International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Functional Outcome of Treatment of Distal Femoral Fracture by Retrograde Intramedullary Nailing - IMSC Nail

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Abstract: ***Introduction: Retrograde intramedullary nailing has been described by several researchers as a reliable, minimally invasive, and reproducible method for managing type A distal femoral fractures. In this study, we assessed the clinical, radiological, and functional outcomes of 30 patients who underwent retrograde nailing, with an average follow-up duration of 18 months. While open reduction and internal fixation with plating remains a commonly used method, retrograde nailing has also demonstrated favorable results. Materials and Methods: A total of 30 patients with distal femoral fractures treated between March 2023 and November 2024 were included in this study. All patients underwent closed reduction followed by retrograde intramedullary nailing. Data collected included laterality of the fracture, gender distribution, duration of surgery, time to fracture union, and postoperative complications. Results: Among the 30 patients, 21 were male and 9 were female, with an average age of 34.3 years (ranging from 18 to 85 years). Twelve of the cases (60%) involved the dominant limb. The average surgical time was 88.98 minutes (range: 50-150 minutes). Radiological union was achieved on average in 14.3 weeks (range: 10-16 weeks), while clinical union occurred at around 10.4 weeks. Conclusion: This study supports retrograde intramedullary nailing as an effective method for treating type A distal femoral fractures. It offers high union rates and excellent functional outcomes. When performed by experienced surgeons, it is a safe, efficient, and cosmetically favorable surgical option compared to traditional plating techniques.***

Keywords: distal femur fracture, retrograde nailing, fracture healing, functional recovery, intramedullary fixation

1. Introduction

The **distal femur** is particularly susceptible to injury due to modern lifestyles and high-speed modes of transportation.

In younger individuals, distal femoral fractures often result from high-energy trauma, such as road traffic collisions or falls from significant heights, and are frequently part of polytrauma cases.

Despite advancements in surgical techniques and the development of improved implants, **the management of distal femoral fractures remains complex and challenging** in many scenarios.

Anatomically, the distal femur comprises the lower 15 cm of the femur, including the **distal metaphysis (supracondylar region)** and the **intra-articular condylar area**.

The supracondylar region is located between the femoral condyles and the junction where the metaphysis meets the shaft. It typically includes the distal 9 cm of the femur, measured from the articular surface.

Accurate classification of these fractures is essential, as **supracondylar fractures differ significantly from distal diaphyseal fractures** in terms of treatment approach and prognosis.

Distal femoral fractures account for approximately **7% of all femoral fractures**, with a higher prevalence in younger patients following **high-velocity trauma** [1].

In recent years, both implant design and surgical methods have seen considerable improvements.

The **concept of intramedullary nailing**, originally introduced by Küntscher, has undergone various modifications and has now become a widely accepted treatment for distal femoral fractures.

Intramedullary interlocking nails offer several benefits over traditional plating methods, including more "biological" fixation, reduced need for bone grafting, and

preservation of soft tissue due to their load-sharing properties.

The preferred point of entry for retrograde nailing—through the **intercondylar notch**—is relatively easy to access. However, potential complications such as **intra-articular infection**, **synovial metallosis**, and **patellofemoral arthritis** should be considered. Successful management of these fractures relies on **accurate anatomical reduction, stable fixation, early knee mobilization, and timely functional rehabilitation**, all of which can be effectively facilitated by intramedullary interlocking nailing.

2. Materials and Methods

This study was conducted in the Department of Orthopaedics at **Simmer Medical College and Hospital, Surat**, between **February 2023 and October 2024**. During this period, **37 patients** presenting with distal femoral fractures were initially identified. Of these, **32 patients** met the inclusion and exclusion criteria and were enrolled in the study. However, **2 patients were lost to follow-up** before completing the minimum required follow-up period of six months, resulting in a final study cohort of **30 patients**.

Inclusion Criteria:
Patients with Extra-articular distal femoral fractures in the supracondylar region.

Exclusion Criteria:
Patients managed conservatively.
Associated with vascular injury that requires amputation.
Fractures with epiphyseal plate open.
Pathological fractures.
Patients lost in follow up

SUPINE POSITION AND DRAPING

SR NO	Age	Sex	Side of Injury	MOI	Operative Time (in min)	Radiological Union (IN WEEKS)	Knee Flexion (In Degree)	NEER RATING (O-100POINTS0
1	25	M	Lt	RTA	125	17	195	68
2	25	F	Rt	RTA	88	12	90	97
3	25	M	Rt	RTA	89	15	120	90
4	25	M	Rt	RTA	120	14	115	68
5	26	M	Rt	RTA	89	21	80	93
6	28	M	Rt	RTA	88	16	120	68
7	29	M	Rt	RTA	89	20	95	100
8	29	F	Lt	FFH	87	14	120	94
9	30	M	Rt	RTA	89	17	120	84
10	31	F	Rt	RTA	95	18	110	99
11	32	M	Rt	RTA	80	14	120	82
12	34	M	Rt	RTA	90	14	95	90
13	35	M	Rt	RTA	88	14	120	60
14	36	M	Lt	FFH	120	16	80	92
15	36	M	Lt	RTA	85	14	115	90
16	36	M	Rt	RTA	89	16	110	60
17	36	F	Lt	FFH	99	14	110	92
18	38	M	Rt	RTA	95	15	120	90
19	40	F	Rt	RTA	87	14	115	98
20	42	F	Lt	FFH	100	15	120	100
21	45	M	Rt	FFH	85	14	100	96
22	45	M	Lt	RTA	88	14	115	92
23	49	M	Rt	RTA	89	16	95	80
24	53	F	Rt	FFH	130	24	85	92
25	54	M	Lt	FFH	110	18	95	64
26	57	M	Lt	FFH	101	16	110	68
27	66	F	Rt	RTA	89	15	110	66
28	69	M	Lt	FFH	94	16	110	90
29	72	F	Rt	RTA	98	16	105	82
30	75	M	Lt	FFH	98	17	95	80

Case 1

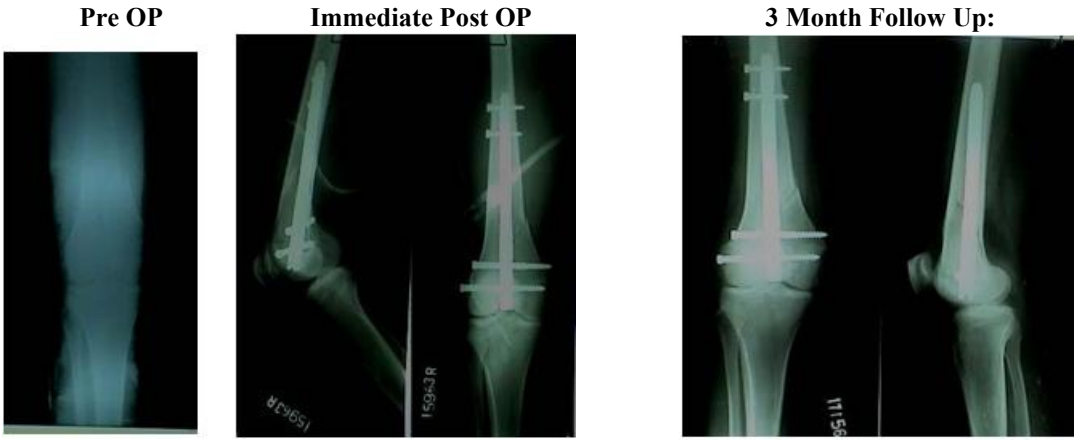

Figure 1

Case 2

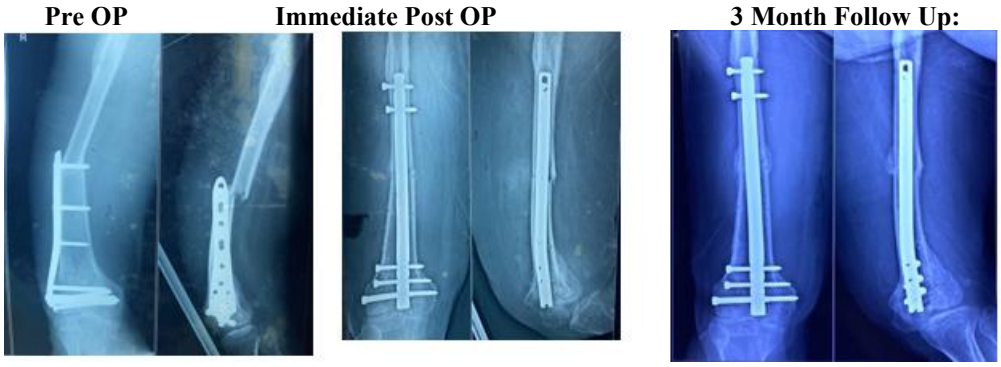

Figure 2

Surgical Technique

Patients were positioned in the **supine position** with the **affected leg placed in 45° flexion**.

Spinal anaesthesia administered in all patients.

A **3-4 cm incision** was made in the ligamentum patellae, approximately **1 cm inferior to the inferior pole of patella**.

Entry taken with awl and guide wire passed under fluoroscopy guidance.

Sequential intra medullary reaming done with reduction held manually.

Appropriate size nail attached with jig and implantation done.

Proximal and distal locking with 4.9 mm cortical screw done through jig.

Fracture alignment and Proper reduction was confirmed before final fixation.

Patellar tendon and skin closure done.

1) Association of functional outcome using Knee Society Score with Sex Distribution

Sex Distribution	Excellent	Good	Fair	Poor	Total
Male	10	5	6	0	21
	47.62%	23.81%	28.57%	0%	100%
Female	5	3	1	0	9
	55.56%	33.33%	11.11%	0%	100%
Total	15	8	7	0	30
	50%	26.67%	23.33%	0%	100%

F-Statistical Value- 1.06773
P- Value- 0.3103

2) Association of functional outcome using Knee Society Score with Mode of Injury

Mode of Injury	Excellent	Good	Fair	Poor	Total
Road Traffic Accidents	10	4	6	0	20
	50%	20%	30%	0%	100%
Fall From Height	5	4	1	0	10
	50%	40%	10%	0%	100%
Total	15	8	7	0	30
	50%	26.67%	23.33%	0%	100%

3) Association of functional outcome using Knee Society Score with open or closed injury

Mode of Injury	Excellent	Good	Fair	Poor	Total
Closed Fracture	10	5	4	0	19
	52.63%	26.32%	21.05%	0%	100%
Open Fracture	5	3	3	0	11
	45.46%	27.27%	27.27%	0%	100%
Total	15	8	7	0	30
	50%	26.67%	23.33%	0%	100%

4) Association of functional outcome using Knee Society Score with type of fracture:

Type of Fracture	Excellent	Good	Fair	Poor	Total
A1	6	4	3	0	13
	46.15%	30.77%	23.08%	0%	100%
A2	8	4	3	0	15
	53.33%	26.67%	20%	0%	100%
A3	1	0	1	0	2
	50%	0	50%	0%	100%
Total	15	8	7	0	30
	50%	26.67%	23.33%	0%	100%

5) Association of functional outcome using Knee Society Score with time taken for union

Time for Union	Excellent	Good	Fair	Poor	Total
<16 Weeks	11	3	0	0	14
	78.57%	21.43	0	0%	100%
16-18 Weeks	4	4	2	0	10
	40%	40%	20%	0%	100%
18-20 Weeks	0	1	1	0	2
	0%	50%	50%	0%	100%
20-22 Weeks	0	0	2	0	2
	0%	0%	100%	0%	100%
22-24 Weeks	0	0	2	0	2
	0	0	100%	0	100%
Total	15	8	7	0	30
	76.66%	16.66%	6.6%	0%	100%

6) Association of functional outcome using Knee Society Score with Injury Surgery Interval

Injury Surgery Interval	Excellent	Good	Fair	Poor	Total
1 to 15 Days	14	4	7	0	25
	56%	16%	28%	0%	100%
>15 Days	1	4	0	0	5
	20%	80%	0%	0%	100%
Total	15	8	7	0	30
	50%	26.67%	23.33%	0%	100%

3. Conclusion

Retrograde intramedullary nailing offers a stable method of fixation for distal femoral fractures, facilitating early mobilization and yielding favorable functional outcomes. It is considered a dependable and effective surgical approach, especially for complex or comminuted fracture patterns. Follow-up observations have shown high union rates and a low incidence of complications, supporting its use as a preferred treatment modality in appropriate cases.

4. Results

Out of the thirty patients who completed a minimum follow-up period of **32 months**, there were **15 males and 15 females**, with a **mean age of 44.7 years** (ranging from 20 to 63 years). A total of **20 patients (66%)** sustained fractures on the **dominant side**. The **average surgical duration** was **84.03 minutes** (range: 50–155 minutes), and the **mean time to radiological union** was **13.7 weeks** (range: 10–16 weeks).

Shoulder function, evaluated using the **UCLA scoring system**, was rated **excellent to good in 23 patients (100%)**. The **most common mechanism of injury** was **road traffic accidents (RTAs)**, accounting for **all 30 cases**. The **average follow-up period** was **32 months**, with a range of 18 to 38 months. **Fracture healing** was confirmed on average at **13.7 weeks**, consistent across the cohort.

5. Discussion

1) Age Distribution

The age profile in our study aligns with findings from previous research by **Mosheiff et al.**, **Patterson et al.**, **Gellman et al.**, and **Henry et al.**

- In our series, the **average age** was **40.77 years** (range: 25–75 years).
- **Mosheiff et al.** reported a mean age of **55 years** (range: 21–101 years).
- **Henry et al.** documented an average of **48.6 years** (range: 16–101 years).
- **Patterson et al.** found a mean age of **40 years** (range: 21–63 years).

These findings suggest that distal femoral fractures are common across a wide age spectrum but tend to affect middle-aged adults prominently.

2) Sex Distribution

Our gender distribution data are consistent with studies conducted by **Patterson et al.**, **Mosheiff et al.**, **Gellman et al.**, and **Henry et al.**

- In our study, **70% of patients were male** and **30% were female**.
- Similarly, **Patterson**, **Mosheiff**, and **Henry** observed a male predominance.
- In contrast, **Gellman et al.** reported a **female predominance (58%)** compared to **42% males**.

This variation may reflect demographic differences or the differing causes of injury across study populations.

3) Type of Fracture (Open vs. Closed)

Our observations regarding fracture type are in line with studies by **Patterson et al.**, **Gellman et al.**, and **Winquist et al.**

- In our study, **63.33%** of cases were **closed fractures**, while **36.67%** were **open fractures**.
- **Winquist et al.** reported **83% closed** and **17% open** fractures.
- However, both **Patterson et al.** and **Gellman et al.** found a **higher incidence of open fractures**.

This indicates variability in fracture exposure, possibly influenced by the severity of trauma or regional differences in injury mechanisms.

4) Fracture Classification

Comparison with studies by **Brijlal et al.** and **Gellman et al.** reveals differences in fracture pattern distribution:

a) In our series:

- **Type A1**: 43.33%
- **Type A2**: 50%
- **Type A3**: 6.67%
- **Types C1, C2, C3**: 0%

b) **Brijlal et al.** reported:
- Type A2: 23%, Type A3: 67%, Type C2: 5%, Type C3: 5%

c) Gellman et al. noted:
- Type A1: 12.5%, Type A2: 12.5%, Type A3: 20%,
- Type C1: 16%, Type C2: 12.5%, Type C3: 25%

Our series shows a predominance of **extra-articular fractures (Type A1 and A2)** with **no intra-articular involvement**, in contrast to Gellman's broader distribution.

5) Range of Knee Motion

The **mean range of knee flexion** achieved in our study was **106.3°**, with most patients falling within the **80°–120°** range. This is **comparable to the findings of Henry et al.**, suggesting effective functional recovery following treatment.

6. Complications

Complications: Comparative Analysis

Our findings show a relatively low complication rate compared to previous studies:
- **Moed et al.** reported a **non-union rate of 9.7%**.
- **Brijlal et al.** observed **19% of cases with limb shortening greater than 2 cm**.
- **Henry et al.** noted a **5.6% non-union rate** and one instance of **angulation >5°**.
- **Leung–KS et al.** reported **anterior knee pain in 8%** of patients.
- **Gellman et al.** found **angulation >5° in 4.5%** of cases and **shortening >2 cm in 25%** of cases.

In comparison, the complication profile in **our study** was as follows:
- **Infection:** 6.66%
- **Non-union:** 0%
- **Angulation >5°:** 0%
- **Anterior knee pain:** 0%
- **Shortening >2 cm:** 0%
- **Screw breakage:** Observed in **1 case (3.33%)**

These results suggest a favorable complication rate with retrograde intramedullary nailing in our patient population.

7. Limitations of the Study Design

1) **Small Sample Size:** The limited number of cases may reduce statistical power and limit the generalizability of the findings to a broader population.
2) **Short Duration of Follow-Up:** Some long-term outcomes, such as delayed complications or implant-related failures, may not have been fully captured.
3) **Lack of a Control Group:** The absence of a comparative group treated with other modalities (e.g., plating) restricts the ability to assess the relative effectiveness of retrograde nailing.
4) **Selection Bias:** Potential bias may exist if specific patient demographics or fracture patterns were preferentially included, potentially skewing results.
5) **Subjective Outcome Measures:** Functional results were partly based on patient-reported outcomes, which may introduce variability and reduce objectivity.
6) **Single-Center Study:** As the study was conducted at a single institution, findings may be influenced by center-specific protocols, surgical techniques, or clinician expertise, limiting wider applicability.

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