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Original Article

Comparison of postoperative pain between InterTan and proximal femoral nail anti-rotation in femoral intertrochanteric fractures: a retrospective study

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Abstract: Objective: To compare the postoperative pain experienced by elderly patients with unstable trochanteric fractures treated with proximal femoral nail anti-rotation (PFNA) and InterTan Nail, focusing on identifying differences among this demographic. Methods: A total of 40 elderly patients (age >80 years old) underwent treatment with either the PFNA Nail or InterTan Nail. Observational metrics included the Visual Analogue Scale (VAS) for pain, changes in implant position via X-ray, blood loss, fixation failures, and Harris Hip Scores (HHS) to assess complications and hip function at various time points. Results: The study included 26 patients in the PFNA Nail group (Group A) and 26 patients in the InterTan Nail group (Group B). No significant differences were found in the main observational indicators between the two groups (all P>0.05). Both groups showed significant improvement in HHS post-surgery (all P<0.05). However, early post-operative pain scores were lower in the Group B (3.65±1.2) compared to Group A (5.5±0.9) (P<0.001). Conclusions: Despite different implant materials being used, outcomes in both groups were consistent and reliable among elderly patients. No significant differences were observed in terms of postoperative functional recovery, mortality, or complications between the groups. Notably, in the early postoperative period (3 days postoperatively), the Group B demonstrated significantly superior pain scores.

Keywords: Elderly, InterTan, proximal femoral nail anti-rotation, intertrochanteric fractures, pain

Introduction

Many countries, particularly developed nations and regions in East Asia like China, are experiencing an aging population. The incidence of proximal femoral fractures is rising significantly, posing severe challenges for this demographic [1]. It is projected that the annual global incidence of these fractures will surpass 7 million within the next 40 to 50 years [2].

Trochanteric fractures, ranking as the second most common type of proximal femur fracture after femoral neck fractures, predominantly affect the elderly, often resulting from minor injuries [3, 4]. These patients frequently have pre-existing chronic diseases, which complicate treatment and increase mortality rates [5]. Due to age-related osteoporosis, these fractures are typically unstable and comminuted, increasing the likelihood of postoperative complications such as coxavara, fixation failure, femoral neck shortening, and implant breakage [6]. Currently, the consensus is that the ideal treatment involves timely surgical intervention characterized by precise reduction, shorter operation times, minimal invasiveness, and early postoperative weight-bearing [7-9].

The preference for implant types has shifted from extramedullary to intramedullary fixation devices for managing unstable intertrochanteric fractures. Historically, extramedullary fixation devices such as the dynamic hip screw have been associated with significant intraoperative blood loss, extensive soft tissue damage, and a higher incidence of postoperative fixation failure due to mechanical design deficiencies [10].

Intramedullary fixation devices such as the Proximal Femoral Nail Anti-rotation (PFNA™) from Synthes, Solothurn, Switzerland, are com-

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monly used for displaced fractures. The PFNA, featuring a helical neck blade, provides rotational and angular stability and is designed for minimal invasive insertion, which facilitates standardized and easy handling [11]. This device has shown superior clinical outcomes and biomechanical stability compared to older cephalomedullary devices [12]. However, despite its effectiveness in stabilizing unstable fractures, the PFNA may lead to stress concentration at the distal tip of the implant, increasing the risk of femoral shaft fractures [13, 14].

The InterTan nail (Smith & Nephew, Memphis, Tennessee), introduced in 2005, incorporates two cephalocervical screws in an integrated mechanism. This design allows for linear intraoperative compression and rotational stability of the head/neck fragments, offering enhanced resistance to implant cutout and reducing neck shortening [15]. Ruecker et al. reported satisfactory postoperative results with the InterTan nail in their study of the first 100 patients treated [15]. Zhang et al. also suggested that the InterTan nail may lead to fewer postoperative complications in patients with unstable trochanteric fractures [16]. However, the InterTan system has some drawbacks, such as higher cost, particularly in China, and the complexity of the required surgical skills.

Recent studies have shown a 59% reduction in the incidence of postoperative hip pain with the InterTan nail compared to the PFNA, with an average hip pain incidence of 6.1% versus 11.4% for other intramedullary nails [9]. Nonetheless, these findings are contentious. For instance, a study in Norway demonstrated that the PFNA performed well [11]. Notably, few studies have compared these approaches in elderly patients over 80 years old, who may require different treatment strategies due to aging factors. This study was thus initiated to fill this gap, with subsequent data and clinical outcomes documented for analysis. The authors declare no conflict of interest.

Materials and methods

In this retrospective study conducted from February 2023 to December 2023, we enrolled 26 patients over the age of 80 who underwent PFNA surgery. These patients were matched based on age, gender, weight, and fracture type. Similarly, another group of 26 patients underwent the InterTan procedure during the same period. Both groups were treated at the same institution, ensuring comparable treatment conditions.

Inclusion Criteria: Patients included were over 80 years of age, had fractures resulting from low-energy trauma, and suffered from a single fracture site with clear consciousness and normal pain sensation.

Exclusion Criteria: We excluded patients younger than 80 years, those with subtrochanteric fractures or extensions, fractures from high-energy trauma, open or pathologic fractures, multiple fractures, previous injuries involving lower limbs, and patients whose general physical condition could not tolerate radical surgery. Additionally, patients with Alzheimer's disease or any cognitive impairment were also excluded. Fractures were classified by an independent radiologist according to the AO/OTA classification [17].

A total of 40 patients met the study criteria. The participants were divided into two groups: the PFNA nail group (Group A, n=26) and the InterTan nail group (Group B, n=26) as illustrated in **Figure 1**. Both groups of patients were informed and consented to participate in the study, which was approved by the hospital's ethics committee.

Preoperative demographic data including sex, age, injured side, fracture type, and pre-existing conditions such as hypertension and diabetes were collected (**Table 1**). All patients underwent surgery within 2-7 days following their injury.

Surgical technique and perioperative treatment

After administering anesthesia, patients were positioned supine on a traction table. Initial attempts at closed axial traction reduction were made using a C-arm to achieve an optimal position on both AP and lateral views. Osteosynthesis was then performed following standard protocols recommended by the manufacturer and as previously described [15, 18].

Prophylactic antibiotics were administered 30 minutes prior to surgery, with an additional dose given within 24 hours postoperatively if necessary. Suction drains were placed for 48 hours, and low molecular weight heparin was

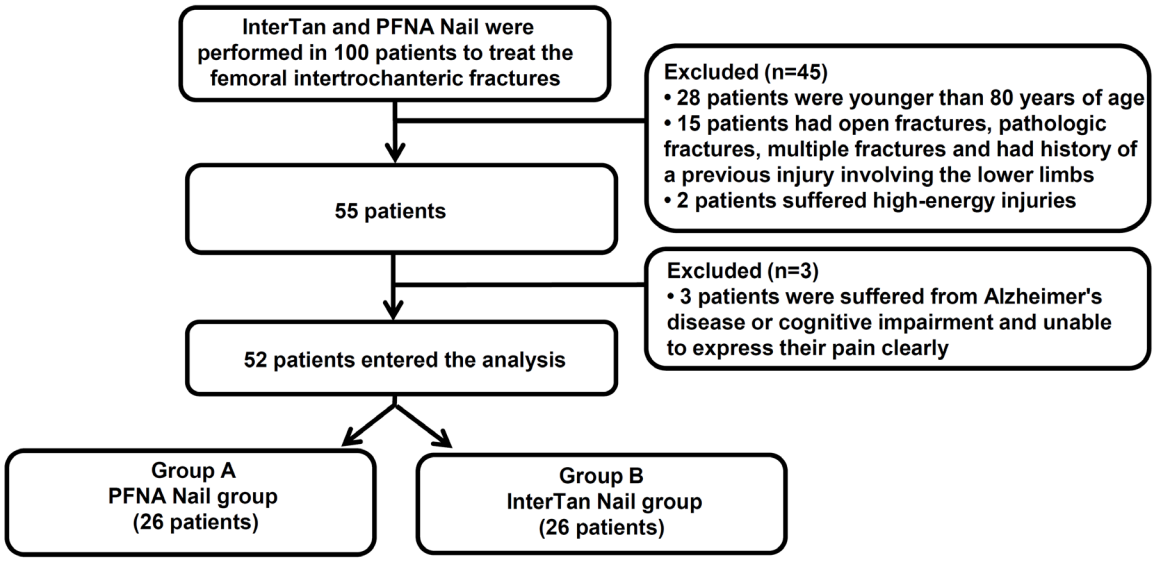

Figure 1. A flow diagram of the research.

Table 1. Comparison of preoperative demographic data

Participant Characteristics				
		Group A (n=26)	Group B (n=26)	*P* value
Age (years)		86.50±3.94	85.12±3.66	0.2860
Gender	Female	15 (57.69%)	16 (61.54%)	0.1115
	Male	11 (42.31%)	10 (38.46%)	
Fracture Side R		16 (61.54%)	15 (57.69%)	0.9733
	L	10 (38.46%)	11 (42.31%)	
Fracture Type (AO/OTA)	I	6 (23.07%)	4 (15.38%)	0.7466
	II	15 (57.69%)	18 (69.23%)	
	III	4 (15.38%)	4 (15.38%)	
Chronic	Diabetes	8 (30.77%)	9 (34.62%)	0.6076
Diseases	Hypertension	15 (57.69%)	16 (61.54%)	0.8641
	Heart Failure	4 (15.38%)	5 (19.23%)	0.8684
	Chronic Cerebral Infarction	16 (61.54%)	15 (57.69%)	0.6847
	Atrial Fibrillation	4 (15.38%)	5 (19.23%)	0.8684
	Pulmonary Infection	3 (11.54%)	4 (15.38%)	0.6313

administered to prevent deep venous thrombosis. Patients were confined to bed rest for the first two days post-surgery and were allowed to turn over once the drainage tubes were removed. Continuous passive motion was employed to aid in the recovery of muscle strength and joint function. Full weight-bearing was permitted only once the fracture line became obscured.

Perioperative details including anesthesia methods, pain scores, operation duration (from incision to suture), intraoperative blood loss, and length of hospital stays were meticulously recorded (**Table 2**).

Follow-up assessment

The primary postoperative outcomes measured were the pain assessment score of the affected limb at 3 days, 2 weeks, and 6 weeks, and the Harris Hip Score (HHS) evaluated before surgery, at 2 weeks, 6 weeks, and 1 year postoperatively. The HHS, a commonly used evaluation system for surgical results after hip surgery, includes a 100-point scale assessing

Table 2. Comparison of perioperative information

Participant Characteristics				
		Group A (n=26)	Group B (n=26)	*P* value
Time of Operation (min)		94.36±8.71	92.12±14.72	0.6134
Blood Loss (ml)		237.14±70.43	232.50±63.36	0.8370
Length of Hospital Stay (days)		17.21±5.66	18.38±7.52	0.6223
Transfusion		9 (34.61%)	12 (46.15%)	0.8416
Postoperative	Postoperative Delirium	3 (11.54%)	4 (15.38%)	0.6313
Complications	Deep Venous	0 (0.00%)	0 (0.00%)	>0.9999
	Wound Infection	2 (7.69%)	2 (7.69%)	>0.9999
	Cut Out	0 (0.00%)	0 (0.00%)	>0.9999
	Pneumonia	1 (3.85%)	2 (7.69%)	0.7466

pain, function, activity, deformity, and motion [19, 20]. Pain in the hip and thigh was quantified using the Visual Analog Scale (VAS). Regular anteroposterior and lateral radiographs were taken at each follow-up to monitor bone healing, with callus growth guiding the intensity of functional exercises and the level of weight-bearing. Fracture healing was defined by visible callus across the fracture line.

The secondary outcome was the rate of postoperative complications, including local issues such as superficial or deep wound infections, implant position changes (cut-out), femoral shaft fractures, coxavara, and nonunion (defined as the absence of radiographic callus across the fracture line at 1 year). General complications such as postoperative delirium, deep vein thrombosis, superficial wound infection, and pneumonia were also documented.

Statistical analysis

Statistical analyses were conducted using SPSS version 20.0 software. Continuous variables, such as age, mean operation time, blood loss volume, length of hospital stay, VAS, and HHS scores, were expressed as mean ± standard deviation (SD). These variables were evaluated using a two-tailed, unpaired Student's t-test for between-group comparisons. For intragroup before-and-after comparisons, a paired sample t-test was used. Categorical variables, including sex, injured side, fracture classification, and postoperative complications, were analyzed using the chi-square test where appropriate. A *p*-value of less than 0.05 between two groups was considered statistically significant.

Propensity score matching

Propensity scores were generated for each subject using a multivariable logistic regression model, accounting for covariates such as age, sex, and body mass index. These scores were utilized to create 1:1 matched pairs, matching PFNA users to InterTan users. The matching was performed using a nearest neighbor matching algorithm without employing a caliper method. This technique aimed to balance the two groups based on the specified covariates, thereby enhancing the comparability and robustness of the study findings.

Results

Comparison of preoperative demographic data

At the 1-year follow-up, three patients were lost to follow-up (one from the Group A and two from the Group B) and nine patients had died (four from PFNA and five from InterTan), as detailed in **Table 1**. There were no significant differences in gender, age, injured side, fracture classification, or preoperative disease between the two treatment groups, confirming comparable baseline characteristics (all P>0.05).

Comparison of perioperative data

As shown in **Table 2**, there were no significant differences in intraoperative blood loss, transfusion requirements, or length of hospital stay between the groups (all P>0.05).

Comparison of HHS and VAS scores

Statistical analysis revealed a significant main effect difference between the HHS and VAS

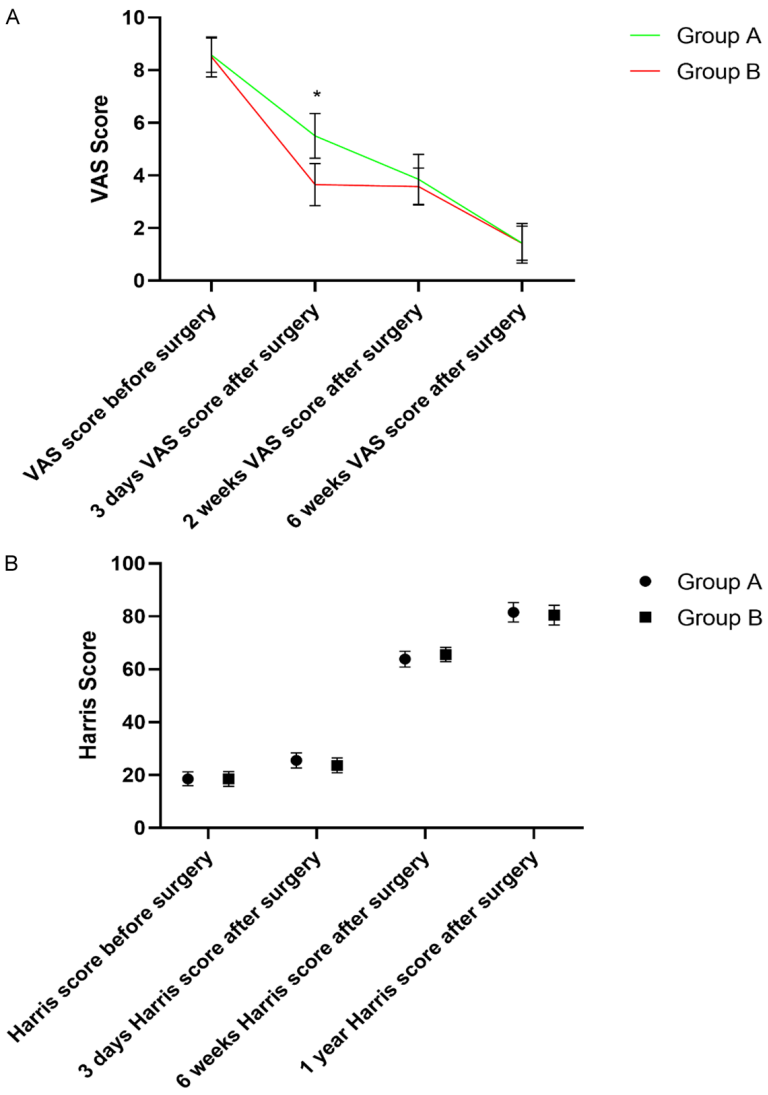

Figure 2. Comparison of VAS and HHS scores over time in Group A and Group B. A. Comparison of VAS scores over time in the two groups. B. Comparison of HHS scores over time in the two groups. *: Comparison of VAS Scores in the two groups, P<0.05. VAS, Visual Analogue Scale; HHS, Harris Hip Scores.

scores at different time points (P<0.001). There was a consistent significant main effect difference across the monitoring times (P<0.001), with interactions observed between groups and time points (P<0.001). At each measurement point, the HHS did not differ significantly between the groups (all P>0.05). However, on the third day post-surgery, VAS scores were significantly lower in the Group B than in the Group A (P<0.05), with no significant differences at other time points (P>0.05), as illustrated in **Figure 2**.

Comparison of postoperative complications

A total of 14 patients experienced complications, with six in Group A and eight in Group B, as shown in **Table 2**. The overall rate of complications did not differ significantly between the groups. No cases of cutting out or screw loosening were noted in either group (P>0.99). Superficial or deep infections were reported in four patients (two in each group; P>0.99). There were no instances of nonunion one year post-surgery. Similarly, there were no significant differences in general complications such as pneumonia, thrombosis, or postoperative delirium between the groups (all P>0.05).

Discussion

Our study assessed the clinical efficacy of two commonly used intramedullary nail devices for treating unstable intertrochanteric fractures. Consistent with prior research, hip pain is a prevalent postoperative issue, reported by over 90.1% of patients according to previous studies [22]. However, our findings in elderly patients revealed significant differences in early postoperative pain, diverging from earlier reports. Notably, the Group B experienced significantly less pain shortly after surgery compared to the Group A.

This reduction in pain can be attributed to two primary factors. Firstly, the blade lag screw of the PFNA may provide insufficient holding force in aged patients with severe osteoporosis, where micromotion at the fracture ends could induce postoperative pain. Secondly, the unique divarication design of the InterTan system likely helps dissipate stress around the nail tip, further alleviating thigh pain. This observation

aligns with findings from Lv et al. [23] and Ruecker et al. [15], who reported reduced hip and thigh pain using the PFNA-II or InterTan nails.

Importantly, the reduced pain observed in Group B during early postoperative activities may facilitate clinical treatment by encouraging patients' willingness for early rehabilitation. Despite similar early HHS function scores between groups, patients in the Group B were more cooperative with prescribed treatment plans. Conversely, patients treated with the PFNA often delayed starting functional exercises until experiencing pain relief. This dynamic suggests that less pain may directly influence patients' engagement and progress in functional recovery.

Our study corroborates existing research suggesting that early patient mobilization significantly reduces the risks of fatal pulmonary embolism and deep vein thrombosis, while prolonged bed rest can increase the likelihood of medical complications such as deep vein thrombosis, pulmonary issues, urinary tract infections, or skin damage [24]. Although long-term HHS outcomes indicate similar functional prognoses between the two groups, the lesser pain observed in Group B potentially facilitates earlier large joint exercises, enhancing initial functional rehabilitation, which is particularly beneficial for elderly patients.

Regarding operative times, our study found no significant differences between the groups, contrasting with some previous research [21]. We hypothesize that the inherently more complex procedure associated with the InterTan group may steepen the learning curve for novices.

Implant cutout and femoral shaft fractures are common complications post-trochanteric fracture surgery and remain contentious. A clinical trial by Wu et al. in 2014 found lower incidences of incision and femoral shaft fractures in the PFNA group, aligning with our findings [21]. It is speculated that the design and geometry of the nails contribute to these complications [25, 26]. The PFNA system's reliance on a single screw for fixation of the head and neck segment offers poor anti-rotation properties and insufficient holding force. This design flaw subjects the screw to excessive load during weight-bearing, potentially leading to screw loosening, varus collapse of the head and neck, and ultimately screw cutout. Furthermore, the PFNA nail's mediolateral curvature design places excessive load at the nail's tip, predisposing patients to femoral shaft fractures [27].

Conversely, the InterTan nail offers several theoretical advantages. It utilizes two head and neck screws in a hybrid worm gear mechanism, converting rotational forces into linear pressure during hip joint movement. Additionally, the "clothes-pin" design at the distal tip helps mitigate stress concentration around the nail, reducing the overall cross-sectional stiffness of the implant distally [15]. Our observations indicate that compared to younger individuals, elderly patients engage in less postoperative activity and have generally poorer physical strength, which hampers prolonged training and weight-bearing capabilities. Consequently, there are fewer adverse mechanical effect-related complications, such as cutout, in this demographic.

This study contains several strengths. It was pragmatically designed and adhered to CONSORT guidelines, executed with strict significance criteria. An 80% follow-up rate among patients enhanced the reliability of the results. However, the study also faced some limitations. The small patient cohort from a single center could diminish the statistical power of the analysis. Additionally, the lack of blinding for patients and assessors might have influenced the clinical outcome assessments.

Nonetheless, the study's impact is limited by its design and the small sample size. Factors such as the prevalence of comorbidities, limited daily activities, physical and cognitive decline among elderly patients introduce significant variability that could affect the evaluation and outcomes of the experiment.

In conclusion, there were no significant statistical differences between the InterTan and PFNA groups regarding long-term prognosis, including function and pain scores, or in overall postoperative complications in the treatment of femoral intertrochanteric fractures. Hospital stays and intraoperative blood loss were comparable between the two groups. However, the InterTan nail was notably effective in alleviating early postoperative pain, thereby enhancing

the quality of early postoperative life and potentially facilitating quicker functional recovery in elderly patients. Based on our findings, the InterTan nail appears to offer a competitive advantage over the PFNA nail for treating femoral intertrochanteric fractures in elderly populations.

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All patients' informed consent was obtained in this study.

Disclosure of conflict of interest

None.

Abbreviations

PFNA, Proximal Femoral Nail Anti-rotation; VAS, A visual analogue scale; HHS, Harris hip score; DHS, Dynamic hip screw; SD, Standard deviation.

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