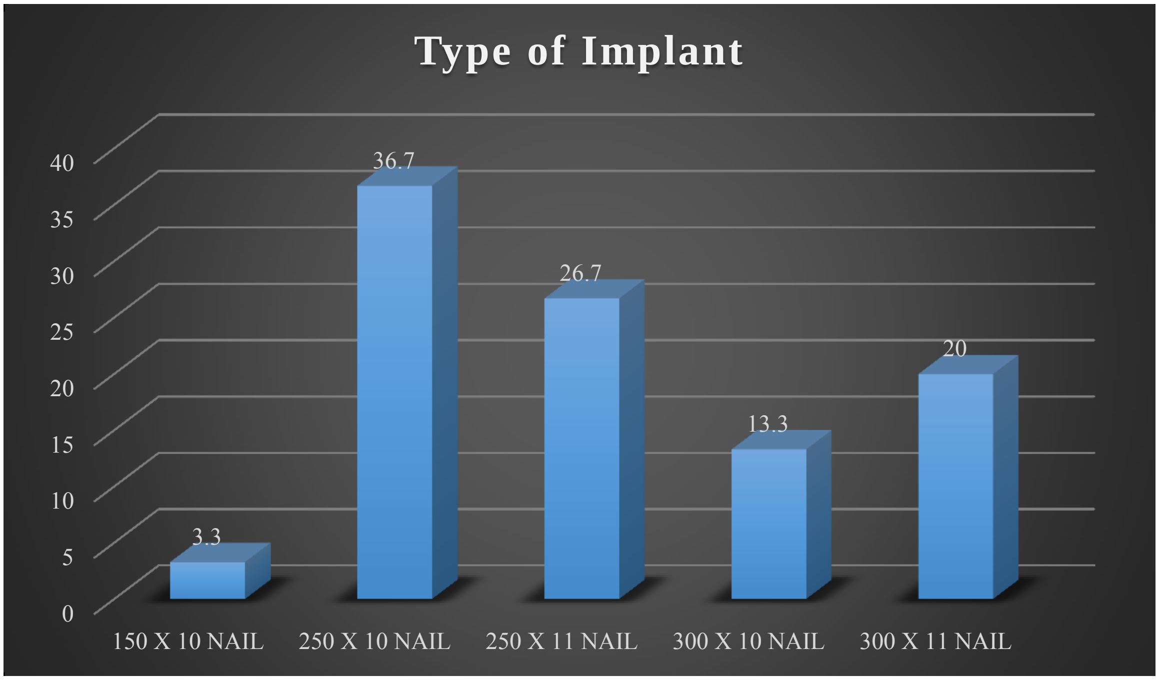


Figure 30: Bar diagram showing type of implant

Table 10: Association between type of fracture and type of implant

Type of #	Type of implant					Total
	150x10 NAIL	250X10 NAIL	250X11 NAIL	300X10 NAIL	300X11 NAIL	
Closed Muller Type A 1	0	10	5	2	6	23
Closed Muller Type A 2	0	0	0	1	0	1
Closed Muller Type A 3	0	0	1	0	0	1
Open Muller Type A1	1	1	2	0	0	4
Open Muller Type A 2	0	0	0	1	0	1
Total	1	11	8	4	6	30

$\chi 2 = 25.74$, df =16, p value = 0.058

Most common type of implant used was 250 X 10 Nail and it was used commonly in Closed Muller Type A1 fracture. There was no significant association between Type of fracture and type of implant. This is because of small sample size.

Table11: Association between sex and type of fracture.

Type of fracture	Sex		Total
	Female	Male	
Closed Muller Type A1	2	21	23
Closed Muller Type A2	0	1	1
Closed Muller Type A3	0	1	1
Open Muller Type A1	0	4	4
Open Muller Type A2	0	1	1
Total	2	28	30

$\chi 2 = 0.652$, df =4, p value = 0.957

Majority of males 21 out of 28 and all the female's i.e. 2 cases had Closed Muller Type A1 fracture. There was no significant association between type of fracture and sex.

Table 12: Post op complications among the subjects

		NO. PATIENTS (n=30)	Percentage
Death		1	3.3%
Screw breakage		1	3.3%
PE		2	6.6%
Shortening	1cm	2	6.6%
	2cm	1	3.3%
Stiffness		3	10 %
Delayed union		7	23.3

In the study one subject died, one subject had implant failure and 6.6% had pulmonary embolism. 3 subjects had shortening of limbs, 3 subjects had stiffness and 7 subjects had delayed union postoperatively and 1 case showed screw breakage.

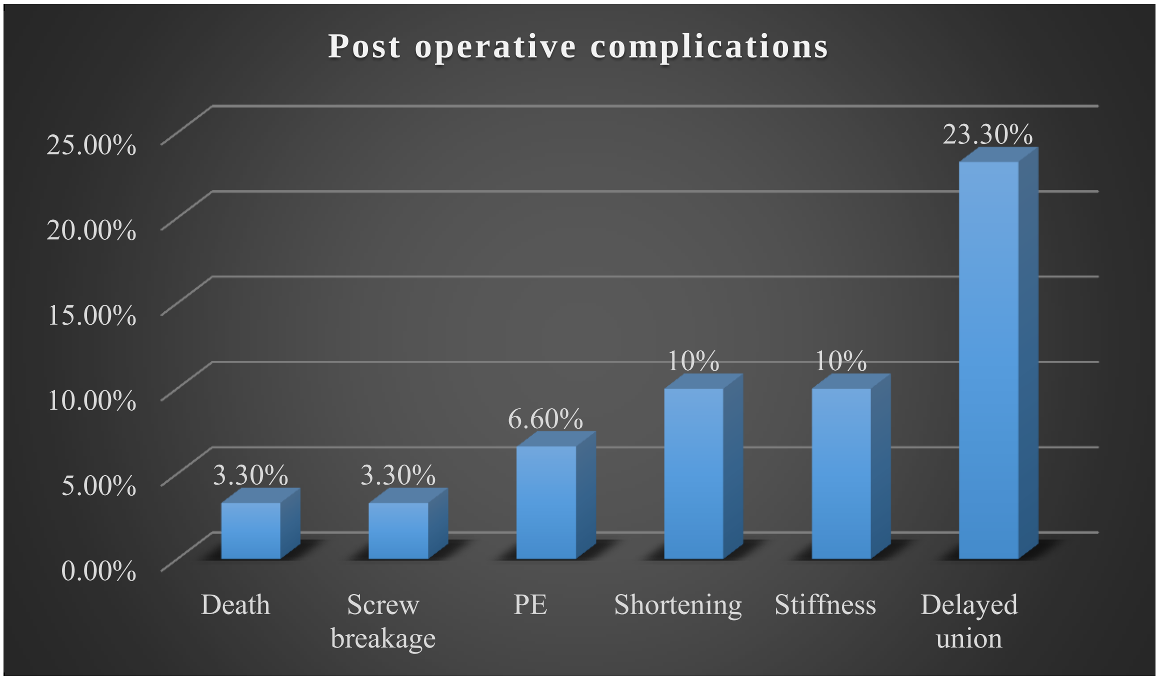


Figure 31: Bar diagram showing Post-operative complications

KNEE FLEXION:

Average flexion in this study was 115 degree with more than 90% patients having knee range of motion more than 110 degree.

Table 13: KNEE FLEXION

Knee Flexion (Degrees)	No. of cases	Percentage
90-110	**3**	**10.00**
111 - 120	**16**	**55.17**
>110	**10**	**34.48**

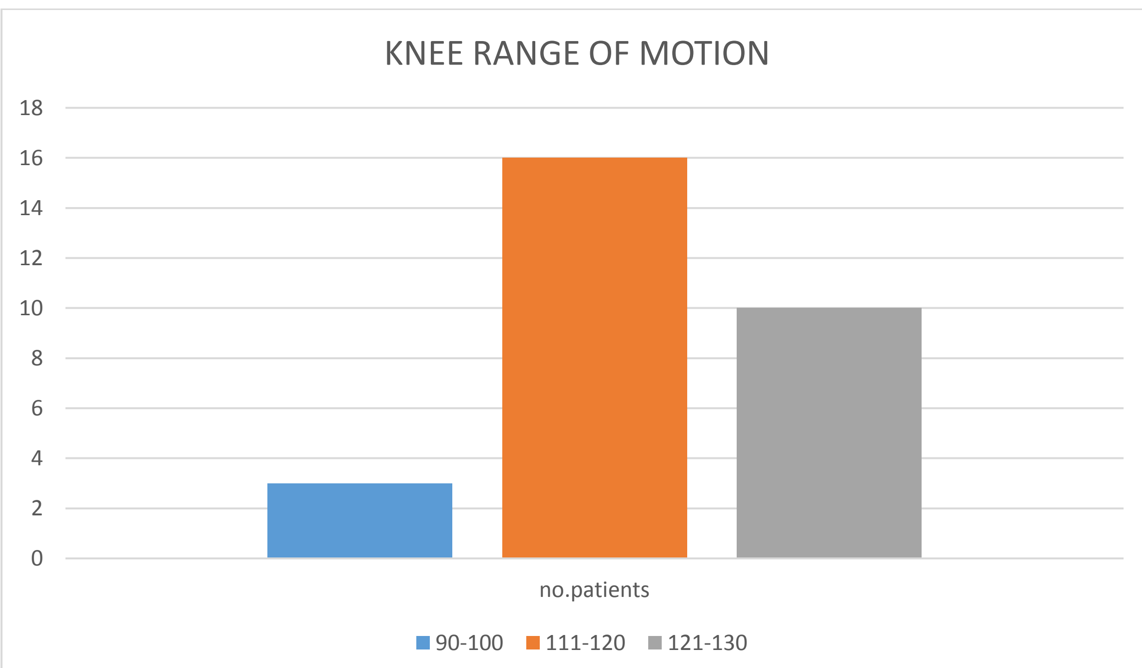


Fig-32- RANGE OF MOVEMENTS

Table 14: Mean active movements at different intervals of follow up by paired t test

	Mean	Std. Deviation	t value	p value
After surgery	27.24	10.986		
1 week	55.17	17.034	-9.598	0.0001**
2 week	75.17	17.242	-16.471	0.0001**
1 months	96.90	14.905	-25.848	0.0001**
3 month	111.03	11.447	-34.171	0.0001**

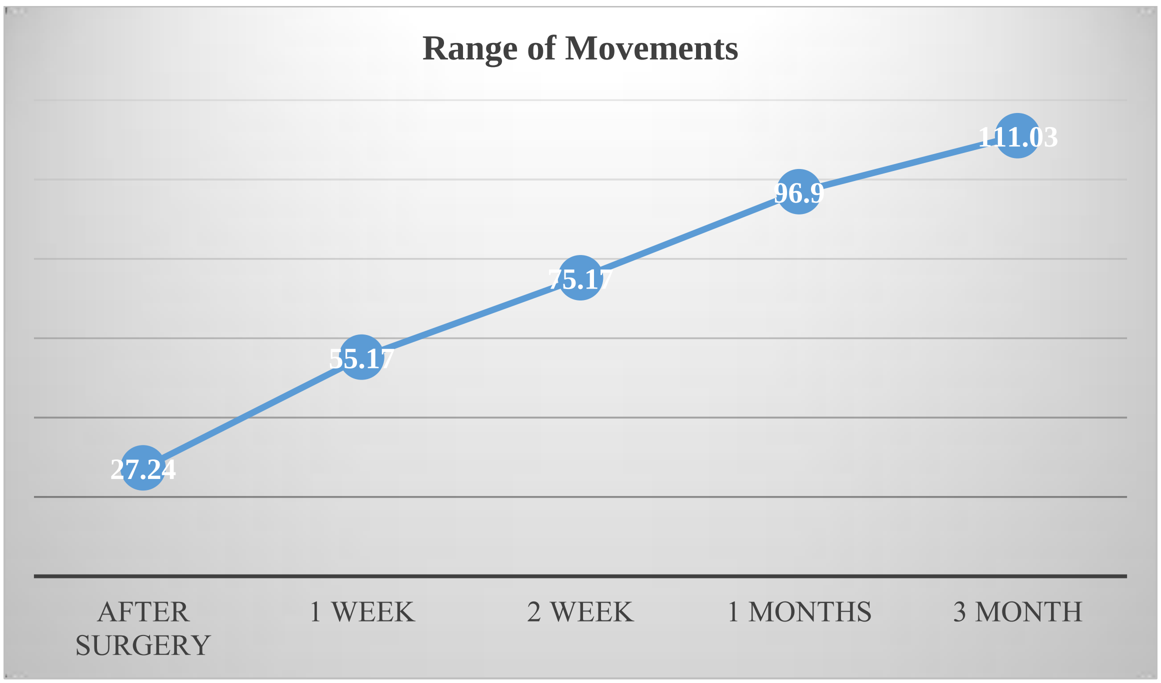


Figure 33: Line diagram showing degrees of active movement during follow-up

Table 15: Union of fracture during follow up

Union		NO. PATIENTS (n=29)	Percent
1 Month	**Uniting**	29	100%
3 Month	**United**	14	46.7
	Uniting	15	53.3%
6 months	**Delayed union**	7	23.3
	United	22	73.3

At 3 month follow up 46.7% cases were united, 53.3% were still uniting and 46.7%

At 6 month of follow up 73.3% showed complete union, 23.3% showed delayed union.

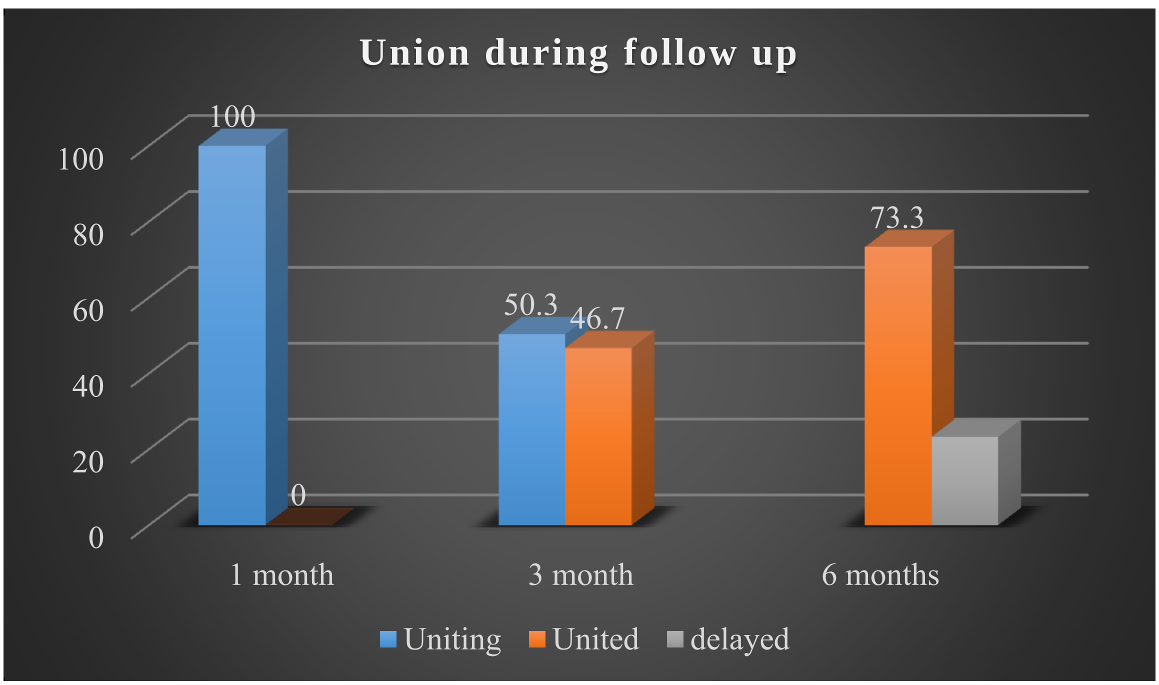


Figure 34: Bar diagram showing union of fracture during follow up

Table 16: Association between type of fracture and union of fracture at 6 month follow up

Type of Fracture	Union of fracture		Total
	Delayed	United	
Closed Muller Type A1	4 (17.3%)	19 (82.7%)	23
Closed Muller Type A2	0	1	1
Closed Muller Type A3	0	1	1
Open Muller Type A1	3 (75%)	1 (25%)	4
Total	7	22	29

$\chi2 = 6.55$, df =1, p value = 0.01**

Majority i.e. 82.7% of Closed Muller Type A1 # united completely at 6 month and 17.3% showed delayed union.

75% of Open Muller Type A1 showed delayed union and 25% showed union at 6 months.

This observation was statistically significant at 0.01 level between closed fracture and open fracture.

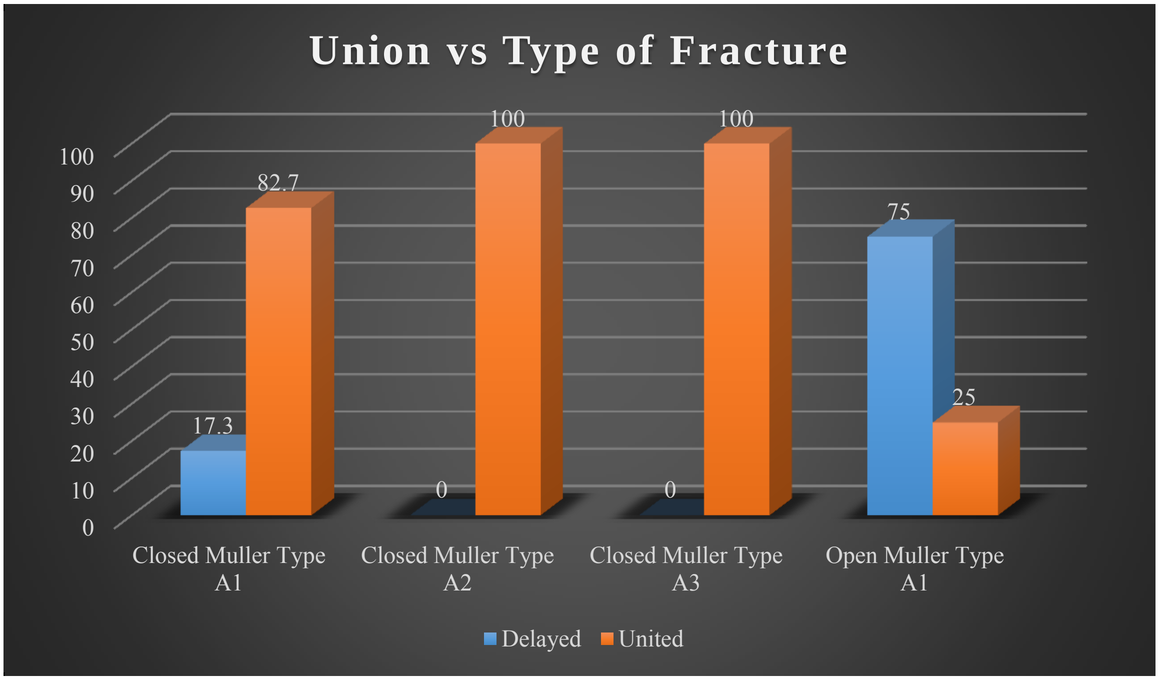


Figure 35: Bar diagram showing association between type of fracture and Union at 6 month

Table 17: Ambulation among the subjects during follow up

Ambulation	Non Weight	Partial	Full
1 Month	28 (96.5%)	1 (3.5%)	0
3 Month	3 (10.3%)	17 (58.7%)	9 (31%)
6 Month	0	7 (24.1%)	22 (75.8%)

In the study at 1 month majority were not bearing weight, at 3 month 58.7% were on partial weight bearing and 31% were full weight bearing. At 6 month 75.8% were fully bearing weight and 24.1% were bearing partial weight [Correlates with Delayed Union of fracture].

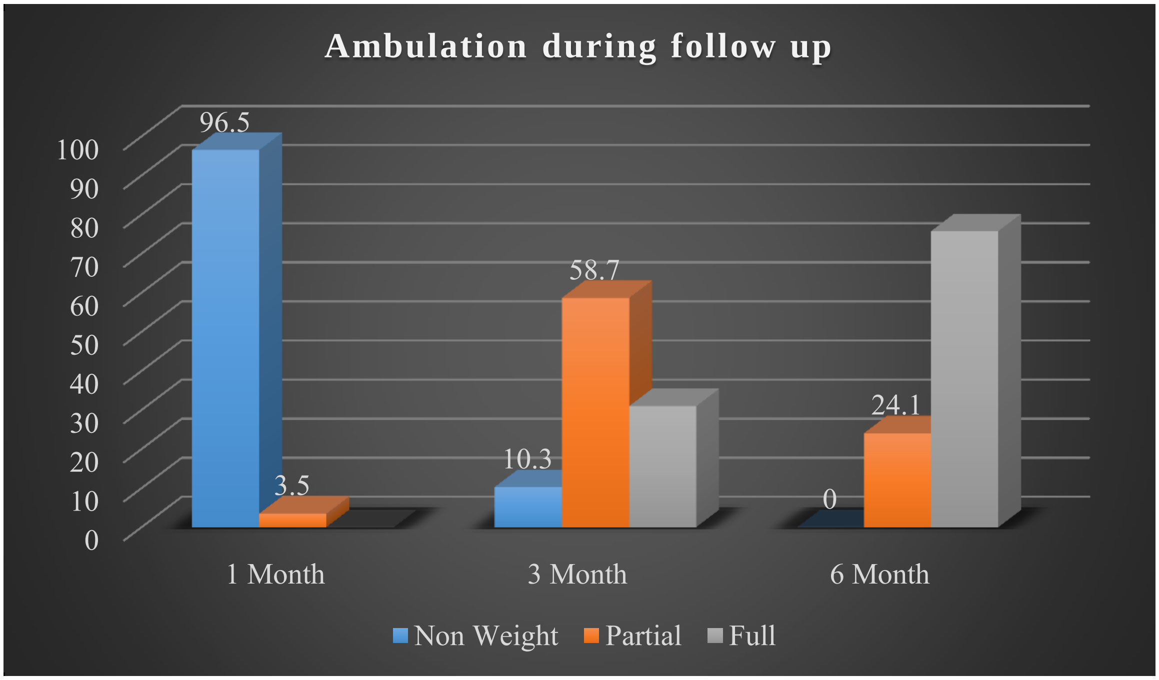


Figure 36: Bar diagram showing ambulation during follow up

Table 18: Other Associated lesions

FRACTURE TYPE	IT#	# Humerus	Floating knee
Closed Muller Type A1	1		6
Closed Muller Type A2		1	0
Closed Muller Type A3			1
Open Muller Type A1			2
Total			9

In the study 9 subjects had associated lesions of which 9 had floating knee. Floating knee was commonly associated with Closed Muller Type A1#. 1 pt had associated intertrochanteric # and 1 pt with associated # humerus shaft.

IT# Intertrochanteric fracture

Fracture

DURATION OF SURGERY:

In 16 cases (65%) the duration was less than 90 minutes, in 6 cases (25%) the duration was 91 – 120 minutes and in 2 cases (10%) it was more than 120 minutes. Average operative time for all fractures was 83.92 minutes. It was observed that operative time was seen to be more in cases which presented late

Table 19: DURATION OF SURGERY

Operative time (minutes)	No. of cases	Percentage
< 90 min	**16**	**65.00**
91 - 120 min	**6**	**25.00**
120-150	**2**	**10.00**
Total	**25**	**100.00**

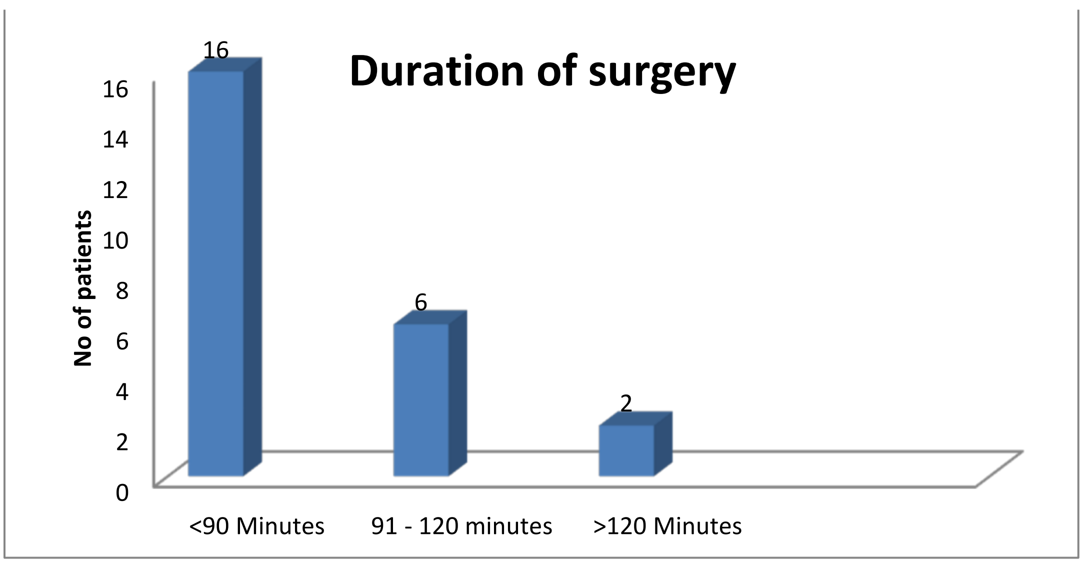


Fig- 36 Duration of surgery

CRITERIA FOR EVALUATION OF THE RESULTS (FROM NEER CS, II GRANTHAN SA, and SHELTON ML) [27]

Functional (70 points)		Anatomical (30 points)	
a) Pain (20 points)		a) Gross anatomy (15 points)	
• No pain	20	• Thickening only	15
Intermittent or during changes in	16	• 5 degree angulation for 0.5 cm shortening	12
• With fatigue	12	• 10 degree angulation or rotation, 2 cm shortening	9
• Limits function	8	• 15 degree angulation or rotation, 3 cm shortening	6
• Constant or at exertion	4-0	• Healed with considerable deformity	3
b) Walking capacity (20 points)		• Non-union or chronic infection	0
• Same as before accident	20	b) Roentgenogram (15 points)	
• Mild restriction	16	• Near normal	15
• Restricted stair side ways	12	5 degree angulation or 0.5 cm displacement	12
• Use crutches or other walking aids	4-0	10 degree angulation or 1 cm displacement	9
c) Joint movement (20 points)		15 degree angulation or 2 cm displacement	6
• Normal or 135 degrees	20	Union but with greater deformity, spreading of condyles and osteoarthritis	3
• Up to 100 degrees	16	Non-union or chronic infection	0
• Up to 80 degrees	12		
• up to 60 degrees	8		
• Up to 40 degrees	4		
• Up to 20 degrees	0		
d) Work capacity (10 points)			
• Same as before accident	10		
• Regular but with handicap	8		
• Alter work	6		
• Light work	4		
• No work	2-0		

Excellent More than 85 points

TABLE 20

Good....... 70 to 85 points
Fair .... 55 to 69 points
poor........ Less than 55

FUNCTIONAL RATING AS PER NEER'S RATING SCORE

Long term final results were rated using Neer's rating system, which allots points for pain, function ,working ability, joint movements, gross and radiological appearance. Neer's score was assigned for each patients after 24 to 36 weeks. Using this scale there were 15(51.7%) excellent results, 6(20.6%) good results, 7(24. %) fair results and 1(3.4%) poor result.

Table 21: functional rating ass per Neer's rating score

Rating	**No. of cases**	**Percentage**
Excellent >85 points	**15**	51.7
Good 70-84 points	**6**	**20.6**
Fair 50-69 points	**7**	**24.1**
Poor <50 points	**1**	**3.4**

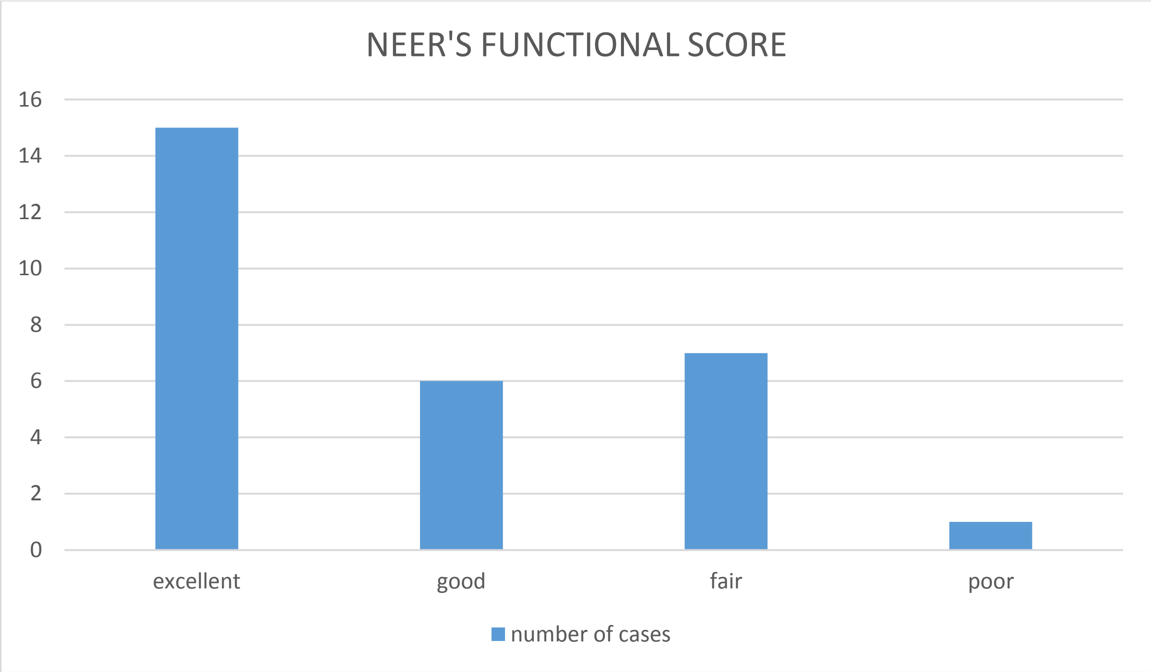


Fig 37- NEER SCORING SYSTEM

DISCUSSION

Comparing our study with that of the previous reported series, the demographic profile is as follows

Table 22:

SERIES	AGE GROUP (YEARS)	AVERAGE AGE	MALE (NO.)	FEMALE (NO.)
Seifert J et al [62]	17-92	44	29 17-75yrs(avg 34.3yrs)	18 19-92yrs(avg 53.8yrs)
Wisniewski T et Al[79]	58-89	67	23	09
Bel JC et al [69]	16-96	61	12	17
Janzing HMJ et Al[79]	65-96	82	02	22
Gellman RE et al [51]	24-84	50	10 29-61yrs(avg 39yrs)	12 26-84yrs(avg 60yrs)
Lucas SM et al [41]	15-69	39	13	11
Present	18-75	41.27 ± 17.43 yrs.	28 21-72(avg 38.21 yrs)	2 45-75(avg 60 yrs)

The demographic profile of our series is closely comparable with Seifert J et al, Lucas SM et al, and Gellman RE et al.

Mechanism of injury and fracture characteristics of our series were comparable with that of Seifert J et al, Lucas SM et al, and Gellman RE et al, Janzing HMJ et al. Extra articular and intraarticular fracture percentages were closely resembling Janzing HMJ et al, Seifert et al and Wisniewski et al.

Table 23(a)

Series	Total no of fractures	Open	Closed	Extra articular (type A)	Intraarticular (type C)
Seifert J et al	48	10(21%)	38(79%)	37(77%)	11(23%)
Wisniewski et al	32	0(0%)	32(100%)	25(78%)	07(22%)
Bel JC et al	33	09(27%)	24(73%)	15(45%)	18(55%)
Janzing HMJ et al	24	01(4%)	23(96%)	20(83%)	04(17%)
Gellman RE et al	24	08(33%)	16(67%)	11(46%)	13(54%)
Lucas SM et al	25	09(36%)	16(64%)	06(24%)	19(76%)
Present	30	05(16.6%)	25(83.3%)	25(100%)	0(0%)

Table 23(b) the numbers and percentage of AO types of fractures are:

Series	A1	A2	A3	C1	C2	C3
Gellman RE et al	3(12%)	3(12%)	5(21%)	4(17%)	3(12%)	6(26%)
Lucas SM et al	0(0%)	4(16%)	2(8%)	4(16%)	10(40%)	5(20%)
Present	27(90%)	2(6.6%)	1(3.3%)	0(0%)	0(0%)	0(0%)

Comparing our data with the previous series, we found similar results regarding union rates, outcome and complications. We had 7 cases of delayed union due to late presentation of cases and associated injuries.

Table 24(a)

Series	Operative time	Follow up	Union rate	Remarks
Seifert et al	----	12-37months Avg:33weeks	9-17weeks Avg :12.6weeks	All fractures healed; 1 open reduction done
Gellman RE et al	60-315min Avg: 154min	4-36months Avg :18months	2-4months Avg :3months	All healed 1bone graft
Bel JC et al	Avg: 150min	Minimum of 12months	Avg :12weeks	All healed
***SKV Gupta et a*l**[77]			average time of 7.4 months	5 cases (9%) developed nonunion
Present	Avg: 83.92min	6months	24weeks 73%	7 delayed union 22 healed

Table: 24(b)

Series	Functional results	Complications
Seifert et al	Leung score: A:16%fair, 16% good,16%excellent C: 18%fair,73% good,19%excellent No difference between type A and C	1DVT,2shortening,1insufficient fracture reposition,1spiral fracture,2retropatellar chondral lesion
Gellman RE et al	Sanders Score: 4excellent,15good,2fair,2poor A:3excellent ,16 good,1poor C:1excellent,9good,2fair,1poor Average flexion 106 degree(55-150)	1malunion,6shortening,3nail impingement,1missed locking bolt,2required arthrolysis
Lucas SM et al	Average ROM 100 degree Average flexion 104 degree Average extensor lag 4 degree A:ROM 92^0 lag 6^0 flexion 98^0 C:ROM 103^0 lag 3^0flexion 106^0	4knee pain,1malunion,1shortening,1bent nail,1brokennail,1infection,6required arthrolysis,7irritation at screw site,2post traumatic arthritis
Bel JC et al	Average ROM 110 degree(range 60-120)	3malunion,1shortening
Janzing HMJ et al	56%excellent,33%good,11%fair No failures	5distal lock bolt loosening,4shortening,5malunion
Present	15(51.7%) excellent results, 6(20.6%) good results, 7(24. %) fair results and 1(3.4%) poor result.	1 died, 1 screw breakage and 3 had pulmonary embolism. 3 shortening of limb, 3 stiffness and 7 delayed union.

Majority of the fractures in the present study healed by 6 months. Numerous rating scales are used to determine the functional outcome after surgical treatment of supracondylar fracture of femur. Neer, HSS, Karlstrom and Olerud.Leung,Schatzker,Sanders are some scales in vogue. We used Neer's score since it emphasizes on important patient outcome variables such as pain, functions as related to daily living activities, range of motion, return to work, gross anatomic alignment and radiological evaluation of union and mechanical alignment. However no rating scale is validated to be superior to other.

True common confounding variables in the present study that were not evaluated properly are associated injuries which can lower the score. We acknowledge these limitations in this study.

Range of motion was on par with previously reported studies; Kolmert et al 92 degree, Gile et al

120degree, Shelton et al 115 degree, Seinscheimer 100degree, Iannacone 90degree, Gynning 130degree, Henry 105degree, Gellman 104degree and Lucas et al 100degree. In this study average ROM is 115 degree for all fractures. Younger patients attained better results than the elderly patients. Presumably this is because the younger group adhere to strict and vigorous physiotherapy postoperatively than elderly group.

The mean operative time was 84 minutes. Increased operation time was seen in cases with delayed presentations.

Extensor lag was noted in patients post operatively 5-30 degrees which reduced after physiotherapy and was absent after 1 month of follow up.

Most of the patients had their healing excellent alignment without shortening. The 1-2cm shortening that occurred in 3 patients but did not affect their function. All of them did well with shoe raise.

1 patient reported with screw breakage due to noncompliance of post-operative protocol and was not willing for a repeat surgery.2 patients had post-operative fat embolism from which one patient died and the other fully recovered. 3 patients reported with knee stiffness. 7 pts. Showed signs of delayed union at the end of 6 months follow up. Dynamisation was done in 2 patients and bone marrow injection was given in 1 patient.

CONCLUSION

1. Retrograde intramedullary supracondylar nail is a good fixation system for distal third femoral fractures, particularly extra-articular type.
2. The operative-time is lessened with decrease in blood loss.
3. If closed reduction can be achieved by not disturbing fracture hematoma and soft tissue.
4. Distal screw related local symptoms is a common problem and is related to implant and technique; and has a definite learning curve.
5. There is no non-union, reduced rates of angular or rotational malunions and delayed unions.
6. Non-requirement of bone graft decreases the morbidity associated with donor site.
7. Early surgery, closed reduction, at least two screws in each fragment and early postoperative knee mobilization are essential for good union and good knee range of motion.
8. There is no much difference in individual fracture type healing and weight bearing

Thus, supracondylar nail is the optimal tool for many supracondylar fractures of femur. It provides rigid fixation in a region of femur, where a widening canal, thin cortices and frequently poor bone stock make fixation difficult. Surgical exposure for nail placement requires significantly less periosteal stripping and soft tissue exposure than that of lateral fixation devices.

SUMMARY

This study comprised of 30 patients treated with retrograde nail. The results are summarized as follows

1. The follow up was 6 months.
2. Mean age of the patients was 41 yrs.
3. Males were affected most commonly.
4. Predominantly right side was involved.
5. Road traffic accidents were the common mode of injury.
6. (17%) were open fractures and 93% were closed.
7. In 60% cases the surgery was performed within 24 hrs. Average operative time was 84 min.
8. All fractures united with an average of for union (16-24weeks), with 7 case of delayed union. There were no case of malunion or non-union.
9. Final range of motion for all fractures was average 115 degrees.
10. We had functional outcome of 72% good to excellent results using Neer's 100 point knee rating scale.
11. In this study shortening was seen in 3 patients, which could be managed by shoe raise.1 patient reported with screw breakage due to noncompliance of post-operative protocol and was not willing for a repeat surgery.2 patients had post-operative fat embolism from with one patient died. 3 patients reported with knee stiffness. 7 pts. Showed signs of delayed union at the end of 6 months follow up.

We conclude that retrograde intramedullary supracondylar nailing for distal femoral fractures is the optimal tool as it provides rigid fixation, a reproducible technique, and requires attention initially to details of technique to reduce complication

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PROFORMA FOR CASE OF FRACTURE DISTAL FEMUR WITH RETROGRADE INTRAMEDULLARY NAILING

NAME IP NUMBER

AGE DATE OF ADMISSION

SEX DATE OF SURGERY

DATE OF DISCHARGE

ADDRESS

PRESENT COMPLAINT

SITE INVOLVED RIGHT / LEFT

MODE OF INJURY TRIVIAL FALL

ROAD TRAFFIC ACCIDENT

FALL FROM HEIGHT

CIRCUMSTANCES UNDER WHICH INJURY OCCURRED

ASSOCIATED INJURY

TREATMENT HISTORY

YES / NO

IF YES OSTEOPATH

GENERAL PRACTITIONER

ORTHOPEDICIAN

METHOD OF FIRST AID

PAST HISTORY

HISTORY OF CO MORBIDITIES

PREVIOUS INJURIES

FAMILY HISTORY AND PERSONAL HISTORY

MARRIED/UNMARRIED

SMOKER/NON SMOKER

ALCOHOLIC/NON ALCOHOLIC

NATURE OF WORK

BLADDER/BOWEL

GENERAL PHYSICAL EXAMINATION

BUILT WELL/MODERATE/POOR

NOURISHMENT WELL/MODERATE/POOR

PALLOR, ICTERUS, CYANOSIS, CLUBBING, OEDEMA, LYMPHADENOPATHY

TEMP FEBRILE/NON FEBRILE

PULSE

BP

RR

SYSTEMIC EXAMINATION

CVS

RS

PA

CNS

LOCAL EXAMINATION

EVIDENCE OF DISTAL FEMUR FRACTURE YES / NO

SWELLING

CREPITUS

DEFORMITY

ABNORMAL MOBILITY

TYPE OF FRACTURE CLOSED/OPEN

SOFT TISSUE DAMAGE

NEUROVASCULAR EXAMINATION

OTHER ASSOCIATED INJURIES TO ILSILATERAL KNEE IF ANY

OTHER LONG BONE INJURIES

INVESTIGATIONS

X RAY AP/LAT

OBLIQUE IF REQUIRED

FRACTURE CLASSIFICATION ACCORDING TO AO MULLER CLASSIFICATION

CHEST X RAY PA VIEW

ECG

ROUTINE BLOOD INVESTIGATIONS

HB PCV TC DC ESR RBS

B.UREA S.CREANINE HIV HbsAg BT CT

BLOOD GRP AND TYPE

URINE ROUTINE

CT IF REQUIRED

OTHER SPECIAL INVESTIGATIONS IF REQUIRED

FINAL DIAGNOSIS

MANAGEMENT

PRE OPERATIVE

IV FLUIDS

ANTIBIOTICS AND ANALGESICS

BLOOD TRANSFUSION

SPLINTING

UPPER TIBIAL SKELETAL TRACTION

DURATION FROM INJURY TO FIXATION

TYPE OF IMPLANT TO BE USED

OPERATION

DATE OF SURGERY

POSITION

ANAESTHESIA

APPROACH

TOURNIQUET

NAIL LENGTH DIAMETER SCREW

BLOOD LOSS DURATION

BONE GRAFTING

BLOOD TRANSFUSION

LIMB LENGTH

MALROTATION

POST OPRATIVE

ANTIBIOTICS

ANALGESIA

CHECK X RAY

WOUND INSPECTION

LIMB LENGTH

MALROTATIONS

RANGE OF MOVEMENTS

COMPLICATIONS IF ANY

AMBULATION

DURATION OF HOSPITAL STAY

PERIOD	**1 WEEK**	**15 DAYS**	**1 MONTH**	**3 MONTH**	**6 MONTH**
CHECK X- RAY					
RANGE OF MOTION					
AMBULATION					
UNION					
COMPLICATIONS					

CONSENT FORM

FOR OPERATION/ANAESTHESIA

I ______________________ Hosp. No. _____________ in my full senses hereby give my complete consent for _________________ or any other procedure deemed fit which is a diagnostic procedure / biopsy / transfusion / operation to be performed on me / my son / my daughter / my ward __________________ age ________________ under any anaesthesia deemed fit. The nature and risks involved in the procedure have been explained to me to my satisfaction. For academic and scientific purpose the operation/procedure may be televised or photographed.

Date:

Signature/Thumb Impression
of Patient/Guardian

Name:
Designation:

Guardian

Relationship
Full address

SERIAL NUMBER	PATIENT NAME	OP/IP No	AGE	SEX	DOA	DOS	SIDE	DURATION OF INJURY	MECHANISM	DIAGNOSIS	IMPLANT	POST-OP COMPLICATION	EXT LAG	ROM	ROM
														ACTIVE	PASSIVE
1	VENKATAMMA	343115	45	F	16/10/2012	19/10/2012	LEFT	3	FALL	CLOSED MULLER TYPE A 1	250X10 NAIL		0	20	60
2	VENKATAMMA	41244	75	F	19/10/2012	20/10/2012	LEFT	1	FALL	CLOSED MULLER TYPE A 1	250X10NAIL	DELAYED UNION	5	30	60
3	VERANNA	36036	50	M	1/12/2012	3/12/2012	RIGHT	2	RTA	OPEN TYPE 1 MULLER TYPE A1	150X10NAIL	DELAYED /STIFFNESS/SCREW BREAK	30	40	40
4	MUNIRAJU	865378	21	M	6/12/2012	10/12/2012	LEFT	4	RTA	CLOSED MULLER TYPE A 1	300X11 NAIL	PE/ICM SHORTENING	5	40	70
5	NARAYANA SWAMY	879612	25	M	25/1/2013	28/1/2013	RIGHT	3	RTA	CLOSED MULLER TYPEA 1	300X11 NAIL		5	40	70
6	GATTAPPA	355458	60	M	6/2/2013	14/2/2013	RIGHT	8	RTA	COLSE MULLER TYPE A 3	250X11 NAIL	STIFFNESS/DELAYED UNION	5	30	70
7	SRINIVAS REDDY	895914	42	M	23/3/2013	25/3/2013	LEFT	4	RTA	CLOSED MULLER TYPE A 1	300X11 NAIL		10	30	70
8	SURESH	897588	30	M	29/3/2013	1/4/2013	LEFT	2	RTA	CLOSED MULLER TYPE A 1	250X10 NAIL		20	10	40
9	RIYAZ	897983	35	M	31/3/2013	2/4/2013	RIGHT	2	RTA	CLOSED MULLER TYPE A 1	250X11 NAIL		5	30	50
10	KARANGAPPA	899848	26	M	6/4/2013	7/4/2013	RIGHT	1	RTA	CLOSED MULLER TYPE A 1	250X11 NAIL		10	30	40
11	PRABHAKAR REDDY	903618	40	M	23/4/2013	24/4/2013	RIGHT	1	RTA	OPEN TYPE 2 MULLER TYPE A 2	300X10NAIL	DEATH/PE	-	-	-
12	MANJUNATH	905562	32	M	27/4/2013	30/4/2013	RIGHT	3	RTA	CLOSED MULLER TYPE A 1	300X11 NAIL	STIFFNESS	20	0	40
13	MANJUNATH REDDY	907335	35	M	3/5/2013	6/5/2013	LEFT	3	RTA	CLOSED MULLER TYPE A 1	250X11 NAIL		5	30	80
14	SRINIVASA	913333	22	M	23/5/2013	24/5/2013	LEFT	1	RTA	CLOSED MULLER TYPE A 2	300X10 NAIL		10	10	70
15	DHANANJAY	897983	38	M	3/6/2013	4/6/2013	RIGHT	1	RTA	OPEN TYPE 1 MULLER TYPE A1	250 X11 NAIL		5	30	40
16	UDAY KUMAR	916646	23	M	4/6/2013	5/6/2013	RIGHT	1	RTA	CLOSED MULLER TYPE A 1	300X11NAIL		10	40	60
17	SUNIL	938835	18	M	21/8/2013	24/8/2013	RIGHT	3	RTA	OPEN TYPE 1 MULLER TYPE A1	250X10 NAIL	DELAYED UNION/SHORTENING 2CM	5	20	50
18	MUNI VENKATA REDDY	945666	25	M	13/9/2013	14/9/2013	RIGHT	1	RTA	CLOSED MULLER TYPE A 1	250 X11 NAIL		5	30	50
19	RAVANNA	957943	50	M	10/10/2013	11/10/2013	RIGHT	1	RTA	CLOSED MULLER TYPE A 1	250X11 NAIL	DELAYED UNION	10	30	40
20	SHANKARAPPA	958209	30	M	26/10/2013	27/10/13	RIGHT	1	RTA	CLOSED MULLWE TYPE A1	300X10NAIL		5	30	40
21	VENKATAREDDY	19942	60	M	1/12/2013	2/12/2013	RIGHT	1	RTA	CLOSED MULLER TYPE A 1	250X10 NAIL		5	20	30
22	ANANTHACHARI	968524	72	M	1/12/2013	2/12/2013	LEFT	1	RTA	CLOSED MULLER TYPE A 1	250X10 NAIL		5	20	40
23	BASAVARAJ	970412	49	M	8/12/2013	10/12/2013	RIGHT	2	RTA	CLOSED MULLER TYPE A 1	300X10NAIL		10	30	50
24	SUNIL	388246	18	M	9/12/2013	10/12/2013	RIGHT	1	RTA	CLOSED MULLER TYPE A 1	300X11 NAIL	SHORTENING 1CM	5	40	60
25	JAGADESH	2643	22	M	15/12/2013	16/12/2013	LEFT	1	RTA	OPEN TYPE 1 MULLER TYPE A1	250X11 NAIL	DELAYED UNION	5	30	50
26	DARSHAN	2652	65	M	20/12/2013	21/12/2013	LEFT	1	RTA	CLOSED MULLER TYPE A 1	250X10 NAIL	DELAYED UNION	5	30	40
27)	SUBBANNA	30263	70	M	27/12/2013	28/12/2013	RIGHT	1	RTA	CLOSED MULLER TYPE A 1	250X10 NAIL		A/K SLAB	A/K SLAB	A/K SLAB
28)	muniramaiah	36289	65	M	29/12/2013	30/12/2013	LEFT	1	RTA	CLOSED MULLER TYPE A 1	250X10 NAIL		5	30	60
29)	VENKATARAYAPPA	62774	50	M	15/1/2014	16/1/2014	RIGHT	1	RTA	CLOSED MULLER TYPE A 1	250X10 NAIL		5	40	50
30)	RAMESH	27242	45	M	28/1/2014	29/1/2014	RIGHT	1	RTA	CLOSED MULLER TYPE A 1	250X10 NAIL		10	30	50

ROM	ROM	ROM	ROM	ROM	X-RAY	X-RAY	X-RAY	UNION	UNION	UNION	AMBULATION	AMBULATION	AMBULATION	ASSOCIATED FRACTURES	SEC PROCEDURE
1 WEEK	**2 WEEK**	**1 months**	**3 MONTH**	**6 MONTH**	**1 month**	**3 month**	**6 month**	**1 month**	**3 month**	**6 month**	**1 month**	**3 month**	**6 month**		
80	90	110	120	120	G	G	G	UNITING	UNITED	UNITED	non wt	full assisted	full		
70	90	90	110	120	A	A	A	UNITING	UNITING	DELAYED	non wt	partial wt	partial wt		
50	60	80	90	90	G	F		UNITING	UNITING	DELAYED	non wt	non wt	partial		
70	80	100	120	130	G	G	G	UNITING	UNITING	UNITED	non wt	partial wt	full	FK	
50	70	100	120	130	G	G	G	UNITING	UNITED	UNITED	non wt	full	full		
50	90	90	110	110	G	G	G	UNITING	UNITING	UNITED	non wt	partial wt	partial	FK	
70	80	100	100	130	G	G	G	UNITING	UNITED	UNITED	non wt	full	full	FK	
70	80	90	100	110	G	G	G	UNITING	UNITING	UNITED	non wt	partial wt	full	FK	
70	90	100	110	120	G	G	G	UNITING	UNITED	UNITED	non wt	partial wt	full		
60	70	100	110	120	G	G	G	UNITING	UNITED	UNITED	non wt	full	full	FK	
-	-	-	-	-	-	-	-		-		-	-	-	FK&H	
10	10	50	90	90	D	G	G	UNITING	UNITING	UNITED	non wt	non wt	partial	IT	
70	70	90	110	120	G	G	G	UNITING	UNITED	UNITED	non wt	full	full		
10	90	100	120	130	G	G	G	UNITING	UNITED	UNITED	non wt	full	full		
50	70	90	120	120	G	G	G	UNITING	UNITING	UNITED	non wt	partial wt	full	FK	
50	80	100	110	130	G	G	G	UNITING	UNITING	UNITED	non wt	partial wt	full		
70	80	120	130	130	G	G	G	UNITING	UNITING	DELAYED	non wt	non wt	partial	FK	
40	90	120	130	130	G	G	G	UNITING	UNITING	UNITED	non wt	partial wt	full	FK	
60	70	90	100	110	G	G	G	UNITING	UNITING	UNITED	non wt	partial wt	full		DYN&BM
40	60	100	110	130	G	G	G	UNITING	UNITING	DELAYED	non wt	partial wt	full		
50	60	70	90	100	G	G	G	UNITING	UNITED	UNITED	non wt	full	full		
60	70	100	110	110	G	G	G	UNITING	UNITED	UNITED	non wt	full	full		
60	90	100	120	130	G	G	G	UNITING	UNITED	UNITED	non wt	full	full		
50	90	130	130	130	G	G	G	UNITING	UNITING	DELAYED	non wt	partial wt	full	FK	DYN
70	80	100	110	120	G	G	G	UNITING	UNITING	DELAYED	partial	partial wt	partial		
50	60	90	100	120	G	G	G	UNITING	UNITING	DELAYED	non wt	partial wt	partial		
30	50	90	100	110	G	G	G	UNITING	UNITED	UNITED	non wt	partial wt	full		
70	90	110	120	120	G	G	G	UNITING	UNITED	UNITED	non wt	partial wt	full		
60	80	100	110	120	G	G	G	UNITING	UNITED	UNITED	non wt	partial wt	full		
60	90	100	120	120	G	G	G	UNITING	UNITED	UNITED	non wt	partial wt	full		

KEY TO MASTER CHART

1. SL NO- SERIAL NUMBER
2. IP.NO-IN PATIENT NUMBER
3. DOA-DATE OF ADMISSION
4. DOS-DATE OF SURGERY
5. DOD-DATE OF DISCHARGE
6. M -MALE
7. F -FEMALE
8. RTA-ROAD TRAFFIC ACCIDENT
9. RT -RIGHT
10. LT-LEFT
11. G-GOOD
12. FK-FLOATING KNEE
13. H-FRACTURE HUMERUS
14. IT = INTERTROCHANTERIC FRACTURE
15. DYN-DYNAMISATION
16. BM-BONE MARROW INJECTION