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Result of intramedullary nailing in segmental femur fracture

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Abstract
Introduction: Intramedullary nailing had become mainstay of treatment in complex fractures excluding joint involvement as it is less invasive procedure, chances of infection are less, patient can be early mobilised and reduces morbidity related to blood loss. This prospective case study was done in civil Hospital Ahmedabad between February 2018 to march 2020.
Aims and Objectives: To evaluate Post-operative alignment of fracture fragments, time for radiological union at fracture site and the post-operative complications in long term follow-up (1 Year).
Results: 31 patients were evaluated in this study in which femur fracture were most common in 21-30 year age group out of which 28 were ale and 3 were female, with 21 patients having close fracturea 3 having OGI and 7 Having OGII, requiring 19.5 weeks for union in closed and 20 and 21 weeks respectively in OGI and OGII, most common complication was non-union and superficial infection in 3 of the patients in each category, and proximal femur nail was used maximally in 11 patients followed by femur nail in 8 patients.
Conclusion: Interlocking nail reduces the chance of infection due to small openings for entry of nails and increases the rate of union due to its locking mechanism which leads to abundant callus formation.

Keywords: Proximal femur nail (PFN), Femur nail, Enders Nail, Distal Femur locking plate (DFLP)

Introduction
Segmental fractures of the femur are commonly encountered in routine orthopaedic practice. As femur is the longest weight bearing bone in the body with plenty of surrounding soft tissue envelope, they are usually fractured due to high- energy trauma and fracture may result in prolonged morbidity and extensive disability unless treatment is appropriate. Segmental fractures are characterized by circumferential loss of cortical contact even after the reduction. They are challenging problems to treat, because of bone defect, severe comminution at the fracture site and associated soft tissue injuries. So the aim of fracture treatment is to obtain union of the fracture, in as near anatomical position, with minimal impairment of function. The spectrum of injury is so great that no single method of treatment is relevant.
The goal should be to achieve anatomic alignment and early mobilization with functional rehabilitation of limb. Many modalities of treatment have evolved over the years for this fracture. The method studied for this study is Intramedullary nailing either antegrade nailing or retrograde nailing.
Among all different methods of internal fixation, intramedullary fixation has become popular during the last few decades.

Advantages of Intramedullary Nailing
- The nail provides internal stabilization along the axial line of forces; as nail lies in the axis of femur.
- Predictable realignment of bone.
- Prevention of excess dissection of fracture site and protection of surrounding soft tissue envelope when done biologically, resulting in abundant callus with less need for bone grafting.
- Minimal potential for contamination.
- Rapid regeneration of bone and union of fracture allows intermittent dynamic axial

compression with weight bearing, which promotes fracture consolidation.
- Less chances of stress shielding being a load sharing implant.
- Early functional use of limb.

The interlocking nail system combines the best of both i.e. not only does it offer axial and rotational stability in comminuted and unstable fractures, but also involves minimal interference with soft tissue around the bone especially when introduced in a closed manner.
Intramedullary Interlocking nailing of femur has now become the treatment of choice in almost all fractures regardless of the fracture pattern and degree of comminution.
Our ultimate goal of femoral fracture management is restoration of alignment, rotation and length, preservation of blood supply to aid union, prevention of infection and early rehabilitation of the patient.
To assess and study femoral segmental fractures with special reference to fracture anatomy, pattern and post operative stability.

Biomechanics of Intramedullary Nailing
Intramedullary nailing acts as an internal splintage and extends from one end of the bone to other through medullary canal. As a result sliding can occur between the bone and the nail. It provides only relative stability without interfragmentary compression and allows some movement at the fracture site, thus ensuring periosteal callus formation.

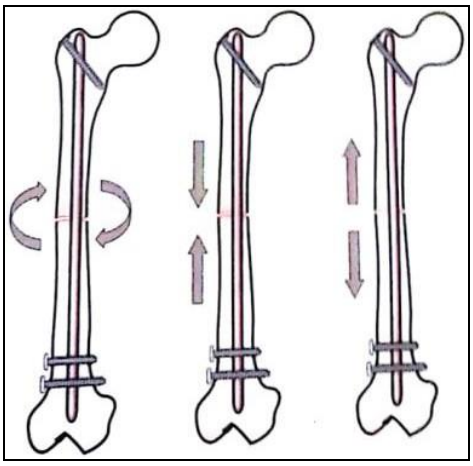

Fig 1: Biomechanics of intramedullary nailing

Nail allows axial forces to be transmitted to the apposed end of the bone fragments and prevents angulation, translation and, to some extent, rotatory movements. This is because contact exists between the nail and the bone at the entry point, along the narrow segments of the medullary canal, and at the cancellous epiphyseal bone on the opposite side.
Physiological loading on an intramedullary nail is a combination of torsion, compression and tension. Bending of the nail under loading creates compressive forces on the concave side of the nail and tension forces on the convex side. When cortical contact is achieved across the fracture site, the cortical bone puts up with the loads. When there is no cortical contact, the interlocking screws endure the loads, facedown four-point bending, and may bend or break.
The medullary vessels are disrupted when a fracture occurs, leading to necrosis of approximately 50-70% of the cortex near the fracture site. Intramedullary nailing also damages the endosteal blood supply, resulting in partial cortical necrosis. The amount of necrosis increases after endosteal reaming, caused either by direct damage to the vascularity of the endosteal surface or by intravasation of marrow elements and fat into the intracortical blood supply, which leads to vessel thrombosis.
This leads to revascularization from the periosteal vessels and eventually callus formation through secondary bone healing.

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

AO / ASIF classification - Figure: AO classification

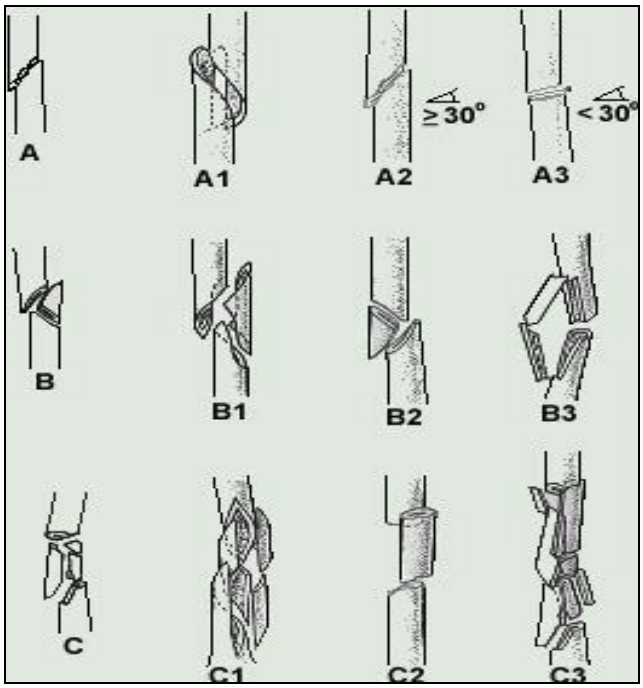

Fig 2: AO Classification of shaft Femur Fracture

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

Simple fracture
Al - Simple spiral
A2 - Simple Oblique (300 or more)
A3 - Simple transverse Wedge fractures
B1 -Spiral wedge
B2 - Bending wedge B3 - Fragmented wedge

Complex fractures
C1 –Complex Spiral
With 2 intermediate fragments
With 3 intermediate fragments
With >3 intermediate fragments

Complex segmental
C2-- fragments
With 1 intermediate segment
With 1 intermediate segment and an additional wedge fracture
With 2 intermediate segments
C3 – Complex irregular

With 2 or 3 intermediate fragments with shattering limited to <5cm length of bone.

Materials and Method

Segmental fracture femur is routinely encountered due to high velocity trauma which is often life-threatening.

For the purpose of this study, a segmental fracture was defined as a two-level long bone fracture with at least one intermediate free segment. Segmental fractures are classified by the Orthopaedic Trauma Association System, as complex fractures Type C.

Data of 31 patients collected having segmental fracture of femur and satisfying the inclusion criteria.

These cases of segmental fracture shaft femur were treated either by femur nail or proximal femoral nail (PFN) or Intramedullary Supracondylar Nail (IMSC) which is locally available and is based on AO design nail with proximal locking jig and two proximal and distal holes and two oblique proximal locking hole in case of Proximal Femur Nail.

Fracture union was taken as the absence of tenderness at the fracture site during weight bearing with callus bridging at least three cortices on two different views of the fracture radiologically. Non-union is defined as ―A fracture that, in the opinion of the treating physician, has no possibility of healing without further intervention.

Inclusion criteria

- Closed segmental femoral fracture
- Open segmental fracture Open Grade 2
- Intertrochanteric fracture and Fracture shaft femur

Exclusion criteria

- Open segmental fracture open grade 3
- Intracapsular neck femur fracture and Fracture shaft femur

Observation and Results

Table 1: Age Distribution

Age in years	No. of patients (n)	Percentage (%)
11-20	3	9.66
21-30	14	45.08
31-40	6	19.32
41-50	6	19.32
51-60	2	6.44
61 & above	0	0
Total	31	100

We found that fracture of femur is most common in 21-30 yr old age, with mean age of 32.78 years.

The result of this particular age group patients leads us to conclude that young age people are more adrenaline junky peoples and increased use of bikes and lack of bike safety gears leads to high energy segmental femur fractures.

Table 2: Distribution of Patient according to SEX

Sex	No of patients
Male	28
Female	3

Out of 31 patients 28 patients were male and 3 patients were female. Young male are prone to accident due to increased use of bikes and thrill of speed and also due to more chances of alcohol consumption in males as compared to females.

Table 3: Open or closed Fracture

Fracture	No of patients
Closed	21
Open grade I	3
Open grade II	7

Out of 31 patients 21 patients had closed fractures,3 are OGI fractures and 7 patients are OGII fractures.

High energy accidents lead to segmental femur fractures but if the energy of injury is very high leads to tearing of deep facia and open wounds and popping up of femur bone out of muscle mass.

Table 4: Average Healing Time

Type	No. of patients (n)	Average Healing Time (weeks)
Closed	21	19.5
Open Grade I	3	20
Open grade II	7	21
Total	31	

Average Healing time for closed fractures is 19.5 weeks, for OGI is 20 weeks and for OGII is 21 weeks.

Closed fracture has hematoma around the fracture site that leads to faster extramedullary callus formation as compared to open wounds which require time to get infected wound cleaned and after that fixation is to be performed, infection leads to delayed union.

Table 5: Post-operative Complication

Post-operative complication	Number of Patients
Bending of Nail	2
Superficial Infection	3
Deep Infection (Osteomyelitis)	2
Rotational Deformity	0
Valgus	1
Varus	1
Non union	3
Malunion	0

Post-operative complication of non-union and superficial infection happened in 3 patients each, Malunion, deep infection and nail bending happened in 2 patients each, varus and valgus in 1 patient each.

Most common complication is deep infection following open grade fractures which led to osteomyelitis of femur followed by non-union due to bone loss and comminution of the fracture. Nail bending is 2nd most common complication as patient started full weight bearing early as all of them are belonging to low socio-economic class and less educated and infection has led to delayed union.

Table 6: Post-Operative Shortening

Post-Operative Shortening	No. of patients (n)	Percentage (%)
< 2 cm	2	6.25
2 – 5 cm	3	9.36
>5 cm	2	6.25
Total	7	21.86

Table 7: Type of Implant used

Type of Implant	Number of Patients
DFLP Plate	1
DFLP Plate with Ender's Nail	1
Femur nail	8
IMSC Nail	2
Linear Fixator	1
PFN	11
PFN with Tension band wiring	2
PFN with CCS in Femur Neck	2
PFN with DFLP plate	2
PFN with Supracondyler femur CCS	1
Total	31

Observation and Results

- We found that fracture of femur is most common in 21-30 yr old age, with mean age of 32.78 years.
- Out of 31 patients 28 patients were male and 3 patients were female.
- Out of 31 patients 21 patients had closed fractures, 3 is OGI fractures and 7 patients are OGII fractures.
- Average Healing time for closed fractures is 19.5 weeks, for OGI is 20 weeks and for OGII is 21 weeks.
- Post-operative complication of non-union and superficial infection happened in 3 patients each, Malunion, deep infection and nail bending happened in 2 patients each, varus and valgus in 1 patient each.
- Post-operative shortening between 2-5 cm seen in 3 individuals with small bone loss in open grade 2 fractures and less than 2 cm shortening developed in patients with comminuted fracture with multifragmentory bone fracture.
- Proximal femur nail is maximally used in 11 patients followed by 8 patients in which femur nail is used.

Discussion

- Young people are more adventurous and increased use of motor vehicles and lack of safety gears leads to high energy segmental femur fractures.
- Young male is prone to accident due to increased use of motor vehicles and also due to more chances of intoxication while driving in males as compared to females.
- High energy accidents lead to segmental femur fractures but if the energy of injury is very high leads to tearing of deep facia and open wounds and popping up of femur bone out of muscle mass.
- Closed fracture has hematoma around the fracture site that leads to faster extramedullary callus formation as compared to open wounds which require time to get infected wound cleaned and after that fixation is to be performed, infection leads to delayed union and also increases the time for definitive fracture fixation.
- Most common complication is deep infection following open grade fractures which led to osteomyelitis of femur followed by non-union due to bone loss and comminution of the fracture. Nail bending is 2nd most common complication as patient started full weight bearing early as all of them are belonging to low socio-economic class and less educated and delayed union causes nail bending.

Conclusion

Young male patient in the age group of 21-30 years is more prone to injury due to high amount of road traffic accidents which is mainly fixed by intramedullary nails either proximal femur nail or femur nail mostly which leads to abundant callus formation and reduced chances of infection due to little opening for insertion of nail, most common complication of non-union occurs in fracture with gap between two of the fragments of bone. Other common complication of infection is due to open fracture in many of the cases.

Intramedullary nailing reduces the chances of infection, malunion and non-union as compared to other techniques like non locking nails and conservative fracture management.

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