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# A LONGITUDINAL STUDY OF SURGICAL MANAGEMENT OF SUPRACONDYLAR FRACTURES OF FEMUR WITH MULTI-DIRECTION LOCKING RETROGRADE INTRAMEDULLARY NAIL

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ABSTRACT

**Background:** Supracondylar fractures of the femur are among the most challenging injuries to manage due to their proximity to the knee joint, complex anatomy, and high risk of complications. These fractures are commonly seen in young adults following high-energy trauma and in elderly patients due to low-energy falls. The development of retrograde intramedullary nailing has significantly improved outcomes by providing stable fixation, early mobilization, and reduced complications compared to conventional plating methods. The present study aimed to evaluate the functional and radiological outcomes of supracondylar femur fractures treated with retrograde intramedullary nailing, and to assess the relationship between fracture pattern, age, and postoperative recovery.

**Materials and Methods:** This longitudinal hospital-based study was conducted in the Department of Orthopaedics, Regional Institute of Medical Sciences (RIMS), Imphal. A total of 97 patients aged 15–85 years with distal femoral supracondylar fractures (Gustillo–Anderson Type I and II) treated with retrograde interlocking nailing were included. Data were collected from September 2022 to March 2024. Sociodemographic details, fracture characteristics, surgical duration, blood loss, and postoperative outcomes were recorded. Patients were followed for an average of 18.88 ± 2.46 months. Functional and radiological outcomes were assessed using Neer's Knee Scoring System and Sander's Functional Evaluation Scale, and data were analyzed using SPSS version 21.

**Results:** The majority of patients were males (79%) with a mean age of 38.71 ± 13.52 years. The most common fracture types were 33A1 (64%) and 33A2 (30%). The mean operative duration was 104.02 ± 18.18 minutes with an average blood loss of 250.52 ± 104.21 ml. The mean time to full weight-bearing was 12.73 ± 1.68 weeks, and mean radiological union occurred at 13.15 ± 1.43 weeks. Functional outcomes were excellent in 57.7%, good in 38.1%, and fair in 4.2% of patients. Complications were minimal, with knee pain being the most common (15.5%).

**Conclusion:** Retrograde intramedullary nailing is a reliable and effective treatment for supracondylar femur fractures, yielding excellent functional and anatomical outcomes with minimal complications. Age and fracture pattern showed no significant effect on healing or final outcome.

**Keywords:** Supracondylar femur fracture, retrograde intramedullary nailing, distal femur, functional outcome, Neer's knee score.

## INTRODUCTION

The second most common type of femur fracture is a distal fracture.[1] It was recently found that the incidence of distal femur fractures is 8.7/100,000/year, with a periprosthetic incidence of 2.4/100,000/year.[2] Distal femur fractures are characterized by female predominance and increasing incidence with increasing age, which are descriptive of a classic fragility fracture. At the time of fracture, the mean age for females is recently reported as 71.6 years with approximately 61% of fractures being the result of a fall from a standing height. These patients are described with a high prevalence of comorbidities and with a high risk of post-operative complications.[2] They have bimodal age distribution; young patients as a result of high-energy injuries and elderly patients after simple falls. Even though they occur in the same anatomical area as younger patients, fractures in the elderly present unique difficulties because of osteoporotic bone and the general health of the patient.[3] Despite the rarity of distal femur fractures, an increase in the incidence of distal femur fractures should be expected, due to an expected shift in demography towards an elderly population. Proximal femur fractures are associated with underlying comorbidity and high mortality rates, which have been extensively documented and described in the literature on multiple occasions.[4] The one year mortality rate of elderly patients with distal femur fractures has been reported between 10% and 38%, which is similar or even higher than patients with proximal femur fractures.[5] Retrograde intramedullary nailing is a well-accepted stabilization technique for fractures of the diaphyseal and supracondylar areas of the femur. As with other minimally invasive techniques. The retention of soft tissues and local vascularity during open reduction and internal fixation (ORIF) operations on the distal femur improves outcomes and lowers high complication rates.[5] Because it avoids protracted immobility and lowers the danger of deadly consequences, the implant is a popular choice among the elderly due to its little tissue dissection and stable fixation. In cases where antegrade femoral nailing is impeded by proximal femur pathologies or in situ implants, retrograde intramedullary nailing is a useful substitute.[6] Retrograde intramedullary supracondylar nails also have the unique benefits of preserving fracture hematoma, lowering blood loss, requiring less dissection of soft tissue, requiring less time to operate, and having a lower infection rate.[7,8] The goal of the research is to assess the outcomes of femur supracondylar fractures, which are treated with internal fixation using a retrograde intramedullary supracondylar nail and either closed or open reduction.

## MATERIALS AND METHODS

This longitudinal, hospital-based study was conducted in the Department of Orthopaedics, Regional Institute of Medical Sciences (RIMS), Imphal, and included all patients presenting to the Orthopaedics Outpatient and Emergency Departments with supracondylar femur fractures who were treated with retrograde interlocking nailing during the study period. Protocol preparation and ethical approval were obtained between May and August 2022, followed by data collection from September 2022 to March 2024. The review of literature was completed in February 2024, and the thesis was finalized in June 2024 and submitted in July 2024. Based on the predetermined formula and parameters, the calculated sample size was 97. All eligible patients who met the inclusion and exclusion criteria were enrolled consecutively from the outpatient and emergency departments, admitted to the inpatient department of Orthopaedics, and subsequently underwent retrograde intramedullary nailing during the study period.

**Inclusion Criteria**

- All medically fit patients with fractures of the distal femur suitable for surgical intervention.
- Patients aged between 15 and 85 years.
- Patients with compound injuries classified as Gustillo–Anderson Type I and Type II.
- Fractures with or without intercondylar extension.

**Exclusion Criteria**

- Patients with polytrauma.
- Patients with associated head injuries or neurovascular injuries.
- Skeletally immature patients or those with pathological fractures.
- Patients with bony metastasis or a previous fracture in the same limb.

The study variables included both independent and outcome parameters. Independent variables comprised socio-demographic characteristics such as age and sex, grade and side of injury, duration of surgery, intraoperative blood loss, type of anaesthesia, and degree of soft tissue involvement. Outcome variables included time to union, leg length discrepancy, range of motion, residual deformity, need for further treatment, and evaluation of radiological and functional outcomes using Neer's Knee Scoring System and Sander's Functional Evaluation Scale. Postoperative complications such as pin tract infection, deformity, stiffness, limping, and pain were also documented. All patients with Gustillo–Anderson Type I and Type II distal femoral supracondylar fractures who underwent retrograde intramedullary nailing were screened for eligibility, and after obtaining informed consent and confirming inclusion and exclusion criteria, participants were enrolled until the target sample size was reached. Data were collected using a detailed, structured proforma that included socio-demographic

information, clinical history, findings from general and local examinations, and results from routine haematological and radiological investigations, including follow-up assessments, all of which were systematically recorded in the predesigned proforma.

**Surgical Procedure:** Patients were thoroughly evaluated and psychologically prepared for the procedure. The treatment plan was explained in detail.

Radiographs were taken in at least two planes. A preoperative antibiotic (1 g cefazolin) was administered in the morning, with a repeat dose if surgery extended beyond four hours. Postoperatively, injectable antibiotics were continued for seven days based on intraoperative culture and sensitivity results, with amikacin (500 mg) for three days, followed by oral antibiotics for ten days. The procedure was generally performed under spinal or epidural anaesthesia, unless general anaesthesia was indicated.

**Retrograde Nailing Technique:** Patients were placed in a supine position with the affected limb free. An anterior midline incision, extending from the inferior pole of the patella to the tibial plateau, was made for extra-articular fractures. The intercondylar notch was accessed by splitting the patellar tendon centrally. Using image intensification, a sharp awl or a 0.25-inch drill was advanced into the notch, 30–40° anterior to the posterior cruciate ligament attachment. For Type C1 intra-articular fractures, closed reduction and fixation of the condyles using percutaneous cannulated lag screws were attempted. If anatomical reduction was not achieved, open reduction via a medial parapatellar arthrotomy was performed. Type C2 and C3 fractures underwent open reduction in all cases.

Once the intercondylar fracture was exposed, temporary fixation was achieved using Kirschner wires or interfragmentary screws. After reconstruction of the condyles, a guide wire was inserted across the fracture into the proximal femur. Sequential reaming was performed 1–2 mm above the selected nail size, followed by insertion of a supracondylar nail allowing at least two bicortical screws in the proximal fragment. The distal tip of the nail was positioned within the notch below the cortical bone to prevent impingement. Proximal and distal interlocking were performed using lateral stab incisions. At least two distal screws were inserted to prevent rotational instability. Accurate measurement of distal interlocking and lag screws was crucial to avoid impingement and discomfort.

**Postoperative Care and Follow-up:** Early range of motion (ROM) exercises were encouraged postoperatively. Outpatient physiotherapy was prescribed for patients with delayed recovery. Weight-bearing was deferred until radiographic evidence of callus formation was observed. Partial weight-bearing was generally allowed at 8 weeks, and full weight-bearing at 12 weeks. Fracture healing was confirmed by: Bridging callus on anteroposterior and lateral radiographs, and Absence of pain or abnormal mobility on clinical examination. Follow-up evaluations were conducted at 4 weeks, 6 weeks, 3 months, 6 months, 9 months, and 12 months post-surgery. Each patient was assessed using Neer's Knee Grading System, Sander's Functional Evaluation Scale, and standardized clinical and radiological examinations.

**Statistical Analysis:** Data were entered and analyzed using IBM SPSS version 21. Descriptive statistics such as mean, standard deviation, and percentages were used to summarize data on age, sex, and injury characteristics. Associations between age group and functional outcomes were tested using the Chi-square test and Fisher's exact test. The Independent t-test was used to compare mean healing times between Gustillo–Anderson fracture types. A p-value of $<0.05$ was considered statistically significant.

**Figure 1: showing preoperative x rays**

**Figure 2: Retrograde IM Nail with distal locking system**

**Figure 3: Locating entry point c arm images**

**Figure 4: Retrograde nail insertion**

**Figure 5: Distal locking**

**Figure 6: Distal and Proximal locking**

## RESULTS

The present study included a total of 97 patients diagnosed with supracondylar femur fractures and treated with retrograde intramedullary nailing. The age distribution of the patients, as shown in [Table 1], indicates that the majority of patients belonged to the younger and middle-aged groups. Specifically, 32.0% were between 18–30 years, followed by 29.9% between 31–40 years, and 19.6% between 41–50 years. Only 12.4% of patients were in the 51–60-year age group, and 6.2% were above 60 years. The mean age of the study population was 38.71 ± 13.52 years, with the youngest patient aged 19 years and the oldest 75 years.

[Table 2] presents the mean duration of operation and intraoperative blood loss. The average operative time was 104.02 ± 18.18 minutes, and the mean blood loss during surgery was 250.52 ± 104.21 ml. These findings suggest that the retrograde intramedullary nailing procedure requires a moderate amount of operative time and results in acceptable intraoperative blood loss, indicating that the technique is both efficient and safe when performed under appropriate surgical conditions.

As shown in [Table 3], intraoperative characteristics revealed that 8.2% of patients required blood transfusion during surgery. Importantly, there were no intraoperative complications or distal neurovascular injuries reported, highlighting the procedural safety of the retrograde nailing technique. All patients received a ten-day course of antibiotics and two days of injectable analgesics, reflecting standardized postoperative management to minimize infection and ensure adequate pain control.

The postoperative and follow-up findings are summarized in [Table 4]. The mean follow-up period for patients was 18.88 ± 2.46 months (range 15–24 months), which was adequate for assessing bone healing and functional recovery. The mean time to full weight-bearing was 12.73 ± 1.68 weeks, while the mean time for fracture union was 13.15 ± 1.43 weeks, ranging from 12 to 20 weeks. This indicates satisfactory healing within the expected clinical timeframe. Regarding knee joint mobility, the mean range of flexion achieved was 123.97 ± 7.14 degrees, with complete extension in all patients (0° extension lag).

Functional and complication outcomes are presented in [Table 5]. According to Neer's functional and anatomical grading, 57.7% of patients had excellent outcomes, 38.1% had good outcomes, and only 4.2% had fair results. Similarly, using Sander's functional evaluation scale, 55.7% achieved excellent results, 39.1% were graded as good, and 5.2% as fair. These parallel findings across both scoring systems affirm that the majority of patients experienced excellent to good recovery, both radiologically and functionally.

Regarding postoperative complications, the most common issue was knee pain, reported in 15.5% of patients, followed by superficial infection in 5.2%, shortening in 4.1%, and delayed union in only 1.0%.

Notably, 74.2% of patients had no complications at all, further supporting the safety and efficacy of this surgical approach.

Finally, [Table 6] shows the association between the type of fracture, age group, and functional outcomes. Among fracture types, 33A1 fractures had the highest proportion of excellent outcomes (66.1%), followed by 33A2 (28.6%) and 33A3 (5.3%), with a p-value of 0.840, indicating no statistically significant association between fracture type and functional outcome. Similarly, when comparing age groups, patients aged ≤ 40 years achieved excellent outcomes in 58.9% of cases compared to 41.1% in those above 40 years, with a p-value of 0.316, again showing no significant correlation between age and functional results.

**Table 1: Age distribution of patients (N = 97)**

| Age group in years | No. of patients | Percentages (%) |
|---|---|---|
| 18–30 | 31 | 32.0 |
| 31–40 | 29 | 29.9 |
| 41–50 | 19 | 19.6 |
| 51–60 | 12 | 12.4 |
| Above 60 | 6 | 6.2 |
| Mean age in years | 38.71 ± 13.52 years (range 19–75 years) | |

**Table 2: Mean duration of operation and blood loss (N = 97)**

| Characteristics | Mean | Standard deviation |
|---|---|---|
| Amount of blood loss in ml | 250.52 | 104.21 |
| Duration of operation in minutes | 104.02 | 18.18 |

**Table 3: Intraoperative characteristics and complications (N = 97)**

| Characteristics | No. of patients | Percentages (%) |
|---|---|---|
| Blood transfusion | 8 | 8.2 |
| Intraoperative complication | 0 | 0 |
| Distal neurovascular complication | 0 | 0 |
| Ten day antibiotic course | 97 | 100.0 |
| Two day injectable analgesics | 97 | 100.0 |

**Table 4: Follow-up time, full weight bearing, time of union, and range of motion of knee joint (N = 97)**

| Parameters / Characteristics | Mean | Standard deviation | Range |
|---|---|---|---|
| Follow up time in months (N = 96) | 18.88 | 2.46 | 15–24 |
| Time of full weight bearing in weeks | 12.73 | 1.68 | 10–20 |
| Time of union in weeks | 13.15 | 1.43 | 12–20 |
| Range of motion for flexion in degrees | 123.97 | 7.14 | 100–130 |
| Range of motion for extension in degrees | 0 | 0 | 0 |

**Table 5: Neer's and Sander's functional outcomes and complications at follow-up (N = 97)**

| Outcome / Complications | No. of patients | Percentages (%) |
|---|---|---|
| Neer's functional and anatomical outcome | | |
| Excellent | 56 | 57.7 |
| Good | 37 | 38.1 |
| Fair | 4 | 4.2 |
| Sander's functional evaluation scale | | |
| Excellent | 54 | 55.7 |
| Good | 38 | 39.1 |
| Fair | 5 | 5.2 |
| Complications at follow-up | | |
| Superficial infection | 5 | 5.2 |
| Knee pain | 15 | 15.5 |
| Delayed union | 1 | 1.0 |
| Shortening | 4 | 4.1 |
| None | 72 | 74.2 |

**Table 6: Association between type of fracture, age group, and functional outcome (N = 96)**

| Variables | Outcome, n (%) | | | P value |
|---|---|---|---|---|
| | Excellent | Good and fair | Total | |
| Type of fracture | | | | |
| 33A1 type | 37 (66.1) | 25 (61.0) | 62 (63.9) | 0.840 |
| 33A2 type | 16 (28.6) | 13 (31.7) | 29 (29.9) | |
| 33A3 type | 3 (5.3) | 3 (7.3) | 6 (6.2) | |
| Age group (in years) | | | | |
| ≤ 40 years | 33 (58.9) | 27 (65.9) | 60 (61.9) | 0.316 |
| > 40 years | 23 (41.1) | 14 (34.1) | 37 (38.1) | |

## DISCUSSION

A total of 97 patients underwent retrograde intramedullary nailing for supracondylar fracture of femur in this study. Out of them 79% were male and remaining 21% were female. Loya LS et al,[9] reported 68.7% of their study population with supracondylar fracture to be male. Gellman RE et al,[10] reported 45.4% male and 54.6% female among their study population. Further the authors reported bimodal distribution of high energy fractures occurring in younger males and low energy fracture in elderly females.

In this study, most of the patient belong to the age group of 18 – 30 years (32.0%) followed by 31-40 years (29.9%). The age group above 60 years has only 6.2% of the patients. The mean age of the patients was 38.71 ± 13.52 years. Christodoulou A et al,[11] reported a median age of 73.2 years among their elderly patients of supracondylar fracture. Kumar A et al,[12] reported a median age of 83 years (62 ± 100 years) among their 16 female patients where low velocity fracture were the cause in all of them.

More than half of the patients in this study had their right femur (60%) fractured. 40% (39) of the patients had their left femur fractured. The pattern of distal femur fracture was classified according to Orthopaedic Trauma Association Classification, most of the patients in this study had type 33A1 (64%) followed by type33A2 (30%). Only 6% (6) of the patients had type 33A3 fracture. Christodoulou A et al,[11] reported 34% type 33A1, 40% type 33A2, 14% type 33A3, 8% type 33C1 and 6% type 33C2 among their population of supracondylar fracture femur. Loya LS et al,[9] also reported 34% type A1, 53% typeA2 and 13% type A3 fracture in their study population which is more or less similar to the current study finding. Remaining 8% had open fracture soft tissue status. Maximum of the patients were given SA (spinal anaesthesia) with 98% (95) followed by GA (general anaesthesia) with only 2% (2). Loya LS et al,[9] and Kumar A et al,[12] reported all of their study population had closed fractures.

In this study the mean amount of blood loss was 250.52 ± 104.21 ml during the operation and the mean duration of operation was 104.02 ± 18.18 minutes. Christodoulou A et al,[11] reported mean blood loss of 118 ± 20.18 ml during operation and mean operative time was 92 ± 8.57 minutes of retrograde intramedullary nailing of their study population. Loya LS et al,[9] reported the average operative time was 68.20 mins, with the highest time taken by type A3 which is lesser than this study. Ingman AM et al,[13] reported the mean duration of operation for percutaneous retrograde nailing as 59.9 (range 40–95) minutes which is also lesser than the current study finding.

The mean duration of follow up period of the patients in this study was 18.88 ± 2.46 months with a range of 15 weeks to 24 weeks. The mean time of full weight bearing was 12.73 ± 1.68 weeks with a range of 10 weeks to 20 weeks. Loya LS et al,[9] reported an average in 11.68 weeks for full weight bearing which is similar to this study finding. The mean follow up for the IMN was 4.1 years (1.0–9.5) in astudy by Howard A et al.[14] Postoperative weightbearing is progressive and is dependent on the fracture stability. In patients with osteoporotic bone, weightbearing was not suggested until callus formation was seen on radiographs (4 to 6 weeks).

The mean time of union of bone was seen in 13.15 ± 1.43 weeks with a range of 12 to 20 weeks. Christodoulou A et al,[11] reported the mean fracture union of their study population to be 4.91 ± 1.45 months. Loya LS et al,[9] reported an average radiological union time of 16 weeks.

In the current study, the mean range of motion for flexion of the knee joint of the patients was 123.97 ± 7.14 degrees with the range of 100 to 130 degrees. Neer's functional and anatomical outcome was assessed and there was excellent outcome in 56 (57.7%) patients, good outcome in 37 (38.1%) patients and fair outcome was seen in only 4 (4.2%) patients. None of the patient had poor outcome. Christodoulou A et al,[11] reported 85% to regain full mobility, 11% could walk with stick and one patient remained bedridden. According to the criteria set by Schatzker and Lambert their results were graded as excellent in 51%, good in 31%, moderate in 9% and poor in 9%. Kumar A et al,[12] reported an average range of motion at the knee of 100.68, with an average extensor lag of 6.98. Thus, retrograde intramedullary nailing for supracondylar fracture has given excellent and good results in most of the studies which is in line with the current study.

In this study, knee pain was the commonest complications with 15.5% followed by superficial infection (5.2%) and shortening (4.1%). Maximum (74.2%) of the patients did not encounter any complications at follow up. Christodoulou A et al,[11] reported 6% stiffness of the knee, 6% non-unions and 6% varus deformities as complications. Watanabe Y et al,[15] reported three varus/valgus deformities greater than 5° at the fracture site, two cases with loosening of the distal locking screws, and two cases with breakage of the distal locking screws.

## CONCLUSION

Supracondylar fractures of the femur were most commonly observed in young males, predominantly of type 33A1 and 33A2 patterns. Retrograde intramedullary nailing provided excellent to good functional and anatomical outcomes with minimal complications. The procedure demonstrated reliable fracture union, satisfactory range of motion, and early weight-bearing. Age and fracture pattern did not significantly influence the overall outcome, confirming the effectiveness and safety of this surgical technique.

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