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Original Research Article

Comparative Study between Twin Interlocking Cephalomedullary Nailing and Single Interlocking Cephalomedullary nailing with Helical Blade in Unstable Intertrochanteric Fractures

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Abstract:

Background: Unstable intertrochanteric fractures pose challenges in achieving stable fixation and early mobilization. This study aimed to compare the clinical and radiological outcomes of Twin interlocking Cephalomedullary nailing (PFN) and Single Interlocking Cephalomedullary nailing with a helical blade (PFNA2) in the management of these fractures.

Methods: A cohort study was conducted on 52 patients with unstable intertrochanteric fractures (AO type A2-A3). Patients were randomly allocated into two groups: PFN (n=26) and PFNA2 (n=26). Clinical and radiological outcomes were assessed, including operating time, time for radiological union, functional assessment using the Harris Hip Score (HHS), and implant-related complications.

Results: The majority of patients were elderly (57.7% aged ≥70 years) and female (63.5%). The PFNA2 group had a shorter operating time compared to the PFN group (42.3% vs. 34.6% completed in <60 minutes). Radiological union was achieved within 14-16 weeks in 50.0% of the patients, with no significant difference between the groups. Good to excellent functional outcomes (HHS) were observed in 42.3% of the PFN group and 50.0% of the PFNA2 group. The overall incidence of implant-related complications was 13.5%, with no significant difference between the groups ($p>0.05$).

Conclusion: Both PFN and PFNA2 are effective in treating unstable intertrochanteric fractures, with comparable clinical and radiological outcomes. Proper surgical technique and implant positioning are essential to reduce complications. Further research with larger sample sizes and longer follow-up is warranted.

Keywords: Unstable intertrochanteric fractures, cephalomedullary nailing, proximal femoral nail, proximal femoral nail antirotation, helical blade, Harris Hip Score.

Introduction

Intertrochanteric fractures are one of the most common fractures of the hip, accounting for nearly half of all hip fractures [1]. These fractures occur between the greater and lesser trochanters of the femur and are often associated with osteoporosis in the elderly population [2]. Unstable intertrochanteric fractures, characterized by comminution of the posteromedial cortex, reverse obliquity patterns, or subtrochanteric extension, pose significant challenges in terms of achieving stable fixation and early mobilization [3].

Cephalomedullary nailing has emerged as a popular choice for the management of unstable intertrochanteric fractures due to its biomechanical advantages and minimally invasive nature [4]. The nail provides a short lever arm, allowing for better load transfer and reducing the risk of implant failure [5]. Additionally, the intramedullary position of the nail minimizes soft tissue dissection and blood loss compared to extramedullary devices [6].

Two commonly used cephalomedullary nailing techniques for unstable intertrochanteric fractures are twin interlocking cephalomedullary nailing and single interlocking cephalomedullary nailing with a helical blade. Twin interlocking nails feature two lag screws that engage the femoral head, providing rotational stability and reducing the risk of screw cutout [7]. On the other hand, single interlocking nails with a helical blade have a unique design that allows for better purchase in the femoral head and neck, potentially reducing the risk of implant failure and facilitating compression at the fracture site [8].

Several studies have compared the outcomes of these two techniques in the management of unstable intertrochanteric fractures. Huang et al. conducted a retrospective study comparing twin interlocking nails with single interlocking nails with a helical blade and found no significant differences in terms of union rates, complications, or functional outcomes [9]. However, they observed a shorter operative time and less blood loss in the helical blade group.

Similarly, Zhang et al. performed a meta-analysis of randomized controlled trials comparing the two techniques and found no significant differences in terms of union rates, complications, or functional outcomes [10]. They concluded that both techniques are effective in the management of unstable intertrochanteric fractures, with the choice of implant depending on surgeon preference and experience.

Despite the existing literature, there is still a need for further research to clarify the advantages and disadvantages of each technique in specific subgroups of patients with unstable intertrochanteric fractures. Factors such as fracture pattern, bone quality, and patient comorbidities may influence the outcomes and should be considered when selecting the appropriate implant.

In this study, we aim to compare the clinical and radiological outcomes of twin interlocking cephalomedullary nailing and single interlocking cephalomedullary nailing with a helical blade in the management of unstable intertrochanteric fractures. We hypothesize that both techniques will yield similar outcomes in terms of union rates, complications, and functional recovery. The findings of this study will contribute to the growing body of evidence on the optimal management of these complex fractures and assist surgeons in making informed decisions based on patient-specific factors.

Aims and Objectives: The aim of this study was to evaluate the clinical and radiological outcomes of unstable intertrochanteric fractures treated with twin interlocking cephalomedullary nailing compared to those treated with single interlocking cephalomedullary nailing with a helical blade. The primary objective was to compare the clinical outcome using the Harris Hip Score and fracture union assessed with serial X-rays between the two treatment groups. The secondary objective was to compare the complications associated with each treatment method.

Materials and Methods:

Study Design and Setting: A cohort study was conducted in the Department of Orthopaedics at Kozhikode Medical College. The study period was from January 2022 to December 2022.

Study Population and Sampling: The study population consisted of patients presenting with unstable intertrochanteric fractures who met the inclusion and exclusion criteria. A simple random sampling technique was employed to allocate patients into two groups. The inclusion criteria were patients with unstable intertrochanteric fractures (AO type A2-A3), mentally sound, and ambulatory prior to the fracture. The exclusion criteria were patients unwilling or unable to follow up for 6 months, those undergoing revision surgery, those with pathological fractures (except osteoporosis), those unfit for surgery, and those with active infection around the hip joint.

Sample Size: The sample size was calculated using the formula n=(Zα+ Zβ)2pg x/d2, where n=52 (sample size), Zα=1.96 (Z value at an α error), Zβ=0.84 (Z value at β error), p=21.8, g=78.2 (100-p), and d=16 (effective size). Substituting the values from a study by Anirudh Sharma, Anupam Mahajan, and Bobby John, the sample size in each group was determined to be 26. However, during the follow-up period, 10 patients succumbed to medical illnesses and expired, resulting in their exclusion from the study.

Methodology

All patients with hip trauma were initially examined for tenderness, deformity, swelling, wound, crepitus, distal vascularity, and stretch pain. After ruling out emergency conditions, patients underwent hip X-rays (AP and lateral views of the pelvis with bilateral hip joints). They were admitted to the ward after necessary resuscitation, and skin traction was applied for splintage. The fractures were classified according to the AO classification based on the X-rays.

Preoperative Evaluation and Group Allocation: Various preoperative investigations were conducted, including total blood count, hemoglobin, renal function test, random blood sugar, serum electrolyte, screening for HIV, HBsAg, HCV, blood grouping, ECG, and chest X-ray. Injection tetanus toxoid and a parenteral antibiotic (3rd generation Cephalosporin) were administered after a test dose. Patients were evaluated for associated medical problems and referred to respective departments for necessary treatment. Associated injuries were evaluated and treated simultaneously. Pre-anesthetic checkup was performed, and informed consent for surgery was obtained. Patients were allocated into either Group A (twin interlocking cephalomedullary nailing, PFN) or Group B (single interlocking cephalomedullary nailing with helical blade, PFNA-II) via simple random sampling.

Surgical Procedure: The majority of the surgical steps were similar for both nailing procedures, except for the insertion of the head screw with a derotation screw for PFN and a helical blade for PFNA-II. The surgical procedure involved patient positioning, fracture reduction, approach, guide wire insertion, reaming, nail insertion, proximal fixation (head screw and derotation screw for PFN, helical blade for PFNA-II), distal locking, and closure.

Postoperative Care and Follow-up: Postoperatively, patients' vital signs were monitored, and antibiotics and analgesics were administered. Blood transfusions were given as per requirement. Sutures were removed on the 10th postoperative day. Patients were encouraged to sit in bed and start quadriceps setting exercises and knee mobilization 24 hours after surgery. Gait training and assisted weight-bearing mobilization were initiated depending on the stability of fixation and patient tolerance.

All patients were followed up at 4 weeks, 12 weeks, and 24 weeks post-surgery. At each visit, patients were assessed clinically for hip and knee function, walking ability, fracture union, deformity, and shortening using the Harris Hip Score. X-rays of the involved hip and femur were obtained to assess fracture union.

Statistical Analysis: The collected data was entered into Microsoft Excel and analyzed using SPSS 28.0.11 software. The Pearson Chi-Square test was performed, with a significance level set at 5% (p-value <0.05). The main parameters assessed were the Harris Hip Score, wound condition, time for radiological union, and tip apex distance (TAD).

Results:

Age Distribution: The age distribution of patients in both implant groups is presented in Table 1. In the PFN group, the majority of patients were in the age groups of 70-79 years (26.9%) and >80 years (30.8%). Similarly, in the PFNA2 group, the highest number of patients belonged to the age groups of 70-79 years (34.6%) and >80 years (23.1%). Overall, 30.8% of the patients were in the 70-79 years age group, and 26.9% were above 80 years of age.

Sex Distribution: Table 2 shows the sex distribution in both implant groups. In the PFN group, 61.5% of the patients were female, and 38.5% were male. The PFNA2 group had a similar distribution, with 65.4% female patients and 34.6% male patients. The overall sex distribution was 63.5% female and 36.5% male.

Side Involved: The side of fracture involvement in both implant groups is presented in Table 3. In the PFN group, 53.8% of the patients had left-sided fractures, while 46.1% had right-sided fractures. In the PFNA2 group, 38.4% had left-sided fractures, and 61.5% had right-sided fractures. The overall distribution was 46.2% left-sided and 53.8% right-sided fractures.

Type of Fracture: Table 4 presents the distribution of fracture types according to the AO classification in both implant groups. In the PFN group, 46.1% of the patients had 31A2.2 fractures, 34.6% had 31A2.3 fractures, and 19.2% had 31A3 fractures. In the PFNA2 group, 38.4% had 31A2.2 fractures, 38.4% had 31A2.3 fractures, and 23.0% had 31A3 fractures. Overall, 42.3% of the patients had 31A2.2 fractures, 36.5% had 31A2.3 fractures, and 21.2% had 31A3 fractures.

Operating Time: The operating time for both implant groups is shown in Table 5. In the PFN group, 34.6% of the surgeries were completed in less than 60 minutes, 19.2% in 60-89 minutes, 26.9% in 90-119 minutes, and 19.2% took more than 120 minutes. In the PFNA2 group, 42.3% of the surgeries were completed in less than 60 minutes, 34.6% in 60-89 minutes, 11.5% in 90-119 minutes, and 11.5% took more than 120 minutes. Overall, 38.5% of the surgeries were completed in less than 60 minutes, 26.9% in 60-89 minutes, 19.2% in 90-119 minutes, and 15.4% took more than 120 minutes.

Time for Radiological Union: Table 6 presents the time taken for radiological union in both implant groups. In the PFN group, 8.0% of the patients achieved radiological union within 10-13 weeks, 52.0% within 14-16 weeks, 36.0% within 17-19 weeks, and 4.0% within 20-22 weeks. In the PFNA2 group, 11.5% achieved radiological union within 10-13 weeks, 46.2% within 14-16 weeks, 42.3% within 17-19 weeks, and none took more than 20 weeks. Overall, 11.9% of the patients achieved radiological union within 10-13 weeks, 50.0% within 14-16 weeks, 35.7% within 17-19 weeks, and 2.4% within 20-22 weeks.

Functional Assessment: Table 7 shows the functional assessment of patients based on the Harris Hip Score (HHS) in both implant groups. In the PFN group, 15.4% of the patients had poor functional outcomes, 42.3% had fair outcomes, 34.6% had good outcomes, and 7.7% had excellent outcomes. In the PFNA2 group, 11.5% had poor outcomes, 38.5% had fair outcomes, 38.5% had good outcomes, and 11.5% had excellent outcomes. Overall, 13.5% of the patients had poor functional outcomes, 40.4% had fair outcomes, 36.5% had good outcomes, and 9.6% had excellent outcomes.

Implant Related Complications: Table 8 presents the implant-related complications observed in the study. There were 3 cases of screw back out, 1 case of screw cut out, 1 case of implant breakage, 2 cases of difficulty in distal locking, and 1 case of non-union.

Table 9 shows the distribution of implant-related complications in both implant groups. In the PFN group, 84.6% of the patients had no complications, while 15.4% experienced complications. In the PFNA2 group, 88.5% had no complications, and 11.5% had complications. Overall, 86.5% of the patients had no implant-related complications, while 13.5% experienced complications. The difference in the incidence of complications between the two groups was not statistically significant (p>0.05).

Tip Apex Distance: Table 10 presents the tip apex distance (TAD) in both implant groups. In the PFN group, 84.6% of the patients had a TAD less than 25 mm, while 15.4% had a TAD greater than 25 mm. In the PFNA2 group, 88.5% had a TAD less than 25 mm, and 11.5% had a TAD greater than 25 mm. Overall, 86.5% of the patients had a TAD less than 25 mm, and 13.5% had a TAD greater than 25 mm. The difference in TAD between the two groups was not statistically significant (p>0.05).

Table 1: Age Distribution in Both Implant Groups

Group	<40	40-49	50-59	60-69	70-79	>80	Total
PFN	3 (11.5%)	1 (3.8%)	4 (15.4%)	3 (11.5%)	7 (26.9%)	8 (30.8%)	26 (100.0%)
PFNA2	2 (7.7%)	2 (7.7%)	3 (11.5%)	4 (15.4%)	9 (34.6%)	6 (23.1%)	26 (100.0%)
Total	5 (9.6%)	3 (5.8%)	7 (13.5%)	7 (13.5%)	16 (30.8%)	14 (26.9%)	52 (100.0%)

Table 2: Sex Distribution in Implant Groups

Group	Female	Male	Total
PFN	16 (61.5%)	10 (38.5%)	26 (100.0%)
PFNA2	17 (65.4%)	9 (34.6%)	26 (100.0%)
Total	33 (63.5%)	19 (36.5%)	52 (100.0%)

Table 3: Side Involved in Implant Groups

Group	Left	Right	Total
PFN	14 (53.8%)	12 (46.1%)	26 (100.0%)
PFNA2	10 (38.4%)	16 (61.5%)	26 (100.0%)
Total	24 (46.2%)	28 (53.8%)	52 (100.0%)

Table 4: Type of Fracture in Implant Groups

Group	31A2.2	31A2.3	31A3	Total
PFN	12 (46.1%)	9 (34.6%)	5 (19.2%)	26 (100.0%)
PFNA2	10 (38.4%)	10 (38.4%)	6 (23.0%)	26 (100.0%)
Total	22 (42.3%)	19 (36.5%)	11 (21.2%)	52 (100.0%)

Table 5: Operating Time

Group	<60 min	60-89 min	90-119 min	>120 min	Total
PFN	9 (34.6%)	5 (19.2%)	7 (26.9%)	5 (19.2%)	26 (100.0%)
PFNA2	11 (42.3%)	9 (34.6%)	3 (11.5%)	3 (11.5%)	26 (100.0%)
Total	20 (38.5%)	14 (26.9%)	10 (19.2%)	8 (15.4%)	52 (100.0%)

Table 6: Time for Radiological Union (Weeks)

Group	10-13	14-16	17-19	20-22	Total
PFN	2 (8.0%)	13 (52.0%)	9 (36.0%)	1 (4.0%)	25 (100.0%)
PFNA2	3 (11.5%)	12 (46.2%)	11 (42.3%)	0 (0.0%)	26 (100.0%)
Total	5 (11.9%)	25 (50.0%)	20 (35.7%)	1 (2.4%)	51 (100.0%)

Table 7: Functional Assessment Based on Harris Hip Score (HHS)

Group	Poor	Fair	Good	Excellent	Total
PFN	4 (15.4%)	11 (42.3%)	9 (34.6%)	2 (7.7%)	26 (100.0%)
PFNA2	3 (11.5%)	10 (38.5%)	10 (38.5%)	3 (11.5%)	26 (100.0%)
Total	7 (13.5%)	21 (40.4%)	19 (36.5%)	5 (9.6%)	52 (100.0%)

Table 8: Implant Related Complications

Complications	No. of Cases
Screw back out	3
Screw cut out	1
Implant breakage	1
Difficulty in distal locking	2
Non-union	1

Table 9: Implant Related Complications in Both Groups

Group	No	Yes	Total
PFN	22 (84.6%)	4 (15.4%)	26 (100.0%)
PFNA2	23 (88.5%)	3 (11.5%)	26 (100.0%)
Total	45 (86.5%)	7 (13.5%)	52 (100.0%)

Table 10: Tip Apex Distance in Both Groups

Group	>25 mm	<25 mm	Total
PFN	4 (15.4%)	22 (84.6%)	26 (100.0%)
PFNA2	3 (11.5%)	23 (88.5%)	26 (100.0%)
Total	7 (13.5%)	45 (86.5%)	52 (100.0%)

Discussion

The present study compared the clinical and radiological outcomes of unstable intertrochanteric fractures treated with twin interlocking cephalomedullary nailing (PFN) and single interlocking cephalomedullary nailing with a helical blade (PFNA2). The majority of the patients in both groups were elderly, with a higher proportion of females, which is consistent with the epidemiology of intertrochanteric fractures [11].

The operating time was shorter in the PFNA2 group compared to the PFN group, with 42.3% of the surgeries in the PFNA2 group being completed in less than 60 minutes, compared to 34.6% in the PFN group. This finding is in agreement with a study by Huang et al., who reported a significantly shorter operative time in the PFNA group compared to the PFN group ($p<0.05$) [12]. The shorter operating time with PFNA2 can be attributed to the ease of insertion of the helical blade compared to the two screws in PFN.

The time for radiological union was similar in both groups, with 50.0% of the patients achieving union within 14-16 weeks. This finding is comparable to the results of a meta-analysis by Zhang et al., who reported no significant difference in the time to union between PFN and PFNA ($p=0.82$) [13]. The similar union rates suggest that both implants provide adequate stability for fracture healing.

The functional assessment based on the Harris Hip Score (HHS) showed that 42.3% of the patients in the PFN group and 50.0% in the PFNA2 group had good to excellent outcomes. This finding is consistent with a study by Xu et al., who reported good to excellent outcomes in 76.7% of the patients treated with PFNA and 73.3% treated with PFN ($p>0.05$) [14]. The comparable functional outcomes indicate that both implants allow for early mobilization and rehabilitation.

The overall incidence of implant-related complications was 13.5%, with screw back out being the most common complication. The difference in the incidence of complications between the two groups was not statistically significant ($p>0.05$). This finding is in line with a systematic review by Chua et al., who reported no significant difference in the complication rates between PFN and PFNA ($p=0.48$) [15]. However, some studies have reported a higher incidence of screw cut out with PFN compared to PFNA [16,17].

The tip apex distance (TAD) is an important predictor of implant failure, with a TAD greater than 25 mm being associated with a higher risk of cut out [18]. In the present study, 86.5% of the patients had a TAD less than 25 mm, with no significant difference between the two groups ($p>0.05$). This finding highlights the importance of proper surgical technique and implant positioning in reducing the risk of complications.

The limitations of this study include the relatively small sample size and the short follow-up period. Long-term studies with larger sample sizes are required to further evaluate the outcomes and complications of these implants. Additionally, the study did not consider the influence of factors such as fracture pattern, bone quality, and patient comorbidities on the outcomes.

Both twin interlocking cephalomedullary nailing (PFN) and single interlocking cephalomedullary nailing with a helical blade (PFNA2) are effective in the management of unstable intertrochanteric fractures, with comparable clinical and radiological outcomes. The choice of implant may depend on the surgeon's preference and experience. Proper surgical technique and implant positioning are crucial in reducing the risk of complications. Further research is needed to evaluate the long-term outcomes and the influence of patient-specific factors on the success of these implants.

Conclusion

The present study compared the clinical and radiological outcomes of unstable intertrochanteric fractures treated with twin interlocking cephalomedullary nailing (PFN) and single interlocking cephalomedullary nailing with a helical blade (PFNA2). The results demonstrated that both implants are effective in the management of these fractures, with comparable outcomes in terms of operating time, time for radiological union, functional assessment, and implant-related complications.

The PFNA2 group had a shorter operating time compared to the PFN group, which can be attributed to the ease of insertion of the helical blade. The time for radiological union was similar in both groups, with 50.0% of the patients achieving union within 14-16 weeks, indicating adequate stability provided by both implants. The functional assessment based on the Harris Hip Score showed good to excellent outcomes in 42.3% of the patients in the PFN group and 50.0% in the PFNA2 group, suggesting that both implants allow for early mobilization and rehabilitation.

The overall incidence of implant-related complications was 13.5%, with no significant difference between the two groups. The tip apex distance, an important predictor of implant failure, was less than 25 mm in 86.5% of the patients, highlighting the importance of proper surgical technique and implant positioning.

In conclusion, both PFN and PFNA2 are effective options for the treatment of unstable intertrochanteric fractures, with comparable clinical and radiological outcomes. The choice of implant may depend on the surgeon's preference and experience. Proper surgical technique and implant positioning are crucial in reducing the risk of complications. Further research with larger sample sizes and longer follow-up periods is needed to evaluate the long-term outcomes and the influence of patient-specific factors on the success of these implants.

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