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Evaluation of the results of intramedullary nailing of subtrochanteric femur fractures using either open or closed technique: a prospective study

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ABSTRACT

Background: Subtrochanteric femur fractures constitute a difficult subset of proximal femoral injuries owing to the complex biomechanical stresses acting across the region. Although intramedullary nailing is the preferred fixation method, there remains controversy regarding whether open or closed reduction provides better clinical outcomes.
Methods: A prospective cohort study was conducted at Dr. RPGMC Tanda from 2022–2024 including 40 patients with subtrochanteric femur fractures. Patients were divided into two groups: open reduction internal fixation (ORIF) with intramedullary nail (n=18) and closed reduction internal fixation (CRIF) with intramedullary nail (n=22). Demographic, perioperative, and outcome parameters were analyzed. Functional outcome was assessed using the Merle d'Aubigné hip score. Statistical analysis was performed using SPSS v25.0; $p<0.05$ was considered significant.
Results: Mean age was 53.2±20.8 years. The mean operative time was significantly higher in the open group (124.2±24.9 min) than the closed group (94.6±9.8 min, $p<0.001$). Blood loss was greater in the open group (274.4±88.5 ml vs. 103.9±44.7 ml, $p<0.001$). Mean union time was 17.7±4.6 weeks in open versus 19.6±5.0 weeks in closed group ($p=0.29$). The open group demonstrated significantly higher Merle d'Aubigné scores at 18–42 weeks ($p<0.05$). Complication rates were similar between groups, with superficial infection noted in two open cases.
Conclusion: Both open and closed techniques of intramedullary nailing are effective for subtrochanteric fractures. Although open reduction entails longer surgery and higher blood loss, it allows better anatomical reduction and improved mid-term functional outcomes without increasing major complications.

Keywords: Subtrochanteric fracture, Intramedullary nail, Open reduction, Closed reduction, Merle d'Aubigné score, Femur

INTRODUCTION

Subtrochanteric femur fractures represent approximately 10–34% of all hip fractures and are among the most complex fractures to manage due to the high stresses acting across this region.[1,2] The subtrochanteric region extends from the lesser trochanter to about 5 cm distally, where the thick cortical bone and limited vascularity contribute to delayed union and implant-related complications.[3] These fractures typically result from high-energy trauma in younger individuals or low-energy falls in elderly osteoporotic patients.[4,5] The incidence increases with age, and women are more frequently affected due to osteoporosis.[6,7] With the global rise in life expectancy, the burden of subtrochanteric fractures is expected to increase significantly in developing countries such as India.[8] Historically, conservative management with traction was associated with high rates of malunion, nonunion, and prolonged immobilization. The introduction of intramedullary devices, such as the proximal femoral nail (PFN), revolutionized treatment by providing superior biomechanical stability, allowing early mobilization and

reducing the risk of fixation failure compared with extramedullary devices.[9-11] However, controversy persists regarding the choice between open and closed reduction during intramedullary fixation. While closed reduction preserves biology and reduces soft-tissue trauma, open reduction may offer superior alignment and rotational control, especially in comminuted fractures or failed closed attempts.[12,13] Some studies report higher infection or nonunion rates after open reduction, while others find no significant difference in outcomes.[14,15]

Given the conflicting literature, this study aims to evaluate and compare the clinical, radiological, and functional outcomes of open versus closed techniques of intramedullary nailing in subtrochanteric femur fractures, with special emphasis on operative parameters, complications, and union rates.

METHODS

Study design and setting

A prospective cohort study was conducted in the Department of Orthopaedics, Dr. Rajendra Prasad Government Medical College, Kangra at Tanda (Himachal Pradesh, India).

Sample and eligibility

Forty patients presenting with subtrochanteric femur fractures were included.

Inclusion criteria

Extra-capsular proximal femur fractures extending ≤5 cm below the lesser trochanter, age > 18 years, willingness to provide informed consent

Exclusion criteria

Pathological or segmental femoral fractures, ipsilateral neck femur fractures, medically unfit or unwilling patients.

Procedure

Patients were allocated into two groups.

Group A (open reduction)

ORIF with intramedullary nail (with or without cerclage/plate).

Group B (Closed reduction)

CRIF with intramedullary nail under fluoroscopic guidance.

All surgeries were performed under spinal or general anesthesia on a fracture table. Prophylactic antibiotics were administered pre-operatively. Closed reduction was attempted first in all cases; if satisfactory alignment was not achieved, open reduction through a standard lateral approach was performed.

The implant of choice was the PFN in 37 patients; three cases required a standard interlocking nail. Supplementary fixation (cerclage wire, trochanteric or PHILOS plate) was used in difficult reductions (9 of 18 open cases).

Post-operative care and follow-up

Quadriceps and ankle exercises were initiated on postoperative day 1. Partial weight bearing began at 6 weeks, progressing to full weight bearing as tolerated. Follow-ups were conducted at 2 weeks, 6 weeks, and then every 6 weeks up to 1 year.

Functional assessment used the Merle d'Aubigné and Postel scoring system. Radiological union was defined as cortical bridging in three of four cortices.

Statistical analysis

Categorical variables were expressed as numbers and percentages. Continuous data were reported as mean±SD. Normality was assessed by Shapiro–Wilk test. t-test, Mann–Whitney U test, and Fisher's exact test were used as appropriate. $p<0.05$ was considered statistically significant.

RESULTS

A total of 40 patients (22 closed, 18 open) were analyzed.

Table 1: Demographic characteristics.

Parameter	Closed (n=22)	Open (n=18)	P value
Mean age (in years)	59.5±23.3	45.5±14.5	0.026
Male:Female	10:12	14:4	0.054
Lower-middle socioeconomic status	59.1%	72.2%	0.51
Comorbidities present	22.7%	0%	0.08

Table 2. Perioperative variables.

Variable	Closed	Open	P value
Operative time (min)	94.6±9.8	124.2±24.9	<0.001
Blood loss (ml)	103.9±44.7	274.4±88.5	<0.001
Transfusion required	18.2%	66.7%	0.003
Hospital stays (in days)	8.7±2.0	10.1±3.2	0.12

Table 3. Functional outcomes (Merle d'Aubigné score).

Time point	Closed	Open	P value
6 weeks	8.9±1.0	9.2±1.0	0.50
12 weeks	10.6±1.0	11.0±1.2	0.27
18 weeks	12.1±1.2	13.1±1.3	0.024
24 weeks	13.3±1.7	14.8±1.6	0.016
42 weeks	15.9±2.2	17.9±0.4	0.004

Table 4. Complications.

Complication	Closed (n=22)	Open (n=18)
None	86.4%	83.3%
Superficial infection	0%	11.1%
Delayed union	4.5%	5.6%
Non-union	4.5%	0%
Revision surgery	4.5%	0%

Intraoperative parameters

The mean operative time was significantly higher in the open group (124.2±24.9 min) compared with the closed group (94.6±9.8 min, $p<0.001$). Mean blood loss was 274.4±88.5 ml in open vs. 103.9±44.7 ml in closed group ($p<0.001$). Blood transfusion was required in 66.7% of open and 18.2% of closed cases ($p=0.003$).

Union and functional outcomes

Radiological union was achieved in 95.4% of closed and 88.9% of open cases (NS). Mean time to union was slightly faster in open reduction (17.7 weeks) compared to closed (19.6 weeks). The Merle d'Aubigné score improved steadily in both groups, with significant superiority in the open group from 18 weeks onward ($p<0.05$).

Complications

Overall complication rate was comparable between groups ($p=0.50$). Superficial infection occurred in two open cases; both resolved with antibiotics. One closed case had loss of reduction requiring re-operation, and one had delayed union treated conservatively.

DISCUSSION

Subtrochanteric fractures are notorious for their instability and high mechanical stresses. Achieving anatomical reduction and stable fixation is crucial to avoid complications such as malunion and implant failure.[2,9] The mean age (53 years) and predominance of male patients in this study are consistent with Indian demographic patterns, where high-energy trauma remains a leading cause among younger adults.[4,10] Similar observations were reported by Zhou et al and Kumar et al.[11,12] The current study confirms that open reduction requires longer operative time and greater blood loss, as shown by Panteli et al and Kim et al. Nevertheless, despite increased surgical exposure, infection and nonunion rates were not significantly higher, in agreement with Knauf et al and Karayiannis et al.[13-16] Functionally, the open group exhibited significantly higher Merle d'Aubigné scores from 18 weeks onward, suggesting better anatomical alignment and earlier restoration of biomechanics. Similar findings were noted by Miedel et al and Codesido et al who reported that optimal reduction directly influences hip function and reoperation rates.

The mean union time (≈18 weeks) compares favorably with global data.[15-19] None of the patients in our study developed deep infection or implant failure, reinforcing that open reduction, when performed carefully, does not compromise healing. Thus, open reduction should not be avoided when closed reduction fails to achieve acceptable alignment. The benefits of precise reduction and mechanical stability outweigh the minor risks of increased blood loss or wound complications.

CONCLUSION

Both open and closed intramedullary nailing techniques are effective for managing subtrochanteric femur fractures. Open reduction achieves better anatomical alignment and improved medium-term functional outcomes, albeit at the cost of longer operative time and increased blood loss. Closed reduction remains preferred when satisfactory alignment is achievable.

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