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Proximal Femoral Lateral Wall Thickness as a Predictor of Fixation Outcome in Stable Intertrochanteric Fractures: A Prospective Cohort Study

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ABSTRACT

Background: The integrity of the proximal femoral lateral wall is increasingly recognized as a critical determinant of stability in intertrochanteric fractures, with its compromise frequently leading to higher complication rates.

Objective: This study aimed to evaluate predictive role of preoperative lateral wall thickness in the outcome of stable intertrochanteric fracture fixation and to compare the functional results of Dynamic Hip Screw (DHS) versus Proximal Femoral Nail (PFN) fixation.

Methods: A prospective cohort study was conducted at Suez Canal University Hospitals on 65 patients presenting with stable intertrochanteric fractures (Evans stable Type 1, corresponding to AO type 31-A1.1 to 31-A2.1). Postoperative outcomes, including lateral wall fracture incidence and functional status via Harris Hip Score (HHS), were assessed.

Results: Postoperative lateral wall fractures occurred in 24 patients (36.9%). A significantly higher incidence was observed in the DHS group compared to the PFN group. Post-injury HHS was significantly better in the PFN group compared to the DHS group. The overall mean pre-injury HHS was 91.66 ± 1.5, which significantly decreased to 73.42 ± 8.98 post-injury. Complications included varus malunion (18.5%), implant failure due to cut-through (3.1%), and shortening (20%).

Conclusion: Preoperative lateral wall thickness serves as an accurate predictor of postoperative lateral wall fracture. Maintaining lateral wall integrity is crucial during fixation to minimize complications. For stable intertrochanteric fractures with a preoperative lateral wall thickness below 20.5 mm, PFN fixation is associated with a lower rate of postoperative lateral wall fracture and superior functional outcomes compared to DHS.

Keywords: Lateral wall thickness, Intertrochanteric fractures, Harris Hip Score, DHS, PFN.

INTRODUCTION

Intertrochanteric fractures, defined as extracapsular fractures of the proximal femur occurring between the greater and lesser trochanters, represent a common and challenging injury, particularly in the elderly population [(1)]. These fractures involve a region characterized by dense trabecular bone, which plays a crucial biomechanical role in absorbing compressive forces during activities such as standing and walking [(2,3)]. The intricate architecture of the proximal femur, with its vertical and horizontal trabeculae, is designed to withstand significant loads, yet it remains susceptible to fracture, especially in the context of osteoporosis [(3)].

The management of intertrochanteric fractures has evolved considerably, with various surgical fixation methods available, primarily categorized into extramedullary devices, such as the Dynamic Hip Screw (DHS), and intramedullary devices, like the Proximal Femoral Nail (PFN). Despite advancements, the optimal treatment choice for these fractures remains a subject of ongoing debate and controversy among orthopedic surgeons [(4)].

Historically, the integrity of the posteromedial cortex was considered the most critical prognostic factor for successful outcomes, particularly with DHS fixation [(5)]. However, recent clinical and biomechanical studies have increasingly highlighted the paramount importance of the lateral femoral wall's integrity for achieving stable fixation and favorable results [(6,7)].

The lateral femoral wall acts as a crucial buttress, providing support for the proximal fragment and facilitating controlled impaction of the fracture fragments, thereby contributing to rotational and varus stability following reduction. Conversely, a compromised or fractured lateral wall can negate this buttressing effect, leading to uncontrolled collapse, varus malunion, and increased rates of implant failure [(8)].

Fractures of the lateral wall can occur either intraoperatively during screw insertion or postoperatively due to mechanical stress [(9)].

Given the significant implications of lateral wall integrity on fracture stability and patient outcomes, a precise preoperative assessment of its thickness has emerged as a valuable tool for surgical planning. This study aims to contribute to the current understanding by evaluating the role of preoperative lateral wall thickness as a predictor of postoperative lateral wall fracture and overall fixation success in stable intertrochanteric fractures. Furthermore, it seeks to compare the functional outcomes and complication rates associated with DHS versus PFN fixation in patients with an intact but potentially thin lateral wall. By providing insights into these critical aspects, this research intends to inform surgical decision-making and ultimately improve patient

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care for individuals suffering from intertrochanteric fractures.

PATIENTS AND METHODS

Study Design and Patient Population

This prospective cohort study was conducted at Suez Canal University Hospitals, enrolling 65 patients who presented with stable intertrochanteric fractures (Evans stable Type 1, corresponding to AO type 31-A1.1 to 31-A2.1). The study period spanned from March 2020 to March 2022. Inclusion criteria comprised adult patients of both genders, aged 18 years or older, who sustained trauma either from a simple fall or a road traffic accident, had no medical contraindications to surgery, and presented with a preoperatively intact proximal femoral lateral wall with a thickness less than 20.5 mm.

Preoperative Assessment

All patients underwent a comprehensive preoperative assessment, which included a detailed clinical history, general physical examination, and local examination of the affected hip.

Lateral Wall Thickness Measurement: Preoperative lateral wall thickness was precisely measured using a standardized radiographic technique. A plain anteroposterior (AP) X-ray view of the hip was obtained, with a 1 Egyptian Pound (LE) coin (2.5 cm in diameter) placed adjacent to the hip as a reference for magnification correction. A reference point was established 3 cm distal to the innominate tubercle of the greater trochanter. From this point, a line angled at 135° upward was drawn towards the fracture line. The perpendicular distance between the outer cortex of the femur and the fracture line along this 135° line was calculated as the lateral wall thickness. In addition to the AP hip X-ray, AP pelvis views showing both hips, and lateral views of the affected hip were performed. Pelvic Computed Tomography (CT) scans were also obtained for detailed fracture characterization.

Intraoperative Procedure

Patients were positioned either laterally or supine on a traction table, depending on the surgeon's preference and fracture characteristics. The surgical approach utilized was either a lateral subvastus approach or a small lateral incision over the tip of the greater trochanter in selected cases. Fixation was performed using either a Dynamic Hip Screw (DHS) or a Proximal Femoral Nail (PFN) under image intensifier guidance to ensure accurate reduction and implant placement. The Tip-Apex Distance (TAD) was meticulously maintained at less than 25 mm in all fractures, irrespective of the chosen fixation method, as this parameter is crucial for preventing cut-out.

Postoperative Management and Follow-up

Postoperatively, all patients were encouraged to mobilize from bed to chair starting on the first or second postoperative day. Bedside exercises and range of motion exercises were initiated while patients were still hospitalized or immediately after discharge. Patients were progressively encouraged to ambulate using walking aids with partial weight-bearing as soon as clinically feasible, considering factors such as fixation type, quality of reduction, bone quality, and the patient's overall general condition. Standardized post-discharge follow-up visits were scheduled at 2 weeks, 4 weeks, 6 weeks, 3 months, and 6 months post-surgery.

Radiographic Assessment: Postoperative X-rays were obtained at each follow-up visit and meticulously assessed for the adequacy of fracture reduction. Poor fracture reduction was defined as angulation exceeding 20° at the fracture site on the lateral radiograph, fragment displacement greater than 4 mm, or significant varus/valgus malalignment in the coronal plane.

Functional Outcome Assessment: Functional outcome was evaluated using the validated Harris Hip Score (HHS) at each follow-up visit. The HHS is a comprehensive scoring system that assesses various aspects of hip function, including pain, function (gait, daily activities), absence of deformity, and range of motion, providing a quantitative measure of hip disability and treatment effectiveness.

Ethical consideration:

The study was approved by ethical committee of Faculty of Medicine, Suez Canal University. An informed consent was obtained from all patients.

Statistical Analysis

All collected data were meticulously coded and entered into a spreadsheet using Microsoft Excel 2016 (Microsoft Corporation, United States). Statistical analysis was performed using IBM Statistical Package for the Social Sciences software (SPSS), Version 25.0 (Armonk, NY: IBM Corp). Inferential analyses for quantitative variables were conducted using the independent t-test for cases involving two independent groups with parametric data, and the Mann-Whitney U test for two independent groups with non-parametric data. For qualitative data, the Chi-square test was utilized for independent groups. Statistical significance was set at a p-value of <0.05.

RESULTS

This study was conducted on 65 patients diagnosed with stable intertrochanteric fractures (Evans stable Type 1, AO type 31-A1.1 to 31-A2.1) who underwent surgical management.

Preoperative Patient Characteristics

The mean age of the 45 male patients was 68.2 years (range: 62-76 years), while the mean age for the 20 female patients was 67.9 years (range: 62-73 years). Comorbidities were prevalent within the cohort: 25 cases (38.5%) were diabetic (15 males, 10 females), 51 cases (78.5%) were hypertensive (38 males, 13 females), and 4 cases (6.2%) had dyslipidemia (2 males, 2 females). Ten patients (15.4%) were medically free (6 males, 4 females). The most common mechanism of injury was a simple fall, accounting for 54 cases (83.1%) (38 males, 16 females), while road traffic accidents (RTA) caused fractures in 11 cases (16.9%) (7 males, 4 females). Fracture classification according to AO system revealed that the most common type of fracture was 31A2.1 in 37 cases (56.9%).

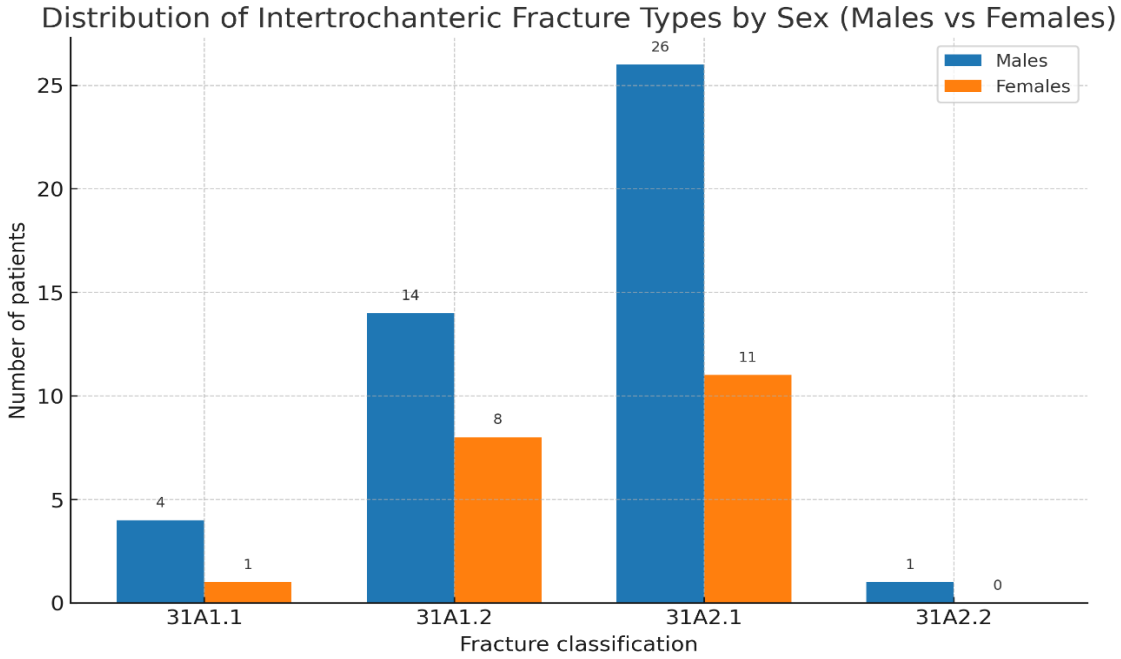

Figure 1: Classification of fracture among the studied patients.

Operative Data

Of the 65 patients, 35 cases (53.8%) were fixed using Dynamic Hip Screw (DHS), and 30 cases (46.2%) were fixed with Proximal Femoral Nail (PFN). The most common type of fracture within DHS was 31A1.2 and within PFN was 31A2.1 (Figure 2).

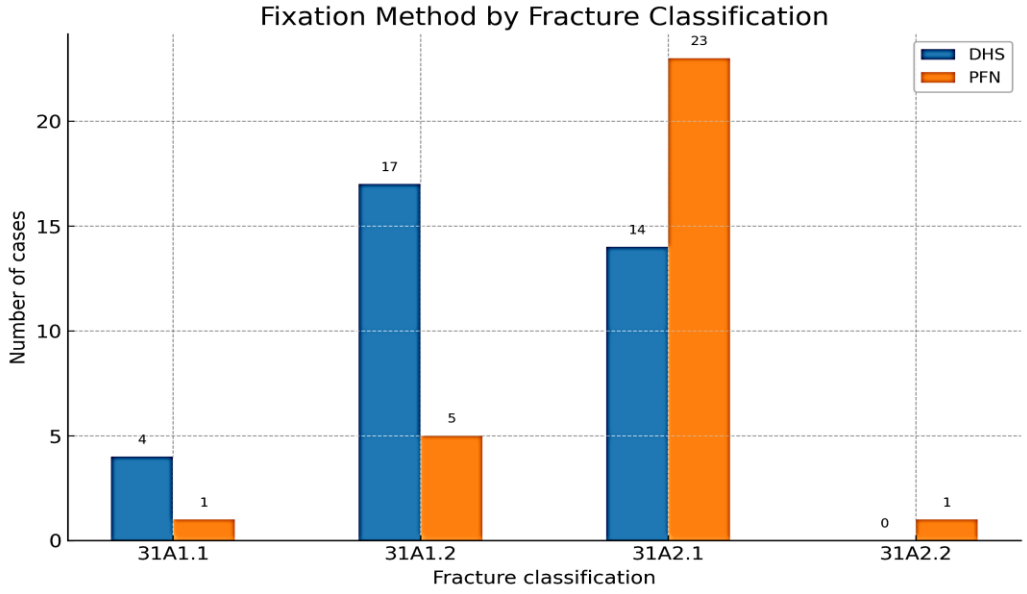

Figure 2: Method of fixation related to classification of fracture.

Postoperative Outcomes

Despite all cases having an intact preoperative lateral wall, 24 patients (36.9%) developed a postoperative lateral wall fracture. A statistically highly significant difference was observed between the two fixation methods regarding the incidence of postoperative lateral wall fracture (Figure 3).

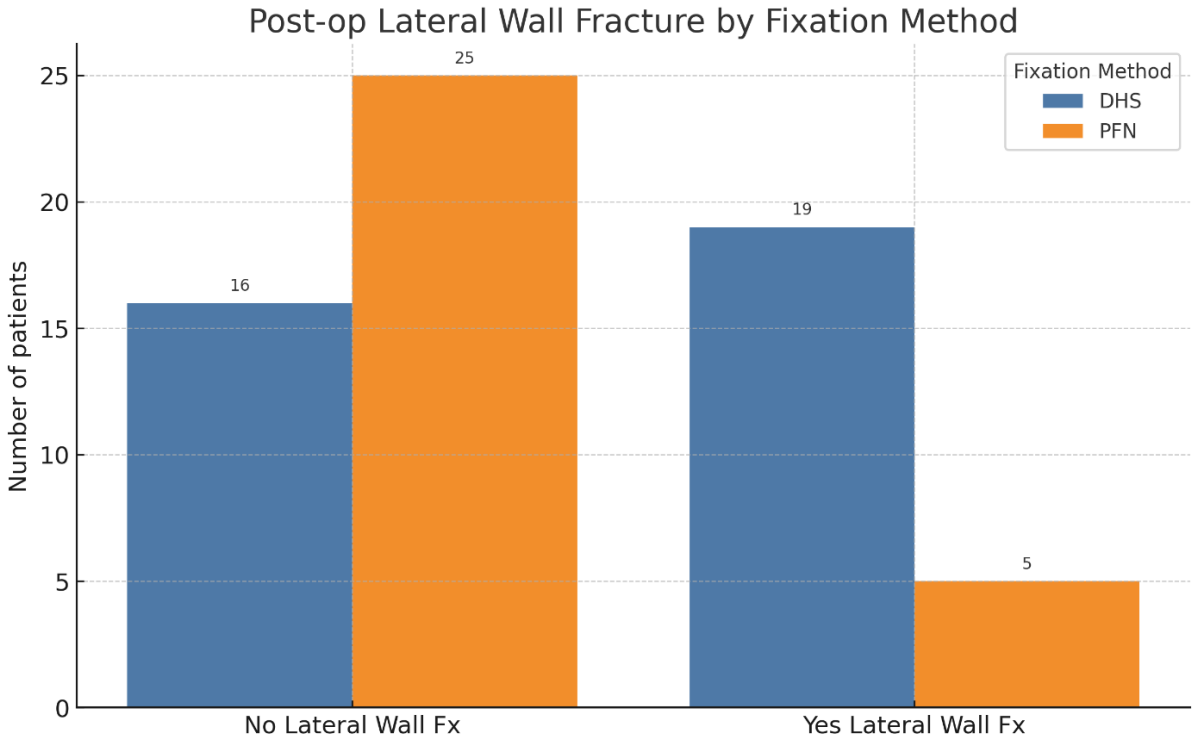

Figure 3: Postoperative lateral wall fracture among the studied patients.

Functional outcomes, assessed by the Harris Hip Score (HHS), showed a highly significant difference between the fixation methods. The mean post-injury HHS was 69.17 ± 9.21 (range: 50-86) for patients fixed by DHS, compared to 78.37 ± 5.62 (range: 64-84) for cases fixed by PFN. Importantly, the post-injury HHS was not statistically significantly related to the fracture type (Figure 4).

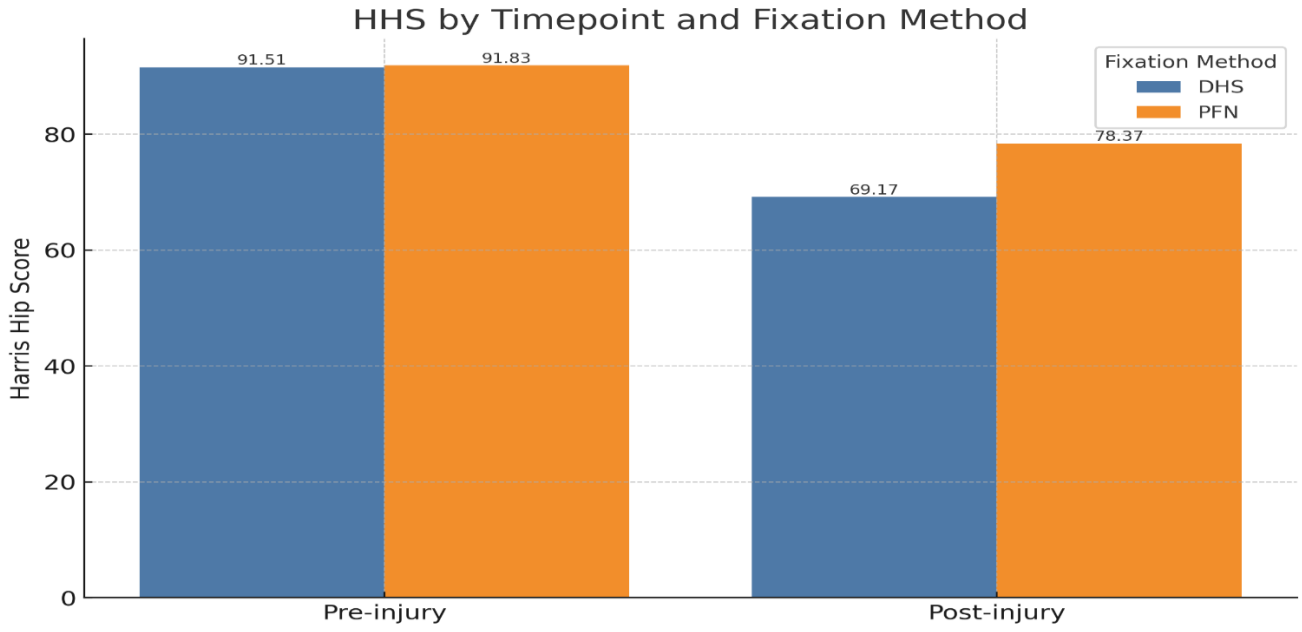

Figure 4: Relation between method of fixation and HHS.

The mean post injury HHS was 69.17 in patients fixed by DHS while 78.37 in cases fixed by PFN this relation was statistically significant as P value< 0.001 (Table 4) post injury HHS is not related to fracture type there was No statistically significant difference between fracture type and post injury HHS (p>0.05) (Figure 5).

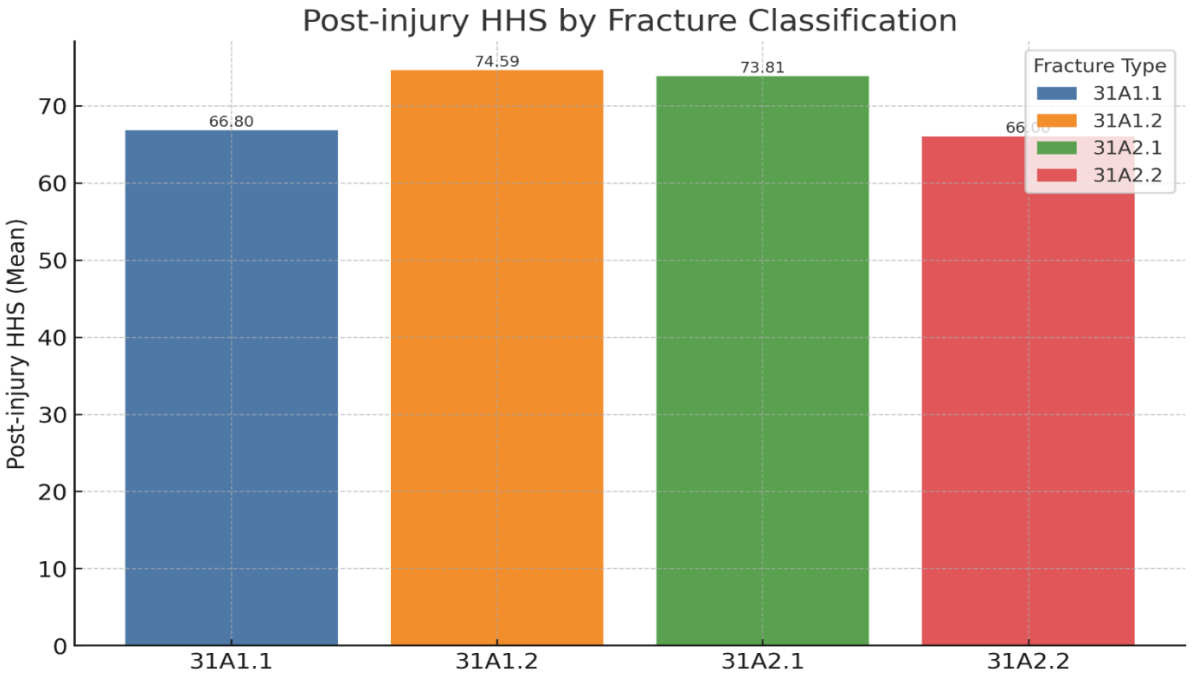

Figure 5: Relation between classification of fracture and post-HHS.

Postoperative complications were reported in 16 patients (24.6%). Specifically, 12 cases (18.5%) experienced varus malunion. Two patients (3.1%) suffered implant failure due to cut-through. Shortening was observed in 13 cases (20%). Two patients (3.1%) required reoperation. No cases of wound infection were reported (Figure 6).

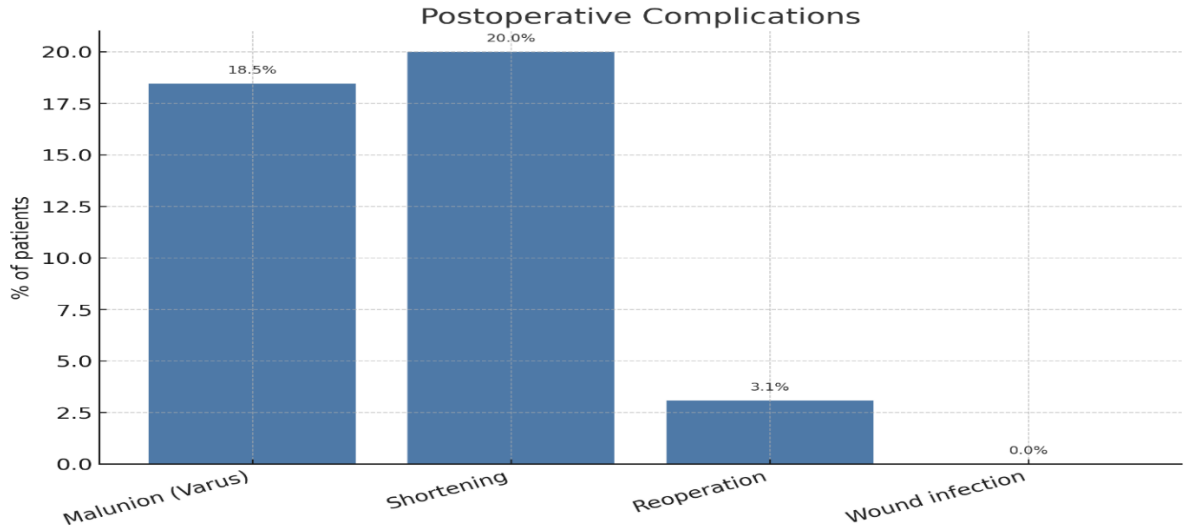

Figure 6: Postoperative complications among the studied patients.

DISCUSSION

The integrity of the proximal femoral lateral wall has gained increasing recognition as a pivotal factor in the successful treatment of intertrochanteric fractures [7]. While historical perspectives often emphasized the posteromedial cortical integrity as the primary prognostic indicator for outcomes following Dynamic Hip Screw (DHS) fixation, recent evidence unequivocally demonstrates that the lateral wall's structural soundness is indispensable for optimal results [6].

Our study's findings strongly corroborate this evolving understanding, particularly concerning the predictive value of preoperative lateral wall thickness. **Pradeep *et al.*** [8] previously highlighted that lateral wall thickness is a simple, quantifiable preoperative parameter and a reliable predictor of postoperative lateral wall fracture, identifying a threshold value of 20.5 mm. Our results align with this, as a significant proportion (36.9%) of our patients, despite having an intact preoperative lateral wall, experienced postoperative lateral wall fracture. Crucially, the incidence of these fractures was significantly higher in the DHS group (54.3%) compared to the Proximal Femoral Nail (PFN) group (16.7%) ($p < 0.002$). This finding underscores that even an *intact but thin* lateral wall is vulnerable to fracture under the biomechanical stresses associated with DHS fixation.

The biomechanical rationale for the lateral wall's importance is well-established. **Gotfried** [10] emphasized its role as a key lateral buttress for the proximal fragment, facilitating controlled impaction and providing crucial rotational and varus stability. When this buttress is compromised, whether intraoperatively or postoperatively, the stable fracture pattern can convert into an unstable one, leading to uncontrolled collapse, varus malunion, and potentially implant failure. The occurrence of a lateral wall fracture at the drilling site during DHS insertion, even with a preoperatively intact wall, can thus be considered a significant surgical complication that predisposes to poor outcomes.

Our study's recommendation against using DHS for stable trochanteric fractures with a thin intact proximal femoral lateral wall (less than 20.5 mm) is supported by several authors. **Sreejith *et al.*** [11] concluded that a preoperative lateral wall thickness less than 20.55 mm significantly increases the chance of postoperative lateral wall fracture with DHS fixation, leading to protracted healing, shortening, and deformity. Similarly, **Hsu *et al.*** [6] proposed a threshold of >20.5 mm for DHS use to minimize the risk of postoperative lateral wall fracture, advocating against DHS alone for fractures with a lateral wall thickness below this value. **Rajesh *et al.*** [12] further recommended considering additional buttressing (e.g., with a trochanteric stabilizing plate) or an intramedullary implant like PFN if the preoperative lateral wall thickness is less than 22.1 mm. These consistent recommendations from independent studies reinforce the clinical relevance of our findings.

Regarding functional outcomes, our study revealed a significant decline in Harris Hip Score (HHS) from a mean pre-injury level of 91.66 to a mean post-injury level of 73.42 ($p < 0.001$). This indicates that patients, regardless of the fixation method, did not fully return to their pre-injury functional status. However, a crucial finding was the statistically significant difference in post-injury HHS between the fixation methods ($p < 0.001$), with PFN yielding a higher mean score (78.37) compared to DHS (69.17). This suggests that for stable intertrochanteric fractures with a thin preoperative lateral wall, PFN provides superior functional outcomes. This finding aligns with the lower rate of postoperative lateral wall fractures observed with PFN, as the integrity of the lateral wall directly correlates with better stability and functional recovery.

It is important to acknowledge contrasting perspectives in the literature. **Deng *et al.*** [9] suggested that lateral wall thickness may not significantly affect the quality of reduction or outcomes in patients receiving PFN, implying that for intramedullary fixation, distinguishing lateral wall integrity might be less critical. This view contrasts with our findings and those of **Pradeep *et al.*** [8] who emphasized the predictive value of lateral wall thickness for intraoperative lateral wall fracture during DHS fixation and suggested considering alternative methods for those with thicknesses less than 21 mm. The discrepancy might stem from differences in fracture types included, patient populations, or the specific definitions of "integrity" and "outcome" used in various studies. Our study, focusing specifically on stable fractures with a thin intact lateral wall, provides a nuanced perspective that highlights the interaction between fracture morphology, implant choice, and lateral wall integrity.

The observed complications in our cohort, including varus malunion (18.5%), implant failure due to cut-through (3.1%), and shortening (20%), are consistent with those reported in the literature for intertrochanteric fractures. The occurrence of varus malunion and shortening, in particular, is often linked to loss of fracture stability, which can be exacerbated by a compromised lateral wall. The relatively low rate of implant failure due to cut-through (3.1%) and the absence of wound infection are positive indicators of surgical technique and postoperative care in our institution.

CONCLUSION

The preoperative assessment of proximal femoral lateral wall thickness is an accurate and valuable predictor of postoperative lateral wall fracture in stable

intertrochanteric fractures. Maintaining the integrity of the lateral wall is a crucial objective during surgical fixation to prevent complications and improve patient outcomes. Our study demonstrates that for stable intertrochanteric fractures with a preoperative lateral wall thickness less than 20.5 mm, fixation with a Proximal Femoral Nail (PFN) results in a significantly lower incidence of postoperative lateral wall fracture and superior functional outcomes (higher Harris Hip Scores) compared to Dynamic Hip Screw (DHS) fixation. The threshold value of 20.5 mm for lateral wall thickness can serve as a practical guideline for surgeons when selecting the appropriate fixation method, thereby minimizing the risk of postoperative lateral wall fracture and associated complications, and ultimately improving the patient's functional recovery.

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