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Original Research Article

Study on the Surgical Fixation Outcome and Complications of Using a Retrograde Intramedullary Nail in Fracture of the Distal Femur

Rahil Pankajkumar Shah[1], Anandkumar Sureshbhai Tailor[2], Rajdeepsinh P. Jadeja[3]

[1]Senior resident, Department of Orthopaedic, BJ Medical College, Ahmedabad
[2]Assistant professor, Department of Orthopaedic, BJ Medical College, Ahmedabad
[3]Assistant professor, Department of Orthopaedic, BJ Medical College, Ahmedabad

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Corresponding author: Dr. Rajdeepsinh P. Jadeja
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Abstract:

Introduction: Osteoporosis and old co-morbidities make distal femur fractures difficult to cure. These fractures are most common in younger guys from high-energy injuries and older males from low-energy falls. Modern retrograde nailing and medial plates offer better stability. Screw location is key to fracture integration. High stress should be avoided when using proximal locking screws and the nail length should match the intramedullary channel.

Aims and Objective: This study examines retrograde intramedullary nail fixation for distal femur fractures.

Method: 50 patients with distal third femur fractures were studied in a retrospective observational cohort study at a trauma care facility during a three-year period from July 2020 to June 2023. After receiving a thorough evaluation, patients underwent fracture fixation (closed or open reduction with retrograde intramedullary nail) and were followed for 4-24 months to assess the success of the procedure and any issues that may have arisen.

Result: Figure 1 shows that 58% of patients are labourers. Right-sided open femoral fractures (68%), largely from car accidents (76%), are shown in Table 1. In Table 2, AO classification A2 fractures (52%) are the most common. Table 3 shows shorter hospital stays (70% under seven days), varied follow-up (36% at 12-18 months), and shorter fracture union times (48% under 16 weeks). Table 4 shows knee mobility, surgical problems, and function and Figure 2 shows that closed fractures.

Conclusion: In the treatment of "distal femur fractures", retrograde intramedullary nails have been shown to be effective, leading to fewer problems, better results, and soft tissue preservation.

Keywords: "Distal femur fractures", Osteoporosis, "open femoral fractures" "retrograde intramedullary nails".

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Introduction

The supracondylar and intercondylar areas on the distal femur frequently sustain fractures. The therapy aims to restore limb alignment, length, and rotation while adhering to the AO ideals of anatomic reduction of the articular surfaces. Treatment of distal femur fractures persists to be challenging because they generally have osteoporotic bone, typically intra-articular, & are comminuted despite advances in implant design. The geriatric trauma group has a high rate of co-morbidities, which may have an impact on the available therapeutic options [1].

The distribution of adult distal fractures of the femur is bimodal. Younger male patients typically show up as a result of high-energy processes, such as car accidents. Elderly patients generally show up following low-energy causes such as ground-level falls [2]. Elderly individuals frequently have serious co-morbidities that have an effect on their capacity to function, recuperate, and survive. The issue may be early joint degeneration and the long-term repercussions of treated intra-articular fracture injury in the pediatric population. Treatment of these complicated fractures has been associated with subpar results, especially as the population ages [3].

Approximately 3-6% of femoral fractures and less than 1% of all fractures are distal femur fractures. According to reports, there are 37 distal femur fractures for every 100,000 Americans [4]. Young males, particularly those who have had older women and high-energy motor trauma are more likely to sustain these fractures. According to one study, generalized osteopenia was present in 80 per cent of those aged 35 and older who suffered distal femur fracture fractures as a result of mild trauma [5]. Additionally, prosthetic fractures around the distal femur have increased in frequency. Distal

femur fractures were reported to happen between 0.3% and 5.5% of the time after a total knee replacement and between 30% and 40% of the time after a revision [6]. Extreme forces are required to fracture the distal femur given the usual mineral composition of the bone. Younger individuals tend to experience fractures at the knee joint more commonly because they commonly co-occur with additional harm and involve high-energy trauma. On the other hand, little trauma, such as a simple fall, can cause a single distal femoral fracture in older individuals with significant osteopenia [7].

Ankylosis, varus and valgus misalignment, and malrotation occur often, and the results of nonoperative therapy are typically dismal. As a result, internal fixation and open reduction with plate & screw osteosynthesis have been the benchmark for surgical treatment since the late 1970s. Comminuted fractures also call for the recommendation of bone grafting. However, the necessary access route may counteract the benefits of internal fixation (early mobilization) by causing iatrogenic periosteal peeling from the bone and soft tissue injury. Additionally, infections and pseudoarthrosis frequently require revision surgery [8].

The notion of "biologic" plate osteosynthesis, which is used in conjunction with other procedures to reduce shaft fractures indirectly, nonetheless necessitates a significant surgical approach. Early in the 1980s, retrograde nailing via Rush pins was practised to address these issues. However, this method did not offer rotational stability [9]. A cannulated, stainless steel GSH spike was consequently created in 1987 for reliable retrograde interlocked nailing. A novel titanium nail (TriGen; Smith and Nephew, Memphis, TN), which can be used for lower limb fractures in their entirety was launched in the late 1990s. The device delivers stable stabilization of the fracture thanks to a multiplanar distal closing mechanism [10]. The nail's proximal bend was also made to match both the antegrade and retrograde motions of the femur. Which distal femur fracture type is most suitable for retrograde nailing is now a matter of debate. According to the AO classification, some writers advise retrograde nailing in A fractures, however, C1 fractures are seen to be a dubious indicator. Intercondylar C2 as well as the field of plate systems is thought to encompass C3 fractures, particularly in European literature [11].

Retrograde nailing was commonly used by other researchers in C1 through C3 fractures. The use of screw osteosynthesis is advised to treat unicondylar type B fractures. Several methods exist for the treatment of supracondylar femoral fractures surgical tools have been employed, including Anterograde in addition to retrograde locked intramedullary nails, buttress condylar dishes, angled blade dishes, locked dishes, polyaxial meals, dynamic condylar bolts, external fixation, etc [12].

Retrograde intramedullary (IM) nailing and angular stability medial plates, both inserted using minimally invasive techniques, maybe today's two most popular treatments. Retrograde intramedullary nails have been regarded as a standard procedure since Moed's study in 1995 [8]. The mounting stability is improved by the contemporary designs' many holes located in the insertion of the lock screws in various planes in the lateral and anterior orientations [13].

Furthermore, the screws placed at the fracture location would have been more successful if they had integrated the broken femoral parts by passing through the fracture gap. As the tension in the space across the screw holes in the metaphyseal region rapidly grew, the distal screw enclosing the metaphyseal area stabilized the femur-nail construction more considerably than the proximal screw [14]. The screw, nevertheless, is length was not examined. In conclusion, because of Utilizing proximal locking screws within the bending region of the femur may be dangerous due to the high stresses at the implant and bone. Furthermore, there were no changes in the levels of stress, or elastic strain within the titanium & stainless steel implants, there may be a fracture gap or bone stress. The retrograde nail ought to remain as long as necessary to meet the intramedullary channel needs to be reamed to fit the nail [15].

Method

Research design

The study employed a research strategy that entailed conducting a retrospective observational cohort analysis on a sample of 50 individuals diagnosed with distal third fractures of the femur. The investigation was carried out at an educational institution associated with a tertiary facility specializing in trauma care, spanning duration of three years, commencing from July 2020 to June 2023. Upon patients' arrival, a comprehensive assessment was conducted, encompassing general and systemic examinations, local examinations aimed at excluding further injuries, musculoskeletal examinations to identify any accompanying fractures, as well as an evaluation of age, sex, mode of trauma, and the time elapsed between the accident and the patient's arrival. The procedure of fracture fixation was carried out by employing either closed or open reduction techniques, along with internal fixation using a retrograde intramedullary supracondylar nail. The duration of follow-up varied between 4 and 24 months, during which the monitoring of post-operative sequelae, including infection, loss of reduction, malunion, non-union, joint stiffness, and neurovascular status,

took place. The primary goal of the research design was to analyse the treatment outcomes and complications related to the specific fracture management procedure.

Inclusion and exclusion criteria

Inclusion

- The study encompasses many modes of injuries, such as those resulting from road traffic accidents, assaults, direct injuries, and falls from heights.
- Both open fractures (OG-1, OG-2, OG-3A & 3B) and closed fractures are encompassed within the scope of surgical intervention.
- The study encompasses all categories of fracture patterns affecting the distal femur.
- Patients who have undergone surgery and have completed a minimum duration of four months post-surgery are eligible for inclusion in the study.
- The location of the fracture extended to a minimum distance of 9 cm proximal to the knee joint.

Exclusion

- The patient presents with an open fracture of grade 3C.
- Individuals who have received conservative treatment.
- Pathological fractures refer to bone fractures that occur as a result of underlying disease or abnormal conditions within the skeletal system. These fractures differ
- Paediatric distal femur fractures refer to fractures that occur in the lower part of the femur bone in children.

Statistical analysis

This study used mean, standard deviation, and percentages to summarise patient demographics, fracture characteristics, and post-operative results. Inferential statistics were employed to measure the relationship between variables and post-operative problems or treatment success.

To find significant correlations or predictors, chi-square tests, t-tests, and regression analysis were used. The level of significance was chosen at $p < 0.05$. If applicable, statistical software was used to analyse data.

Ethical approval

The study received ethical approval from our hospital authority.

Result

The various patient vocations are shown in Figure 1. Manual and agricultural labourers made up the bulk of the population (58%). The percentage of stay-at-home mothers was 13%, while the "Others" category included 30%. This information reveals that labourers were the most often affected group among the study participants, which may indicate a higher risk for distal femur injuries in this occupational category.

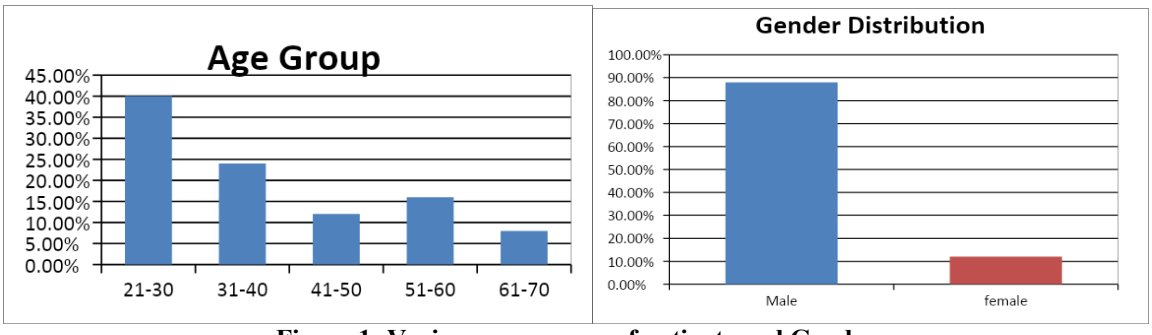

Figure 1: Various age groups of patients and Gender

Table 1 summarizes important data regarding individuals with open femoral fractures. Most occurrences occurred on the right side (68%), whereas the left side was affected by the minority (32%). Seventy-six per cent of all injuries occurred in automobile collisions, whereas 24 per cent of all injuries occurred in falls from a height. The study found that whereas 72% of fractures were classified as closed, 28% were open. The majority (71.43%) of open fractures were classified as Gustilo type II fractures, while the minority (28.57%) was classified as Gustilo type III fractures. These results highlight the fact that right-sided fractures and automobile accidents are the most common causes of injury and that among open fractures, Gustilo type II fractures are the most common subtype.

Table 1: Type of open fracture

Side affected	**No of patients**	**Percentage**
Right	34	68.00%
left	16	32.00%
Total	50	100.00%
Mechanism of Injury	**No. of cases**	**Percentage**
Road traffic accident	38	76.00%
Fall from height	12	24.00%
Total	50	100.00%
Type of fracture	**No of fracture**	**%**
Open	14	28.00%
Closed	36	72.00%
Total	50	100.00%
Type of open fracture	**No of patients**	**Percentage**
Gustilo type II	10	71.43%
Gustilo type III	04	28.57%

Table 2 displays crucial information pertaining to the categorization of fractures using the AO classification system, the timing of surgical intervention, and the duration of operative procedures. Regarding the classification of fractures, the predominant category seen was A2, accounting for 52% of the cases. Subsequently, A1 fractures constituted 40% of the cases, while A3 fractures represented 8% of the total. The observed distribution indicates that A2 fractures exhibited the highest prevalence within this particular patient sample. When contemplating the timing of surgical procedures, a notable percentage of patients (78%) received surgery during the initial five days subsequent to the occurrence of the injury, signifying a predilection for prompt intervention. The analysis of operative time data indicates that a significant proportion of surgical procedures (64%) were successfully concluded within a duration of less than 90 minutes, hence highlighting the effectiveness and efficiency of these operations in the majority of instances.

Table 2: Type of fracture based on AO classification

AO Type	**No. of patients**	**Percentage**
A1	20	40.00%
A2	26	52.00%
A3	4	8.00%
Total	50	100.00%
Time (Days)	**Patients**	**Percentage (%)**
01-05	39	78.00%
06-10	9	18.00%
11-15	2	4.00%
TOTAL	50	100.00%
Operative time (minutes)	**No. of cases**	**Percentage**
< 90 min	32	64.00%
91 - 120 min	12	24.00%
>120 min	6	12.00%
Total	50	100.00%

Table 3 presents significant findings pertaining to the length of hospitalization, duration of follow-up, and the timeframe required for fractures to attain union. Upon analyzing the length of hospitalization, it was observed that a significant proportion of patients (70%) were discharged within a period of less than seven days, suggesting comparatively brief durations of hospital stays.

In relation to the follow-up periods, the data indicates that patients were subjected to diverse lengths of post-operative surveillance. The prevailing duration for follow-up was seen to be within the range of 12 to 18 months, constituting approximately 36% of the total cases. This implies that a thorough and prolonged postoperative monitoring of patients was conducted.

In relation to the time required for fracture union, it is noteworthy that around 48% of the cases demonstrated union within a period of less than 16 weeks. Conversely, the remaining instances exhibited a range of union dates spanning from 16 to 24 weeks, thereby underscoring the heterogeneous nature of the healing timelines observed for these fractures.

Table 3: Duration of Hospital Stay

Time (weeks)	**Patients**	**Percentage (%)**
<1	35	70.00%
1-2	11	22.00%
>2	4	8.00%
TOTAL	50	100.00%
Follow up in months	**No of patients**	**Percentage**
<6	6	12.00%
6-12	14	28.00%
12-18	18	36.00%
18-24	12	24.00%
Total	50	100.00%
Union (Weeks)	**No. of cases**	**Percentage**
<16	24	48.00%
16 - 18	12	24.00%
18 - 20	4	8.00%
20 - 22	4	8.00%
22 - 24	6	12.00%
Total	50	100.00%

Knee range of motion and postoperative problems are listed in detail in Table 4.

In terms of knee flexion, 42% of patients achieved a range of 110-120 degrees, while 20% showed flexion greater than 120 degrees, showing reasonably high mobility after surgery.

There were, however, examples with restricted motion; 12% had a range of motion of 80 degrees or less. Osteomyelitis and malunion were not recorded as problems, although nonunion (8%) and implant failure (2%), implant loosening (2%), joint stiffness (20%), and shortening (4%) were. A high percentage of patients had a positive outcome, with 56% receiving an outstanding rating and 16% receiving a decent one. 74% had no need for a cane or other walking aids. 54% could walk indefinitely, whereas 28% could walk no more than 1 km. 64% of patients had trouble squatting, and the same percentage had trouble sitting cross-legged, suggesting possible impairments in lower limb function after surgery.

Table 4: Knee Range of Movement

Knee Movement (Degrees)	**Patients**	**Percentage (%)**
>120	10	20.00%
110-120	21	42.00%
100-110	5	10.00%
90-100	4	8.00%
80-90	4	8.00%
<80	6	12.00%
Total	50	100.00%
Complications	**N**	**%**
Osteomyelitis	0	0.00%
Nonunion	4	8.00%
Malunion	0	0.00%
Implant Failure	1	2.00%
Implant Loosening	1	2.00%
Joint Stiffness	10	20.00%
Shortening	2	4.00%
Rating	**No. of cases**	**Percentage**
Excellent >80 points	28	56.00%
Good 70-79 points	8	16.00%
Fair 60-69 points	12	24.00%
Poor <60 points	2	4.00%
Total	**50**	**100.00%**
Walking ability	Patients	Percentage (%)
Without limp and Support	37	74.00%
With Limp	6	12.00%
One cane	2	4.00%

Two Crutches	5	10.00%
Not able to walk	0	0.00%
TOTAL	50	100.00%
Distance	**Patients**	**Percentage (%)**
Unlimited	27	54.00%
Up to 1 km	14	28.00%
<0.5 km	5	10.00%
Indoor	4	8.00%
Bed & Chair	0	0.00%
Total	**50**	**100.00%**
Squatting	Patients	Percentage (%)
With ease	10	20.00%
With difficulty	32	64.00%
Unable to squat	8	16.00%
TOTAL	50	100.00%
Sitting Cross-Legged	**Patients**	**Percentage (%)**
With ease	10	20.00%
With difficulty	32	64.00%
Unable to sit cross-legged	8	16.00%
TOTAL	50	100.00%

Figure 2, "Type of Injury vs. Results," shows how injury type affects outcomes. All 36 closed fracture patients (100%) had excellent, good, or fair results. However, 2 (14%) of 14 patients with open fractures had unsatisfactory results due to the severity of the open wounds and soft tissue injuries. This graphic shows that closed fractures had better post-operative outcomes than open fractures in this study.

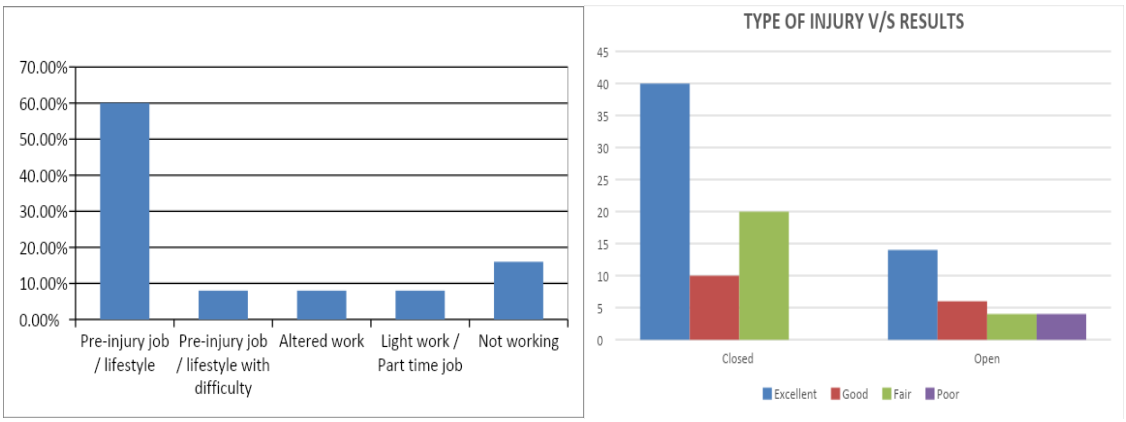

Figure 2: Assessment of results comparing return to work and injury

Discussion

A study was conducted previously to look at the treatment and results for distal femur fractures fixed retrogradely. Utilizing common the result was assessed using radiographic parameters for time to union, risk of infection, malunion, and knee function (Leung score). Retrograde nailing is recommended as a substitute to plate the process of osteosynthesis in stabilizing distal femoral injuries in type C fractures [16].

The decision of antegrade & retrograde intramedullary (IM) nail in regard to maintaining the joint's ability to receive the nail in the future stirred up discussion despite the fact that femoral shaft fractures are the focus of significant current knowledge. to assess the difference IM is hitting the mark between antegrade & retrograde patients that had a healed femoral shaft fracture. 1. Both in order to stabilise femoral shaft fractures, antegrade & retrograde IM nailing equivalent knee function. 2. The degree of osteoarthritis existing at trauma should also be taken into consideration when deciding which IM nailing technique to use, in addition to orthopaedic reasons [19].

It is debatable whether or not retrograde intramedullary nailing is appropriate for intra-articular distal fractures of the femur with metaphyseal or epiphyseal comminution. A study examined the union rate, complications, and follow-up procedures for comminuted, intra-articular, and distal fractured femurs following open reduction & retrograde intramedullary nailing. Comminuted intra-articular femoral distal fractures can be successfully treated using retrograde IMN

fix, and the risk of complications is consistently lower than that reported with plate fixation [20].

The surgical treatment of distal femur fractures evolved over time and currently depends on a variety of variables, such as the type of fracture—open versus closed—the form of the fracture, the level of metaphyseal crushing, the intra-articular extension, and the bone quality. Retrograde intramedullary nails or locking plates (LP) can be used to treat these fractures (RIMN). The best way to use the two gadgets, meanwhile, is still up for dispute because it's not apparent which is better [21]. Therefore, it was intended for this meta-analysis and systemic review to contrast the results of RIMN in distal femur LP. Research demonstrates that, despite the latter having a greater postoperative knee range of motion, there are considerably fewer RIMN group nonunions and infections for distal fractures of the femur than in the LP group. However, there is no gap between the two distinct surgical approaches in the sense of fracture union over the years, general frequency of problems re-operation rates, or length of procedures [22].

Despite substantial advancements in implant design and build modulation, Nonunion rates in lateral locked plating (LLP)-treated distal femur fractures remained as high as 18–22%. It is unclear, nevertheless, if using rIMN to treat distal femur fractures results in better outcomes than LLP. A study compared the effects of LLP and rIMN treatment in complete articular distal fractures to the femur (AO/OTA 33-C). The findings showed that LLP had a greater nonunion rate & coronal plane misalignment than rIMN. Despite the need for more prospective data, for complete articular proximal femur fractures, rIMN appears to be a successful treatment possibly lowering the nonunion rate [23]. Following total knee arthroplasty (TKA), periprosthetic distal femur fractures (PPDFFs) constitute a frequent complication. Treatment options for well-fixed TKA components include lateral locked plating or retrograde intramedullary nailing (rIMN). When utilising traditional nails, treatment using rIMN was historically linked to the risk of extension deformity. In contrast to standard intramedullary nails, we predicted that PPDFFs cured by an intramedullary nail with a 10-degree distal bend were specifically designed so that periprosthetic fractures would line better after surgery [24].

In a study compared to a traditional 5° nail, retrograde intramedullary nailing with PPDFF produces a noticeably improved alignment in the sagittal plane. A substantial increase in extension deformities was seen when a 5° nail was used. In order to effectively treat PPDFFs, we advise using a rIMN with an angle of 10° distal bend [25]. When a patient has low bone quality and little available bone supply, periprosthetic distal femur fractures (PPDFFs) provide difficulty for fixation optimisation. The two basic forms of therapy are intramedullary nailing and laterally-based plating. In comparison to plating, the study predicted that intramedullary nailing of PPDFFs would enhance the union rate, reduce problems, and cause an equal amount of misalignment. In a series, intramedullary nailing was linked to a higher likelihood of malalignment, most frequently an extension deformity. Malalignment, however, wasn't linked to lower results [26].

Conclusion

In conclusion, retrograde intramedullary supracondylar nails are highly effective for extra-articular distal third femoral fractures, reducing operative time and blood loss. Closed reduction methods preserve fracture hematoma and soft tissue, decreasing post-surgery stiffness.

Patients with distal screws had local complaints that were acceptable and had a learning curve effect. The technique had clear advantages over traditional plating, including lower rates of malunion, delayed union, and non-union, no bone grafting, and less donor site morbidity, highlighting the importance of thorough irrigation to prevent infection. Union and knee range of motion required immediate surgery, closed reduction, numerous screws, and knee mobilization. Healing and weight-bearing did not differ between fracture types, which is positive.

Retrograde intramedullary supracondylar nailing is a useful treatment for supracondylar femoral fractures because it provides robust fixation with minimal periosteal stripping and soft tissue exposure.

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