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Analysis of Nonunion in Intramedullary Interlocking Nailing in Fracture Shaft of Femur

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Abstract: ***Introduction*: The femur is essential for the lower extremities to support weight. 10 to 37 femur shaft fractures occur for every 100,000 patients. Femur shaft fractures frequently result from car accidents and falls from heights. The most common option for treating a femur shaft fracture is intramedullary nailing (IMN). *Aim of Study*: This study aim to analyse the fracture non-union in intramedullary interlocking nailing for fracture shaft of femur. *Material and Methods*: Prospective clinical studies were carried out in the orthopaedics department of NMCH Patna. Patients with fractured femur shafts were admitted from OPD and EMERGENCY between January 2021 and December 2022. Following routine investigation and emergency management, the femur's interlocking nail was done. Clinical examinations and radiological investigations are performed on patients at regular intervals of 3 weeks, 6 weeks, 12 weeks, 6 months, 9 months, and 12 months. The incidence and management of nonunion were evaluated. The study provides valuable insights into the treatment outcomes of intramedullary interlocking nailing for femur shaft fractures.***

Keywords: Fracture Shaft of Femur, Intramedullary Interlocking Nailing, Non-Union

Results

Based on functional outcome.

Scoring System for the result of treatment (Thoeresen B.O.Et.Al.)

		RESULTS		
	Excellent	Good	Fair	Poor
MALALIGNMENT OF FEMUR				
Varus/Valgus	5^0	5^0	10^0	$>10^0$
Antecurvatum/ Recurvatum	5^0	10^0	15^0	$>15^0$
Internal rotation	5^0	10^0	15^0	$>15^0$
External rotation	10^0	15^0	20^0	$>20^0$
Shortening of femur in cm	1	2	3	>3
RANGE OF MOTION OF KNEE				
Flexion	120^0	120^0	90^0-120^0	$<90^0$
Extension deficit	5^0	10^0	15^0	$>15^0$
Pain or swelling	None	Sporadic	Significant	Severe

1. Introduction

Femoral shaft fractures are a common orthopedic injury occurring in high energy trauma or low energy trauma in the elderly. The incidence of femur shaft fractures is 10 to 37 per 1 lakh patients annually, with a peak in young men at age 27 years and in older women at age 80 years.

Intramedullary nailing (IMN) is the first choice for managing femur shaft fracture with low complication rates (4.9%) and an excellent option for aseptic non-unions of noncomminuted femoral shaft fractures with union rates reported to range from 72% to 100%.

Complications related to fracture shaft of femur fractures are one of the leading causes of death and disability in patients who have experienced severe trauma.

Causes of morbidity include on-going pain, altered gait, non-union, and their complications, limb shortening, malalignment leads to delayed return to work and psychosocial impairment. Fat embolisms, acute respiratory distress syndrome, and subsequent multi-organ failure are rare but potentially fatal complications for polytrauma patients. Early reduction and internal fixation of the fracture decrease complications and improve survival. The goal of therapy is to achieve a good union at the fracture site, which will allow for the restoration of alignment, rotation, and length, the preservation of blood supply to aid union, and the early rehabilitation of the patient. A variety of factors, including the type and location of the fracture, level of comminution, the patient's age, the patient's socioeconomic status, and the patient's ability to pay for care, might affect the course of therapy. When femoral non-unions do occur, the treatment options can be time consuming, challenging, and expensive from the patient's perspective. Therefore, it is critical to understand fracture union in middle-aged patients because this will lead to positive clinical outcomes and early back to work. Therefore, the focus of our research is on the factors—such as age, open versus close interlocking nailing, time between accident and operation, fracture type, etc.—that contribute to a femoral shaft fracture not healing properly.

Treatment options for femoral shaft fractures include:

1) **Conservative**- traction, pop cast etc
2) **Operative –**
   a) Intramedullary-K-Nailing, Enders Nailing, intramedullary interlocking nailing etc.
   b) Extramedullary-Plating, External fixator, Illizarov ring fixator, LRS Fixator etc.

2. Materials and Methods

Place of work
Department of Orthopedic, Nalanda Medical College and Hospital Patna.

Study design
Prospective clinical observational study

Study period
Jan 2021 to Dec 2022

Plans of work and methodology
Patients was selected from those who attend emergency And outpatient Department

Inclusion Criteria
1) 18 years to 50 years of age
2) All closed femoral shaft fracture distal to lesser trochanter and up to distal 1\5th femoral shaft
3) Gustilo Anderson grade I and II open fracture

Exclusion Criteria
1) Age less than 18 years and more than 50 years
2) Gustilo Anderson grade III open fracture
3) Pregnant women

2.1 Methods

Pre-Operative Management:
A hypovolemic shock state may exist in a patient with a femoral shaft fracture, necessitating blood transfusion and fluid replacement. Because of the possibility of secondary injuries, it may be necessary to involve professionals from other fields. Skeletal traction, in the form of upper tibial pin traction on a Bohler - Braun splint with a weight of 10% of patient body weight, is applied once the patient has been stabilised. To prevent soft tissue contraction and preserve limb length, this traction lessens the need for intra-operative stripping of fragments to diminish the fracture.

Implant Selection
The nail's length was measured on the normal side from the greater trochanter to the patella's superior pole. X-rays measured nail diameter at the isthmic level.

Instruments
Regardless of which type of nail is used, a full set of nail length and sizes must be available for surgery

- **Anaesthesia:** Epidural or spinal anaesthesia.
- **Position:** Patient is positioned supine on fracture table with perineal post and suitable sand bags and pillows.
- **Entry Point:** By 5cms gluteal incisions starting from 3cm proximal to tip of the greater trochanter.

Reaming and Fracture Reduction
Serial reaming with stiff or flexible reamers to desired nail size and crossing the isthmus. Trial reduction and guide wire antegrade into proximal and distal fragments. Nail length is estimated, and the mechanical targeting system aligns nail holes.

Nail Insertion
Nail is inserted in ante-grade manner over the guide wire by gentle taping.

Bone Grafting:
Autologous cancellous bone graft is harvested from iliac crest is packed around the fracture site in winquest type III and IV comminuted fracture.

Post-Operative:
Parentral antibiotics were given for 3days, then converted into oral antibiotics for 7days. Suture removal done in 12-14 days.

Mobilisation:
Quadriceps and hamstring strengthening should start immediately. These workouts maintain muscle tone, strength, micro movement at fracture site, local vascularity, callus, and union.

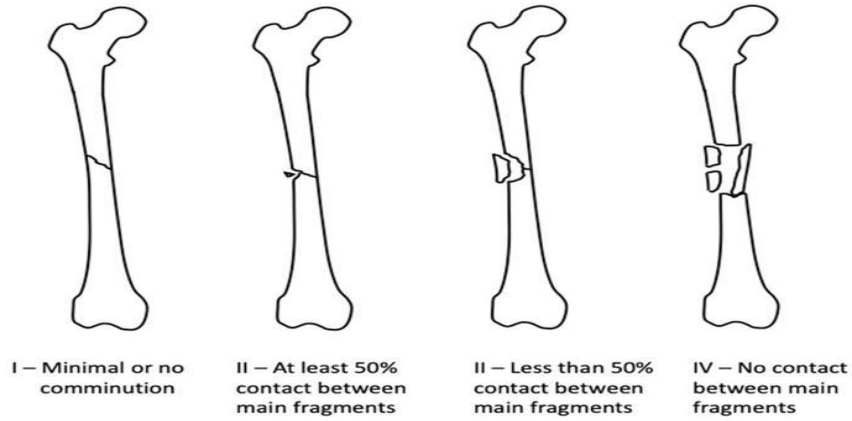
Knee mobilisation began three days following drain removal. After two weeks, non-weight bearing mobilisation began. Simple transverse fracture patients could bear weight after 3 weeks and full weight after 6 weeks. After bridging callus, segmental and comminuted fracture patients could bear partial weight after 6 weeks and full weight after 12 weeks without support.

Data Collection

Collection of Data of patients presenting with fracture shaft of femur are as follows
1) History: To know the cause, MOI, Velocity of injury etc
2) Clinical examination: To know site of fracture, open or close fracture, need of others speciality. Etc
3) Radiological Examination: To know Topographical and pattern of fracture.

Classification

Winquist and Hansen Classification of Fracture Comminution.



Winquist and Hansen Classification:

- Type 1: There is only a tiny cortical fragment.
- Type 2: The "butterfly fragment" is larger but there is still atleast 50% cortical contact between main fragments
- Type 3: The "butterfly fragment" involves more than 50% of bone width.
- Type 4: It is essentially a segmental fracture."

4) Routine investigation: - Routine Blood examination and other as per hospital protocol.
5) Diagnosis- Clinical and Radiological
6) Surgery: - Intramedullary interlocking nailing for fracture shaft of femur
7) Routine antibiotics and Analgesics
8) Post-operative evaluation
9) Assessment of complication
10) Rehabilitation
11) Follow-Up: - At 3WKS, 6WKS, 3 months,6 months, 12 month

3. Results

Table 1: Age wise distribution of studied subjects

Age	Frequency	Percent
<25	4	10
25-34	9	22.5
35-44	15	37.5
45-50	12	30
Total	40	100.0

The commonest age of presentation is between 35 and 44 years. Mean age of studied subjects was 37.65years (±8.81).

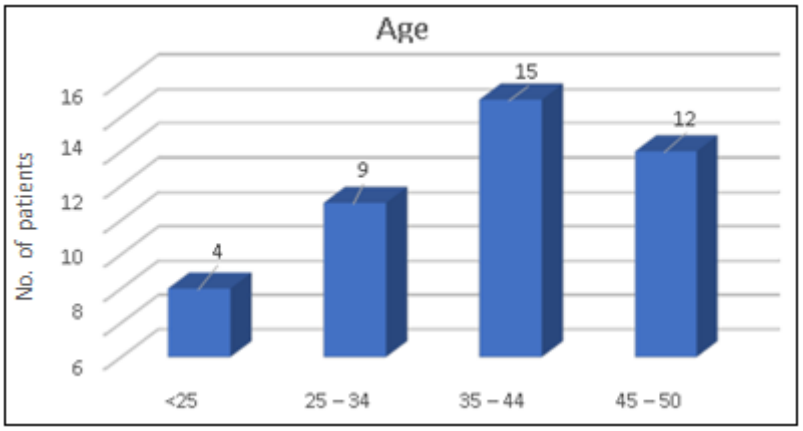


Figure 1: Age wise distribution of studied subjects

Table 2: Gender wise distribution

Sex	Frequency	Percent
Male	30	75
Female	10	25
Total	40	100

Majority of patients were male (75%) and 25% were female.

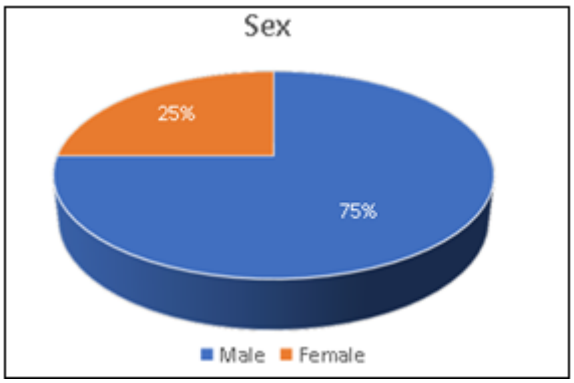


Figure 2: Gender wise distribution

Table 3: Mode of injury (MOI)

MOI	Frequency	Percent
Fall from height	2	5
Road traffic accidents	38	95
Total	40	100.0

In present study, 95% of patient had injury due to road traffic accidents and only 5% of patient had injury due to fall from height.

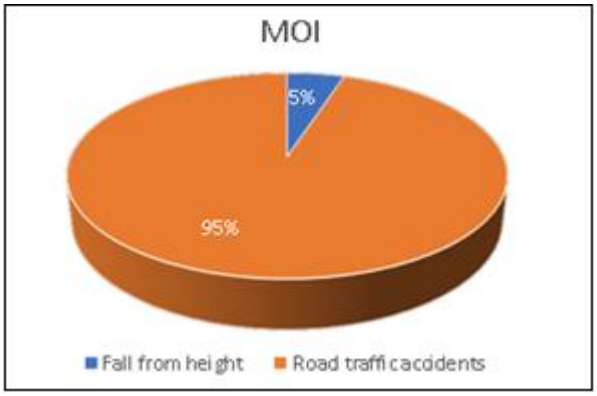


Figure 3: Mode of injury (MOI)

Table 4: Winquest Hansen-Diaphyseal comminution

Type	Frequency	Percent
I	22	55
II	16	40
III	1	2.5
IV	1	2.5
Total	40	100.0

Frequency of Type I, Type II, Type III and Type IV were 22 (55%), 16 (40%), 1 (2.5%) and 1 (2.5%) respectively.

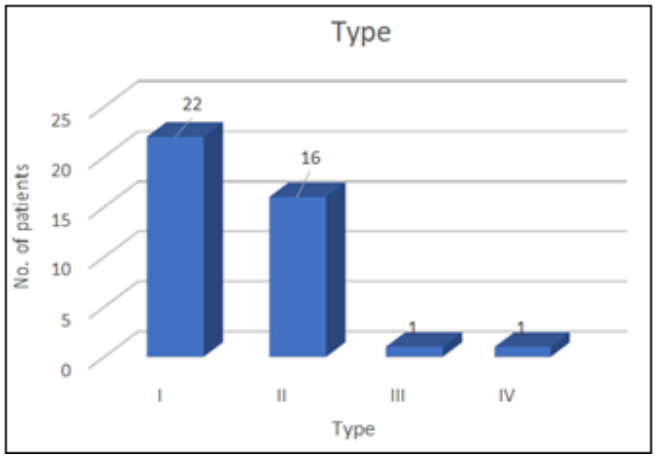


Figure 4: Winquest Hansen-Diaphyseal comminution

Table 5: Type of injury

	Frequency	Percent
Close	38	95
Open	2	5
Total	40	100.0

Out of 40 patients 38 (95%) patients had close type of injury.

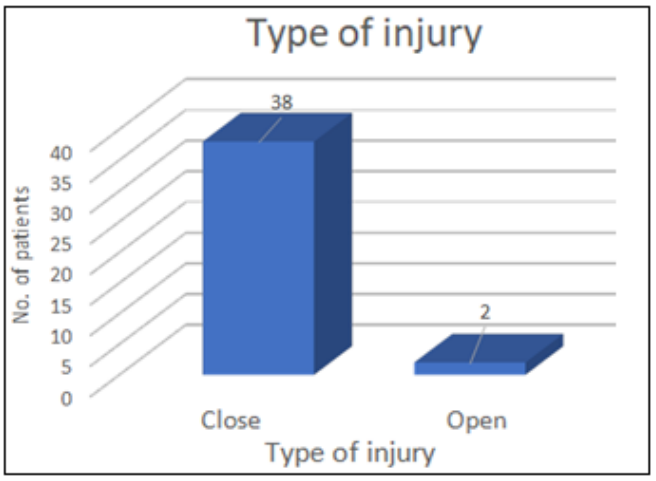


Figure 5: Type of injury

Table 6: Method of reduction

	Frequency	Percent
Open	15	37.5
Close	25	62.5
Total	40	100.0

Out of 40 patients 25 (62.5%) patients had close reduction.

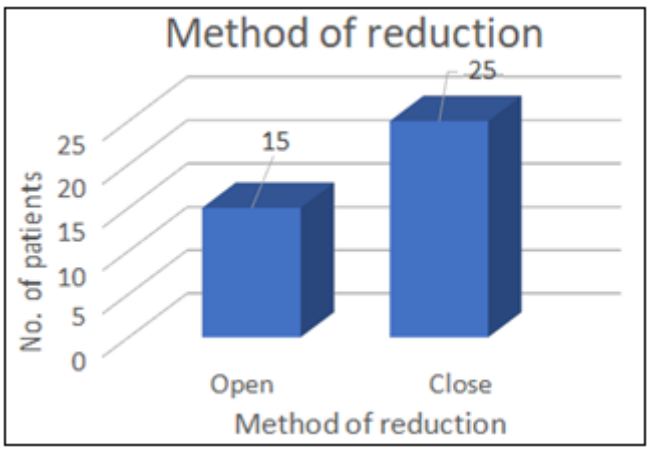


Figure 6: Method of reduction

Table 7: Duration between injury and surgery (DBIS): Days

	Minimum	Maximum	Mean	SD
DBIS	6.0	24	13.5	5.31

Mean duration between injury and surgery was 13.5 Days.

Table 8: Medullary reaming

	Frequency	Percent
Reamed	38	95
Unreamed	2	5
Total	40	100.0

Medullary reaming was found in 38 (95%) patients.

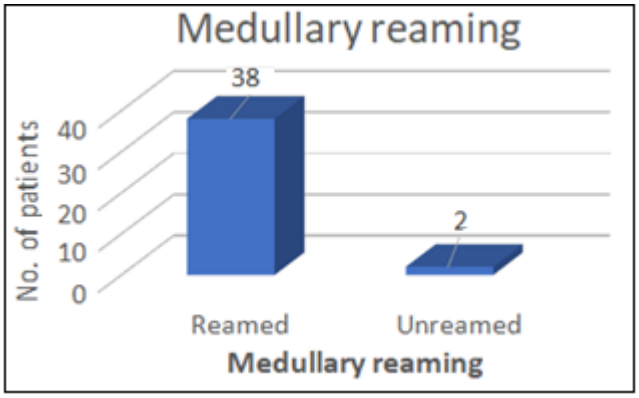


Figure 7: Medullary reaming

Table 9: Bone grafting procedure

	Frequency	Percent
Yes	5	12.5
No	35	87.5
Total	40	100.0

Among 40 patients, 5 patients had Bone grafting procedure (12.5%).

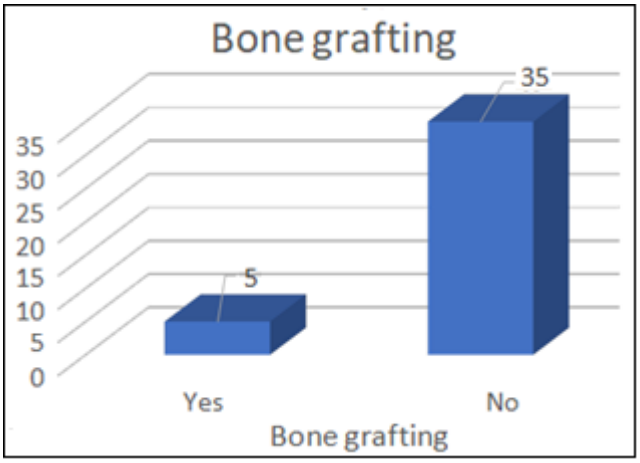


Figure 8: Bone grafting procedure

Table 10: Dynamization

	Frequency	Percent
Yes	6	15
No	34	85
Total	40	100.0

Out of 40 patients, 6 patients had dynamization (15%).

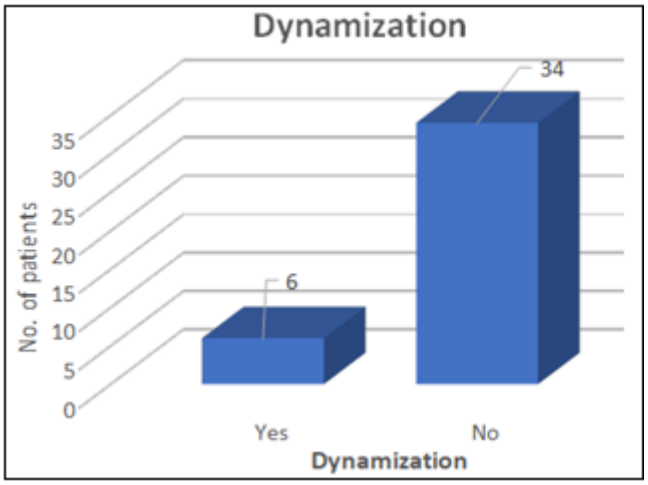


Figure 9: Dynamization

Table 11: Gender wise Average Union time

Gender	Average Union Time (WKS)
Male	24.6
Female	25.3

Average union time in male was 24.6 weeks and in female was 25.3weeks.

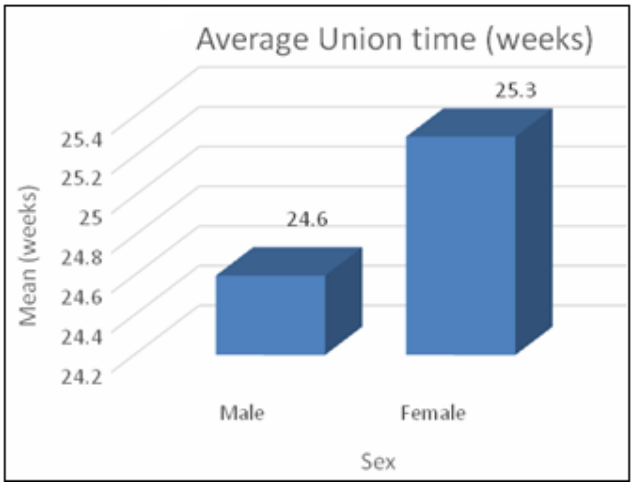


Figure 10: Gender wise Average Union time

Table 12: Average Union time and Nailing

Nailing	Average Union time(weeks)
Open	26.42
Close	23.73

Average union time in open was 26.42 weeks and in close was 23.73 weeks.

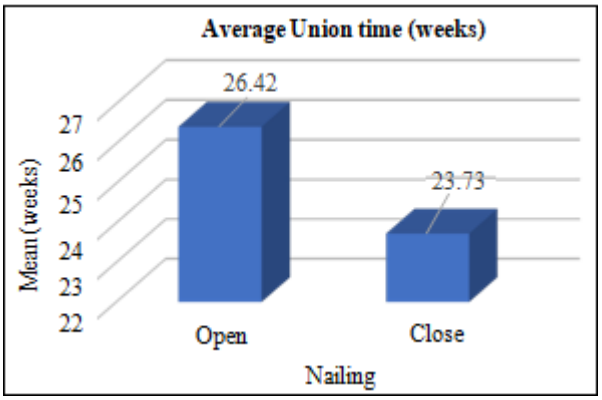


Figure 11: Average Union time and Nailing

Table 13: Average Union time and age groups

Age group (YR)	Average Union time (weeks)
<25	23
25 – 50	25

Average union time in age group below 25 years was 23 weeks and in age group between 25 to 50 years was 25 weeks.

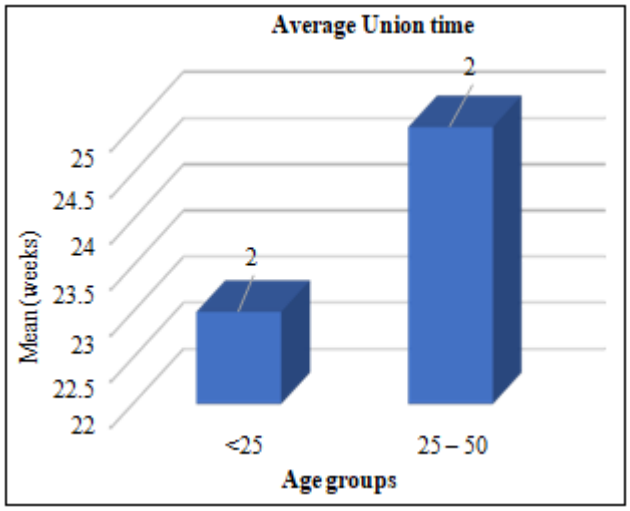


Figure 12: Average Union time and age groups

Table 14: Average Union time (weeks) and type of fracture

Type of fracture	Average Union time (weeks)
I	24.9
II	23.7
III	30.0
IV	34.0
Total	24.8

Average union time in type I was 24.9 weeks, type II was 23.7 weeks, type III was 30 weeks and in type IV was 34 weeks.

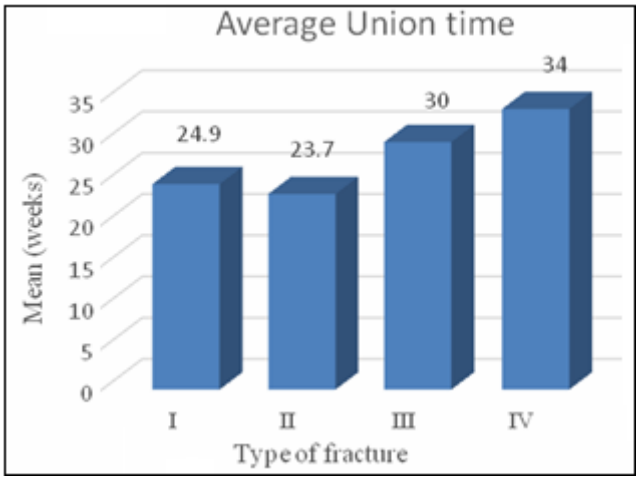


Figure 13: Average Union time (weeks) and type of fracture

Table 15: Outcome

Outcome	Frequency	Percent
Excellent	31	77.5
Good	7	17.5
Fair	2	5.0
Total	40	100.0

Out of 40 patients,31 (77.5%) patients had excellent outcome, 7 (17.5%) patients had good outcome and whereas 2 (5%) patients showed fair outcome.

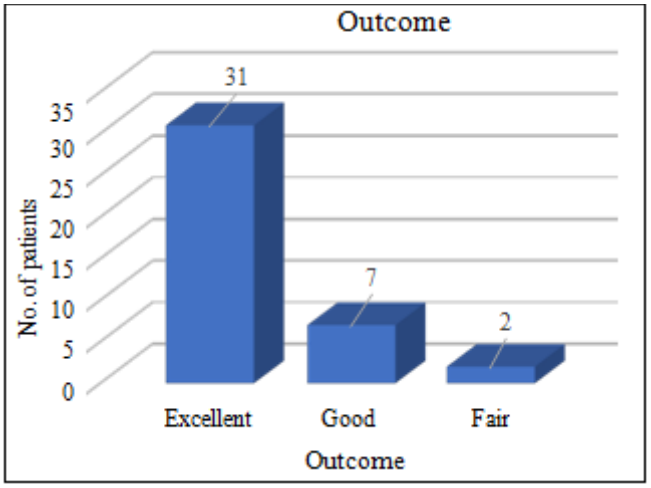


Figure 14: Outcome

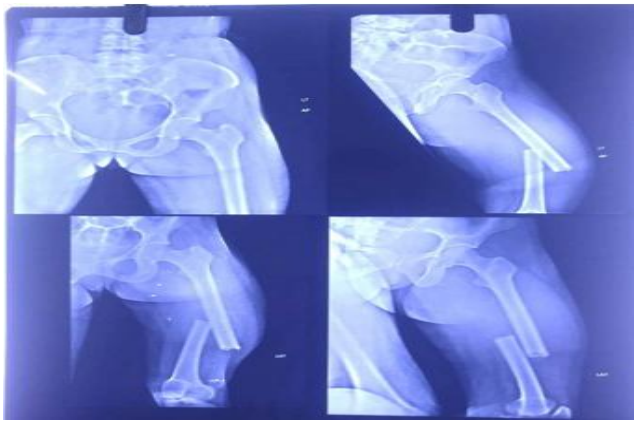
Case I

Pre- OP

IMM. POST-OP

AT 1YR FOLLOW-UP

Case II



PRE-OP

IMM. POST-OP

4. Discussion

"In the domain of adult femoral shaft fracture treatment, intramedullary interlocking nailing has been proven as an effective method. Winquest R.A. and Clawson DK[1] demonstrated in their study that intramedullary interlocking nails serve as load-sharing implants, providing substantial torsional rigidity and rotational stability."

"A separate study conducted by Robert et al.[2, 3] revealed that femoral shaft fractures treated with un-reamed nailing exhibited slightly higher rates of delayed union and non-union compared to those treated with reamed nails. Therefore, reamed interlocking nails remain the preferred treatment option for adult femoral shaft fractures. As the femoral shaft benefits from a rich periosteal blood supply, reaming does not impede the healing of fractures. In our study, we routinely perform reamed interlocking nailing except in cases of two open fractures."

"Brumback et al.[4] reported a 92% union rate with an average union time of 4.8 months in a series of 100 closed interlocking nailing cases. In our series, the union rate was above 90% with an average union time of 25 weeks (5.75 months)."

"In a study conducted by Pati and Bansal et al.[5] involving 90 patients with open interlocking nailing, an 85.87% union rate was reported with an average union time of 5.7 months. In our study, the union rate for open interlocking nailing was 85% with an average union time of 6.1 months. The poorer results in open interlocking nailing can be attributed to the disturbance of fracture hematoma and periosteal stripping. The mean duration between injury and surgery in our study was 14 days due to delays in patient reporting to the hospital after initial treatment, unavailability of operating time, and

associated comorbid illnesses. This delay resulted in postponement and difficulty in closed reduction, ultimately leading to open interlocking nailing."

"Covey, Claiborne A., and Christian[6, 7] reported an average union time of 3.97 months in the age group below 25, 4.67 months in the age group between 25 and 50, and 6.87 months in the age group above 50. In our study, the average union time in age group below 25 years was 5.2 months (23 weeks) and in age group between 25 to 50 years was 5.75 months (25 weeks)."

"Kettek[10] and Mattz W[11] reported an average union time of 3.72 months for Type I fractures, 4.03 months for Type II fractures, 5.68 months for Type III fractures, and 6.2 months for Type IV fractures. In our study, the average union time in Type I was 5.7 months (24.9 weeks), Type II was 5.4 months (23.7 weeks), Type III was 6.9 months (30 weeks) and in Type IV was 7.8 months (34 weeks)."

"Donald A. Wiss and William W. Brien[8] concluded in their series that closed interlocking nailing is the treatment of choice for most segmental femoral fractures. Rinaldi et al. 1989 and Braten et al[9]. 1990 concluded in their study that further open reduction in segmental femoral fractures leads to substantial soft tissue injury and decreases the union rate."

"Gross et al[12] recommended dynamization in the 3rd to 5th postoperative month if no radiological evidence of union was present. In our study, four patients with a fracture gap underwent dynamization at 16 to 20 weeks. Union was achieved after an additional 3 to 5 months (ranging from 3 to 6 months)."

"Pagie.A. and Whittle[13] concluded in their series that bone grafting was necessary for Winquest type III and type IV femoral shaft fractures to enhance union. This finding justifies the utilization of autologous bone grafting in our series for Winquest type III and type IV fractures (13.3%)."

"Brumback et al[14] in their series advocated immediate weight bearing to allow for micro movements at the fracture site, which promotes union. In our study, partial weight bearing was initiated at the end of the 3rd week and full weight bearing was allowed at the end of the 6th week for all stable fractures. For comminuted fractures and segmental fractures, partial and full weight bearing were permitted at 6 weeks and 12 weeks, respectively."

5. Result

- In present study, 90% of patients were in age group of 25 to 50 years
- Mean age of incidence was 37.65 years
- 75% of patients were male and 25% were female.
- Frequency of Type I, Type II, Type III and Type IV were 22 (55%), 16 (40%), 1 (2.5%) and 1 (2.5%) respectively.
- 95% of patient had closed injury
- 62.5% of cases had been operated by close method of reduction
- Among 40 patients, 5 patients had Bone grafting procedure (12.5%).
- Out of 40 patients, 6 patients had dynamization (15%).
- Average union time in male was 24.6 weeks and in female was 25.3 weeks.
- Average union time in open was 26.42 weeks and in close was 23.73 weeks.
- Average union time in age group below 25 years was 23 weeks and in age group between 25 to 50 years was 25 weeks.
- Average union time in type I was 24.9 weeks, type II was 23.7 weeks, type III was 30 weeks and in type IV was 34 weeks.
- In present study, 77.5% patients had excellent outcome, 17.5%patients had good outcome and where as 5% patients showed fair outcome.

6. Concussion

In conclusion, this study provides valuable insights into the management of fracture nonunion using intramedullary interlocking nailing for femur shaft fractures. The results demonstrate the efficacy of this treatment approach in promoting fracture healing and achieving positive patient outcomes. Early diagnosis, appropriate surgical intervention, and diligent follow-up contribute to successful fracture union. Further research is warranted to explore additional factors that may influence the occurrence of nonunion and identify strategies to minimize its occurrence and optimize treatment outcomes.

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