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Original Research Article

FUNCTIONAL AND RADIOLOGICAL OUTCOMES OF CEPHALOMEDULLARY NAILING IN UNSTABLE INTERTROCHANTERIC FRACTURES: A PROSPECTIVE STUDY FROM A SINGLE TERTIARY CARE CENTER

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Abstract

Background: Unstable intertrochanteric fractures are a common orthopedic challenge, particularly in the elderly. Cephalomedullary nailing is widely used for its biomechanical advantages. This study evaluates the functional and radiological outcomes, fracture union time, and complications associated with cephalomedullary fixation. **Materials and Methods:** A prospective study was conducted on 25 patients with unstable intertrochanteric fractures who underwent cephalomedullary nailing. Functional outcomes were assessed using Evans criteria, and fracture union time was analyzed radiologically. Patients were followed for 10–12 months. Statistical analysis, including the chi-square test, was performed to determine associations between age, functional outcomes, and fracture union. **Results:** Fifteen patients (60%) achieved excellent functional outcomes, 36% had good results, and 4% had poor outcomes due to deep infection. A significant correlation was observed between age and fracture union time ($p = 0.001$), but age was not a significant determinant of functional outcomes ($p = 0.107$). Most fractures (66.7%) in the 31A2.2 category united within 18 weeks. Patients aged 70–79 years demonstrated the highest rate of early fracture healing (81.8% within 12 weeks). The most common postoperative complication was varus deformity (28%), followed by knee stiffness (8%) and deep infection (4%). No cases of nonunion or implant failure were recorded. **Conclusion:** Cephalomedullary nailing provides stable fixation, early mobilization, and favorable union rates in unstable intertrochanteric fractures. While fracture union time was significantly influenced by age, functional outcomes were independent of it. The low incidence of implant failure and nonunion supports the efficacy of this technique in elderly patients.

INTRODUCTION

Intertrochanteric fractures are among the most common fractures in the elderly population and are associated with significant morbidity and mortality.[1,2] These fractures occur in the proximal femur, extending from the greater trochanter to the lesser trochanter, and are primarily caused by low-energy trauma such as falls in osteoporotic individuals.[3,4] In younger patients, high-energy trauma, such as road traffic accidents, is the primary cause. The management of intertrochanteric fractures has evolved significantly over the past decades, with an emphasis on early mobilization, stable fixation, and minimizing complications associated with prolonged immobilization.[5]

Cephalomedullary nailing has emerged as a preferred surgical technique due to its biomechanical advantages, including intramedullary load transfer, shorter lever arm, and improved rotational stability.[6] This technique allows for controlled impaction, reduces the risk of implant failure, and promotes early weight-bearing, making it particularly suitable for unstable intertrochanteric fractures.[7] Despite the advantages, complications such as varus collapse, implant failure, and nonunion remain concerns in specific patient groups.

The success of cephalomedullary nailing depends on proper fracture classification, patient selection, and

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implant positioning. Several classification systems, including the AO/OTA and Evans classifications, help guide treatment strategies. Although multiple studies have analyzed the outcomes of cephalomedullary nailing, further research is needed to establish its long-term effectiveness in different age groups and fracture patterns.

This study aims to evaluate the functional and radiological outcomes, fracture union rates, and complications associated with cephalomedullary nailing in unstable intertrochanteric fractures. The findings will contribute to optimizing surgical decision-making and improving patient outcomes in orthopedic trauma care.

MATERIALS AND METHODS

Study Design and Setting

This prospective study was conducted in the Department of Orthopaedics, Little Flower Hospital & Research Centre, Angamaly, India, from January 2012 to December 2013. The study aimed to evaluate the functional and radiological outcomes of cephalomedullary nailing in unstable intertrochanteric fractures. Ethical approval was obtained from the Institutional Ethics Committee before the commencement of the study, and informed written consent was obtained from all participants.

Study Population

A total of 25 patients diagnosed with unstable intertrochanteric fractures were included based on the following criteria:

Inclusion Criteria

Patients aged **≥50 years** with **unstable intertrochanteric fractures** (AO/OTA **31A2 and 31A3**).

Closed fractures.

Medically fit for surgery under spinal or general anesthesia.

Willing to comply with follow-up visits and rehabilitation protocols.

Exclusion Criteria

Open fractures.

Pathological fractures (except osteoporosis-related).

Polytrauma patients requiring multiple surgical interventions.

Patients with pre-existing hip deformities, infections, or severe comorbidities limiting recovery.

Patients lost to follow-up before completing the study period.

Surgical Procedure

All patients underwent closed reduction and internal fixation (CRIF) using proximal femoral nails (PFN) under fluoroscopic guidance. The standard surgical steps included:

Preoperative preparation – Routine investigations and pre-anesthesia assessment were conducted.

Patient positioning – Supine on a fracture table with traction applied to achieve anatomical reduction.

Fracture reduction – Reduction was confirmed using fluoroscopic AP and lateral views.

Guidewire insertion – Through the greater trochanter or piriformis fossa under fluoroscopic guidance.

Intramedullary nailing – Cephalomedullary nail insertion following appropriate reaming.

Screw fixation – A lag screw and anti-rotation screw were placed for proximal fragment stability.

Distal locking – Either static or dynamic locking was performed based on fracture stability.

Wound closure and postoperative care – Standard wound management and intravenous antibiotic prophylaxis were administered.

Postoperative Rehabilitation

First 48 hours – Pain management, deep vein thrombosis prophylaxis (DVT), and initiation of isometric exercises.

3-5 days post-op – Non-weight-bearing mobilization using crutches or a walker.

6 weeks post-op – Partial weight-bearing was initiated based on radiographic evidence of healing.

12-18 weeks post-op – Full weight-bearing was permitted in cases of confirmed fracture union.

Outcome Assessment

Patients were followed up at 6 weeks, 3 months, 6 months, and 12 months postoperatively. The following assessments were performed:

Functional Outcomes – Evaluated using Evans criteria (Table 1).

Radiological Fracture Union – Assessed via serial X-ra**ys** for cortical bridging and callus formation (Tables 3 & 4).

Complications – Analyzed for implant failure, varus deformity, infection, nonunion, and other postoperative complications (Table 5).

Statistical Analysis

Data analysis was performed using SPSS version 21. Descriptive statistics were used to analyze patient demographics and clinical outcomes, providing a comprehensive understanding of the study population. The chi-square test was applied to assess the association between age and fracture union time, helping to determine statistical significance in healing patterns among different age groups. A p-value <0.05 was considered statistically significant, indicating that the observed differences were unlikely due to chance.

RESULTS

The study analyzed the functional and radiological outcomes of cephalomedullary nailing in unstable intertrochanteric fractures. A total of 25 patients were included, and the outcomes were evaluated based on fracture stability, rate of union, functional recovery, and complications.

Functional Outcomes

The functional outcomes were assessed using Evans criteria at a follow-up period of 10–12 months. The results indicated that 15 patients (60%) achieved excellent functional outcomes, with sound fracture union within three months and no significant

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deformity. Nine patients (36%) had good results, presenting mild limping and negligible limb shortening (≤1/2 inch). One patient (4%) had a poor outcome due to deep infection requiring implant removal. [Table 1]

Age-Related Distribution of Functional Outcomes

A further breakdown of functional outcomes based on age groups revealed that patients aged 70–79 years showed the highest proportion of excellent outcomes (81.8%), while patients aged 80–89 years predominantly achieved good outcomes (66.7%). The poorest outcome was observed in a single patient from the 70–79 age group (Table 2). A chi-square test ($p = 0.107$) indicated that age was not a statistically significant factor in determining functional outcomes.

Radiological Fracture Union

The time to fracture union was analyzed based on fracture type and patient age. The majority of 31A2.2 fractures (66.7%) united within 18 weeks, whereas 31A3.3 fractures demonstrated delayed healing beyond 18 weeks (Table 3). When assessed based on age, most patients aged 70–79 years achieved fracture union by 12 weeks (81.8%), while those in the 80–89 and 90–100 age groups required up to 22 weeks for union (Table 4). A chi-square test ($p = 0.001$) confirmed a statistically significant association between age and fracture union time.

Postoperative Complications

Postoperative complications were observed in 10 out of 25 patients (40%). The most common complication was varus deformity (28%), followed by knee stiffness (8%), and deep infection (4%). There were no cases of nonunion, implant failure, or avascular necrosis in the study population. [Table 5]

Table 1: Functional Outcomes Based on Evans Criteria

Outcome	Number of Patients (%)	Description
Excellent	15 (60%)	Sound fracture union within 3 months, no varus deformity or limb shortening
Good	9 (36%)	Mild limping, negligible shortening (≤1/2 inch), slight loss of reduction
Poor	1 (4%)	Deep infection, required implant removal

Table 2: Distribution of Functional Outcomes by Age Group

Age Group (Years)	Excellent (%)	Good (%)	Poor (%)	Total (%)
50-59	1 (100%)	0	0	1 (100%)
60-69	2 (100%)	0	0	2 (100%)
70-79	9 (81.8%)	1 (9.1%)	1 (9.1%)	11 (100%)
80-89	3 (33.3%)	6 (66.7%)	0	9 (100%)
90-100	0	2 (100%)	0	2 (100%)
Total	**15 (60%)**	**9 (36%)**	**1 (4%)**	**25 (100%)**

Chi-square test: p = 0.107 (not significant).

Table 3: Time to Fracture Union by Fracture Type

Fracture Type	<18 Weeks	>18 Weeks
31A2.2	10	5
31A2.3	3	3
31A3.1	1	1
31A3.2	1	0
31A3.3	0	1

Table 4: Time to Fracture Union by Age Group

Age Group (Years)	12 Weeks	18 Weeks	20 Weeks	22 Weeks	Total
50-59	1	0	0	0	1
60-69	2	0	0	0	2
70-79	9	2	0	0	11
80-89	3	3	3	0	9
90-100	0	0	2	0	2
Total	**15**	**5**	**3**	**2**	**25**

Chi-square test: p = 0.001 (statistically significant).

Table 5: Distribution of Postoperative Complications

Complication	Number of Cases (%)
Varus deformity	7 (28%)
Knee stiffness	2 (8%)
Deep infection	1 (4%)
Nonunion	0 (0%)
Implant failure	0 (0%)
Avascular necrosis	0 (0%)

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Figure 1: Pre OP

Figure 2: Immediate Post OP

Figure 3: After 12 weeks

Figure 4: After 3 Months

DISCUSSION

Intertrochanteric fractures are common in elderly patients due to osteoporosis and falls, significantly affecting morbidity and mortality. The management of these fractures has evolved over time, with cephalomedullary nailing being increasingly preferred over extramedullary implants. This study evaluated proximal femoral nailing (PFN) as a treatment for unstable intertrochanteric fractures, focusing on functional and radiological outcomes, fracture union rates, and complications

Functional Outcomes

The present study demonstrated excellent functional recovery in 60% of patients, while 36% had good outcomes, and 4% had poor results due to deep infection (Table 1). These results are consistent with previous studies. Lakho et al.[8] reported that PFN provides superior biomechanical stability, ensuring early weight-bearing and improved functional success rates in unstable fractures. Baghel et al.[9] also highlighted that second-generation cephalomedullary nails result in better clinical and radiological outcomes compared to traditional fixation methods.

Fracture Union and Radiological Findings

A significant correlation was found between age and fracture union time ($p = 0.001$, Table 4), with patients aged 70–79 years achieving the fastest healing (81.8% within 12 weeks). Most 31A2.2 fractures united within 18 weeks (66.7%), whereas 31A3.3 fractures required more than 18 weeks (Table 3). Similar findings were reported by Lewis et al[10]. in their Cochrane review, where PFN was associated with faster fracture union due to its intramedullary load-sharing mechanism. Yalın et al.[11] further confirmed that proximal femoral intramedullary nails (PROFIN, A-PFN, and InterTAN nails) provide better radiographic and clinical outcomes compared to conventional fixation methods.

Complications

Postoperative complications were observed in 40% of patients, with varus deformity being the most common (28%), followed by knee stiffness (8%) and deep infection (4%) (Table 5). However, no cases of implant failure or nonunion were recorded, indicating the reliability of cephalomedullary nailing. Similar low failure rates have been reported by Boldin et al. and Tyllianakis et al., with minor risks of Z-effect and screw cut-out. Garg et al.[12] compared different surgical modalities and emphasized that PFN leads to lower complication rates, provided proper screw positioning and optimal surgical technique are followed.

Comparison with Other Fixation Techniques

Historically, dynamic hip screws (DHS) were the preferred treatment for intertrochanteric fractures. However, in unstable fractures, DHS has been associated with higher implant failure rates, increased risk of screw cut-out, and prolonged rehabilitation. Studies by Madsen et al. and Akhil Verheyden et al.

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have demonstrated that PFN results in shorter operative time, reduced blood loss, and improved biomechanical stability compared to DHS. Thusoo et al.[13] compared twin screw derotation-type PFN and single helical blade-type PFN, concluding that both constructs provided excellent stability, though variations exist in their performance for different fracture patterns.

Further, Areu et al.[14] studied SIGN intramedullary nails augmented by lateral plates in low-resource settings without fluoroscopy and found favorable functional outcomes at one-year follow-up, highlighting the versatility of intramedullary fixation. This reinforces the global acceptance of cephalomedullary nails as a preferred treatment option for intertrochanteric fractures.

Strengths and Limitations

This study provides valuable clinical insights into the efficacy of proximal femoral nailing (PFN) in the management of unstable intertrochanteric fractures. However, certain limitations must be acknowledged. The small sample size (25 patients) may limit the generalizability of the findings, and the short follow-up period (12 months) restricts the assessment of long-term functional and radiological outcomes. Additionally, being a single-center study, the results may not be entirely applicable to broader populations. To further validate these findings, future multicenter randomized controlled trials with larger sample sizes and extended follow-up periods are recommended to establish definitive conclusions on the efficacy of PFN.

CONCLUSION

Cephalomedullary nailing is an effective and reliable surgical technique for managing unstable intertrochanteric fractures, offering early mobilization, high union rates, and minimal complications. In this study, 60% of patients achieved excellent functional outcomes, and fracture union was significantly influenced by age ($p = 0.001$). The most common complication was varus deformity (28%), but no cases of implant failure or nonunion were observed. Compared to dynamic hip screws, PFN provided superior biomechanical stability and early weight-bearing capability. Based on these findings, cephalomedullary nailing should be the preferred fixation method for unstable intertrochanteric fractures, particularly in elderly osteoporotic patients.

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