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Original Article

Functional Outcome of Proximal Femoral Nail Antirotation (PFNA) in Proximal Femur Fracture

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ABSTRACT

Background: The Proximal Femoral Nail Antirotation (PFNA) has become a cornerstone in managing proximal femur fractures, offering varied outcomes across different studies. The technique's success, particularly in achieving acceptable reduction, stable fixation, and minimizing complications, significantly hinges on the precise understanding and execution of the implant's entry point.

Objective: This study aimed to evaluate the effectiveness of PFNA in treating proximal femur fractures within a tertiary care setting, focusing on patient outcomes post-surgery.

Methods: The study enrolled patients aged 18-60 years, of any gender, presenting with proximal femur fractures reported within two weeks of the injury. All participants underwent PFNA within three days of admission for definitive fracture fixation. The Harris Hip Score was utilized to assess functional outcomes at final follow-up, categorizing results into excellent, good, fair, and poor.

Results: Among the 125 patients, the mean age was 50.63 ± 8.36 years, comprising 55 (44%) males and 70 (56%) females. Functional outcomes were predominantly positive, with 47 (37.6%) achieving excellent, 21 (16.8%) good, 16 (12.8%) fair, and 14 (11.2%) poor outcomes. Statistical analysis revealed significant correlations between functional outcomes and several factors: age ($p<0.001$), gender ($p<0.001$), Body Mass Index (BMI) ($p<0.001$), comorbidities ($p<0.001$), fracture type ($p<0.001$), and injury mechanism ($p<0.001$).

Conclusion: The majority of patients treated with PFNA for proximal femur fractures experienced excellent functional outcomes, underscoring the procedure's effectiveness within the study's demographic. The significant associations between outcomes and patient-specific factors highlight the need for tailored surgical approaches.

Keywords: Body Mass Index, Comorbidities, Functional Outcome, Proximal Femoral Nail Antirotation, Proximal Femur Fracture, Surgical Technique, Tertiary Care.

INTRODUCTION

In the field of orthopedic surgery, proximal femur fractures represent a significant clinical challenge, reflecting both their widespread incidence and the considerable impact they have on patient morbidity and mortality, particularly among the elderly population (1). The prevalence of these fractures is on a notable rise, correlating directly with the increased life expectancy observed in recent decades (2). Currently estimated at around 230 per 100,000 individuals, with a concerning proportion (5-10%) occurring within the ST region, these fractures predominantly afflict individuals over 50 years of age, with females experiencing a 2-3 times higher incidence rate than males (3, 4). The classification of proximal femur fractures into neck of femur fractures, intertrochanteric fractures, and subtrochanteric fractures is essential for directing specific treatment strategies and managing the associated risks and complications (5). The comprehensive approach required for managing hip fractures emphasizes not only the need for swift surgical intervention but also the importance of addressing underlying medical conditions and facilitating early mobilization and rehabilitation to restore pre-fracture functional mobility and independence (6).

The introduction of various intramedullary nail designs, notably the Proximal Femoral Nail Antirotation (PFNA) and the Proximal Femoral Nail (PFN), has advanced the treatment of unstable fractures (7). While the PFN, with its dual screw system, has been linked

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to improved outcomes, its application is not without complications, fueling an ongoing debate over the most efficacious treatment modalities (8). This discourse is set against the backdrop of over 250,000 hip fractures annually recorded in the United States alone, primarily affecting the elderly, and carrying a dire prognosis with 1-year mortality rates between 14% and 36% (9). The early detection and accurate classification of hip fractures are paramount, as they guide the timely and appropriate treatment interventions that are crucial to averting severe complications such as avascular necrosis (AVN), fracture nonunion or malunion, and fixation hardware failure (10).

The biomechanical understanding of the hip and the structural integrity of the proximal femur highlight the crucial role of both cortical and trabecular bone in mitigating applied forces, revealing their anisotropic nature (7). Recent studies have also underscored the impact of osteoporosis, particularly the loss of trabecular bone, in predisposing individuals to fractures by altering force transmission through the medial cortex at the base of the femoral neck (8, 9). Moreover, the vascular anatomy of the proximal femur is integral in determining the optimal treatment approach, with fracture classification increasingly reflecting the potential for vascular compromise (11). This nuanced approach to treatment, considering both fracture type and the overarching goal of preserving or restoring blood flow to the femoral head, underscores the need for continued research and treatment protocol refinement to enhance patient outcomes (12).

The management of femoral head fractures, particularly those resulting from high-impact events such as car accidents or falls, adds another layer of complexity (13, 14). The Pipkin classification system, which categorizes these fractures based on their anatomical location and associated injuries, aids in treatment decision-making (15). Similarly, osteochondral impaction fractures present a diagnostic and therapeutic challenge, particularly in determining the direction of hip dislocations and identifying concurrent acetabular fractures (16).

The evolving treatment landscape, highlighted by the transition towards more individualized care and the consideration of patient-specific characteristics, demands a high level of expertise and adaptability from orthopedic surgeons. The adoption of the Russell-Taylor classification system for subtrochanteric fractures exemplifies this trend, providing a framework that informs surgical planning and implant selection (17). The management of atypical fractures, particularly those associated with long-term bisphosphonate therapy, further illustrates the complexity of treatment strategies, necessitating vigilant monitoring and, in some cases, prophylactic fixation to prevent complication progression (18).

The management of proximal femur fractures requires a multifaceted approach that integrates the latest advances in surgical techniques, a deep understanding of bone biomechanics, and a personalized treatment strategy that considers the unique characteristics of each patient. Despite the challenges, the orthopedic community continues to refine its methodologies, striving for optimal outcomes through a combination of early intervention, innovative treatment modalities, and ongoing research into the mechanisms underlying these common yet complex fractures.

MATERIAL AND METHODS

The study was meticulously designed as a descriptive research endeavor, conducted at the Department of Orthopaedics, Liaquat National Hospital, Karachi, over a span of six months from May 16, 2020, to November 16, 2020. A calculated sample size of 125 participants was deemed necessary, based on the WHO software calculations. This determination factored in the prevalence of an excellent outcome following the proximal femoral nail antirotation (PFNA) procedure in patients with proximal femur fractures, setting the prevalence (P) at 13.5%, with a margin of error at 6%, and a confidence level at 95%.

Employing a non-probability consecutive sampling technique, the study selected participants based on specified inclusion criteria: individuals of any gender, aged 18-60 years, presenting with any type of proximal femur fractures as defined operationally, and fractures reported within two weeks of injury. Exclusion criteria were also rigorously applied to ensure the integrity of the study's outcomes. Participants who did not consent, those with multiple traumas, open or infected fractures, hip arthritis, severe osteoporosis as diagnosed on X-rays, or patients with pathological fractures indicative of underlying conditions such as tumors or osteoporosis, were systematically excluded from the study.

Following the approval from the College of Physicians and Surgeons Pakistan (CPSP) and the institutional ethical & review committee, patients meeting the inclusion criteria were enrolled after obtaining informed consent, which allowed for the use of their data in research. A thorough clinical examination and complete patient history, including the history of comorbidities such as type 2 Diabetes Mellitus, Hypertension, cerebrovascular Accident, and Cardiovascular disease, were conducted. The diagnosis of fractures was confirmed through X-ray imaging of the involved hip.

All patients underwent PFNA for definitive fracture fixation within three days of admission, with fractures classified according to the AO/OTA classification system. The surgeries, performed under either general or spinal anesthesia by a consultant orthopedic surgeon with over five years of experience, followed a standard protocol for PFNA. The post-operative care included three doses of

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prophylactic antibiotic therapy initiated two hours before the operation and low-molecular-weight heparin administered daily for four weeks.

Clinical and radiographic assessments were carried out upon hospital admission, after one month, and subsequently at three-month intervals. Variables such as operation time, blood loss, duration of hospitalization, bone union, and functional outcomes were meticulously recorded and analyzed. Functional outcomes were assessed using the Harris Hip Score, categorizing results as excellent, good, fair, or poor according to predefined criteria.

Data were compiled and analyzed utilizing the Statistical Package for Social Sciences (SPSS) version 21. Quantitative variables like age, operation time, blood loss, hospital stay, and Harris Hip Score were summarized using means and standard deviations. In contrast, qualitative variables such as gender, comorbidities, type of fracture, and functional outcomes were presented as frequencies and percentages. Stratification techniques addressed potential effect modifiers or confounders, such as age and gender, allowing for a nuanced analysis of their impact on outcome variables. Statistical significance was determined using the t-test or chi-square test, with a p-value of ≤ 0.05 deemed significant.

RESULTS

Table 1: Demographic and Clinical Characteristics of Patients with Proximal Femur Fractures (n=125)

Characteristic	Mean ± SD	Minimum	Maximum
Age (years)	50.63 ± 8.36	35	60
BMI (kg/m^2)	26.01 ± 5.05	18.40	34.70

Table 1 presents the demographic and clinical characteristics of 125 patients who participated in the study aimed at evaluating the outcomes following proximal femoral nail antirotation (PFNA) in treating proximal femur fractures. The table delineates the mean age and Body Mass Index (BMI) of the patients, providing insight into the study population's general health profile. The age of the patients ranged from 35 to 60 years, with a mean age of 50.63 years, indicating a middle-aged cohort. The BMI values ranged from 18.40 to 34.70 kg/m^2, with a mean BMI of 26.01 kg/m^2, suggesting a population with a moderate average body mass, relevant to assessing the impact of PFNA treatment efficacy and recovery in a diverse patient demographic within the specified age and BMI ranges.

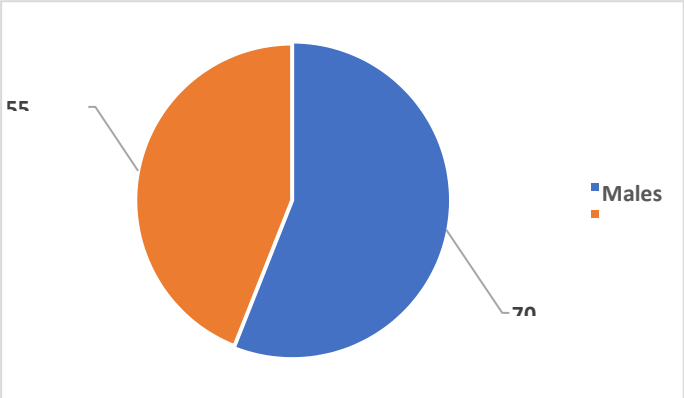

Figure 1 Gender distribution of the patients (n=125)

Table 2: Surgical and Postoperative Outcomes in Patients Undergoing PFNA for Proximal Femur Fractures (n=125)

Outcome Measure	Mean ± SD	Minimum	Maximum
Operative Time (mins)	68.28 ± 14.93	50	95
Blood Loss (ml)	315.40 ± 185.23	125	600
Harris Hip Score	3.22 ± 0.76	2	5

Table 2 summarizes the surgical and postoperative outcomes of 125 patients who underwent proximal femoral nail antirotation (PFNA) for the treatment of proximal femur fractures. The table reports on three critical aspects of the surgical procedure and recovery: the operative time, the amount of blood loss during surgery, and the functional outcomes measured by the Harris Hip Score. The operative time for the procedure ranged from 50 to 95 minutes, with an average duration of approximately 68 minutes, reflecting the efficiency of the surgical process. Blood loss during the procedure varied significantly among patients, with a mean value of 315.40 ml, indicating the variability in surgical complexity and patient response. The Harris Hip Score, a measure of

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postoperative recovery and function, averaged 3.22, with scores ranging from 2 to 5, suggesting a range of recovery outcomes among the patients. This table provides a comprehensive overview of the surgical and recovery experiences of patients treated with PFNA, highlighting the procedure's efficacy and the variability in patient outcomes.

Table 3: Comparison of Functional Outcome by Age and Gender in Patients Undergoing PFNA for Proximal Femur Fractures (n=125)

Variable	Category	Excellent	Good	Fair	Poor	p-value
Age	≤50 years	25 (33.8%)	21 (100%)	1 (6.3%)	0 (0%)	<0.001
	>50 years	49 (66.2%)	0 (0%)	15 (93.8%)	14 (100%)	
Gender	Males	46 (62.2%)	0 (0%)	10 (62.5%)	14 (100%)	<0.001
	Females	28 (37.8%)	21 (100%)	6 (37.5%)	0 (0%)	

Table 3 illustrates how age and gender influence functional outcomes after proximal femoral nail antirotation (PFNA) surgery in patients with proximal femur fractures. Analysis of 125 cases showed that individuals aged 50 or younger largely achieved excellent results, highlighting age as a critical factor in postoperative recovery, with a significant statistical correlation (p-value < 0.001). Similarly, gender differences were evident, with males displaying a range of outcomes and females predominantly experiencing good recovery, suggesting gender-specific responses to PFNA surgery. This underscores the importance of considering demographic variables in planning postoperative care to enhance recovery prospects following PFNA for proximal femur fractures.

DISCUSSION

The management of unstable intertrochanteric fractures, especially in the context of osteoporosis, presents a significant challenge for orthopedic surgeons (19). Osteoporosis, a prevalent condition in the elderly, exacerbates the difficulty of achieving stable fixation due to the increased risk of screw migration and implant failure, as highlighted by biomechanical and clinical studies. These complications have spurred ongoing efforts to enhance fixation techniques, such as the use of cement augmentation and innovative implant designs, in treating osteoporotic intertrochanteric fractures (20).

Introduced by the AO/ASIF group in 2004, the Proximal Femoral Nail Antirotation (PFNA) emerged as a cutting-edge solution designed specifically to address the complexities associated with these fractures (21). The PFNA's distinctive feature—a single blade with an extensive surface area—facilitates an exceptional fit through bone compaction, minimizing the need for extensive bone removal typical of screw systems (22). This design has been biomechanically validated to offer superior resistance against rotational forces and varus collapse, particularly beneficial in osteoporotic bone found in the elderly.

The current study, involving 125 patients, revealed a mean operative time of 68.28 minutes and a mean blood loss of 315.40 ml. The patients exhibited a mean Harris Hip Score of 3.22, indicating the functional success of the PFNA. These findings are in line with international research, which predominantly associates low-energy trauma, such as falls, with these fractures. The AO/OTA classification system further identified Type A2 fractures as the most common among patients, underscoring the PFNA's applicability across a broad spectrum of intertrochanteric fractures (23).

Comparative studies have similarly documented the efficacy of PFNA, noting significant variations in operative times, blood loss, and hospital stays, thereby affirming the PFNA's role in reducing surgical and recovery times. Remarkably, the maintenance of the neck shaft angle in a vast majority of cases and a relatively low incidence of secondary varus collapse further substantiate the PFNA's biomechanical advantage (24, 25).

The demographic analysis within this study also provided insightful observations, with a notable distinction in functional outcomes based on age, thereby emphasizing the PFNA's versatility across different age groups. However, the superior functional outcomes observed with PFNA usage also prompt a reflection on the limitations encountered in this study, particularly the lack of observation of potential complications and the absence of analysis on health-related quality of life and other significant variables that could influence patient recovery.

CONCLUSION

The PFNA stands out for its remarkable performance in managing proximal femur fractures, attributed largely to its unique design that ensures compact bone compaction and stabilization. Despite its proven efficacy, the study underscores the indispensable role of meticulous surgical technique and proper implant positioning in achieving optimal outcomes. The findings advocate for the PFNA as a valuable tool in the orthopedic arsenal, particularly for patients with osteoporotic bone, highlighting the need for further research to explore its full potential and limitations.

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