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Original Article

Hip biomechanics, health-related quality of life and walking ability after intramedullary fixation in intertrochanteric fracture: a prospective cohort study

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Abstract: Objectives: Altered hip biomechanics following intertrochanteric fracture fixation can result in impaired mobility, decreased functional outcomes, and a reduced quality of life. Despite achieving optimal reduction and fixation, patients often fail to regain their pre-injury activity levels. This study aims to evaluate how changes in hip biomechanics after intertrochanteric fracture fixation using a proximal femoral nail impact the quality of life. Methods: This prospective cohort study, conducted from July 1, 2020, to June 30, 2022, included individuals aged 18 years and older with isolated intertrochanteric fractures managed using the Proximal Femur Nail Antirotation 2 (PFNA2). Clinical assessments included range of motion, pain levels, abductor strength, the modified Harris Hip Score (HHS), and the Parker and Palmer Mobility Score (PPMS) at 6 weeks, 3 months, and 6 months' post-surgery. Hip biomechanics were evaluated radiographically through parameters such as telescoping, tip-apex distance (TAD), neck-shaft angle, and femoral offset. These findings were correlated with functional scores and health-related quality of life (EQ5D-EuroQol 5 Dimension) score. Results: Out of 47 eligible patients, only 30 could be followed up for six months due to the COVID-19 pandemic, and three patients died in the postoperative period. 25 of 33 patients were over 60 years old. Twenty-nine patients had unstable fractures. All patients had hypovitaminosis D, and 92% of patients had osteoporosis. Fracture union occurred in all cases, with a mean union time of 2.9 ± 0.8 months. Radiographic evaluation showed minimal changes in tip-apex distance and other hip biomechanical parameters (femoral offset, neck shaft angle, telescopy). Functional scores, including modified Harris Hip score and health-related quality of life (HRQOL) measures, improved significantly after surgery. However, at six months, these scores were lower than pre-injury levels. Walking ability varied considerably between age groups (< 60 years' vs > 60 years) at 6 weeks, but abductor strength did not differ significantly in subsequent follow-ups. Conclusion: Poor bone quality, characterized by osteomalacia and osteoporosis, is significantly associated with intertrochanteric fractures in Indian populations. The PFNA 2 nailing system effectively maintains reduction and prevents varus collapse. Functional outcomes and HRQOL improve over time with intramedullary fixation, yet patients seldom return to pre-injury levels, potentially influenced by recall bias.

Keywords: Hip fracture, osteoporosis, health-related quality of life, abductor strength, proximal femoral nail, proximal femoral nail anti-rotation

Introduction

The rising incidence of intertrochanteric (IT) hip fractures among the elderly population raises significant concerns due to its substantial impact on socio-economic factors. According to the existing literature, as many as 50% of these patients do not regain their pre-injury mobility [1-5]. Prolonged immobilization, the burden of injury, and muscle deconditioning contribute to weakness and a deficit in power in the affected limb [1]. Hip biomechanics as evaluated using several key parameters play a crucial role in this scenario [6-8].

Femoral offset, defined as the perpendicular distance from the center of the femoral head to the long axis of the femur, is critical for hip stability. A reduced femoral offset diminishes the abductor lever arm, leading to muscle insufficiency and impaired function. Similarly, decrease in neck-shaft angle (NSA) results in

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varus collapse, shortening, and compromised weight distribution. Another crucial parameter is the tip-apex distance (TAD), which measures the distance from the tip of the helical blade or screw to the apex of the femoral head. A TAD greater than 25 mm is associated with an increased risk of implant failure due to screw cut-out and loss of fixation [8]. Telescoping, which refers to the sliding of the helical blade or lag screw out of the lateral femoral cortex, permits controlled collapse and fracture union. However, excessive telescoping may contribute to leg length discrepancy and altered gait mechanics. Additionally, proximal femoral shortening (PFS) is a significant factor affecting recovery. Shortening of the proximal femur alters the hip's lever mechanics, increasing abductor muscle workload and reducing gait efficiency. Severe shortening can lead to Trendelenburg gait, back pain, and secondary degenerative changes in the contralateral hip and knee.

Fracture collapse in unstable intertrochanteric fracture is virtually unavoidable due to comminution, osteoporosis, and premature weight bearing, resulting in shortening [1, 4]. The healing process of IT fractures with supra-trochanteric shortening alters the lever moment arm of the abductor's muscles and the offset of the femoral head. Consequently, modified hip biomechanics lead to an abductor limp, negatively impacting functional outcomes [5-8].

The proximal femur intramedullary devices are load-sharing devices that offer effective fracture stabilization and prevent medialization of the shaft, thus minimizing disruptions to hip biomechanics [1, 9-17]. However, issues such as fracture collapse and osteoporosis can result in some movement between the screw and the nail. Additionally, the trochanteric entry portal for the intramedullary device disrupts a few abductor muscle fibers, contributing to altered hip biomechanics and morbidity [12-14]. McConnell et al. observed approximately 53% abductor disruption during trochanteric entry nailing in a cadaveric study [14].

Globally, IT femur fractures are often categorized as fragility fractures and are commonly associated with minor falls among older adults [1-4]. However, a substantial portion of cases in the Indian subcontinent is attributed to road traffic accidents, affecting younger individuals [18-20]. Despite literature recommending early surgical intervention, challenges such as delayed presentation and overcrowding in hospitals within developing countries pose significant obstacles to addressing this issue [20]. In the elderly population, the presence of numerous comorbidities, along with osteoporosis and generalized disability due to aging, further exacerbates the negative impact on health-related quality of life (HRQOL) [20, 21]. In contrast, we hypothesize that young trauma victims will likely resume their preinjury activity levels after fracture healing. Additionally, due to their better bone quality and compliance, alterations in hip biomechanics may be minimal in this group. Therefore, this study was designed to investigate changes in hip biomechanics following intertrochanteric fracture fixation using an intramedullary device and its subsequent impact on HRQOL. Given that we encounter almost equal instances of geriatric IT fractures and high-velocity IT fractures in young trauma victims, a more comprehensive comparison of HRQOL between these two age groups can be performed. The study also aims to assess whether alterations in hip biomechanics in these two age groups influence HRQOL.

Methodology

Patient recruitment

In a prospective cohort study conducted from July 1, 2020, to June 30, 2022, all individuals aged 18 years and older who sustained an isolated intertrochanteric fracture and underwent treatment with the Proximal Femur Nail Antirotation 2 (PFNA2) were evaluated. The study aimed to assess changes in hip biomechanics over time and their impact on the patient's quality of life.

Inclusion Criteria: (1) Adults aged 18 years and above. (2) Patients with isolated intertrochanteric fractures. (3) Fractures managed with PFNA2 fixation.

Exclusion Criteria: (1) Participants with pathological fractures or open fractures. (2) History of inflammatory or infective bone diseases. (3) Patients with concurrent knee, hip, or ankle problems on the same or opposite side. (4) A prior history of hip surgery on the same or opposite side. (5) Individuals with lower limb extra-articular deformities. (6) Patients with neurological or psychiatric disorders.

The study received approval from the institutional ethics committee, and written informed consent was obtained from all participants before enrolment.

Data collection: All patients with IT femur fractures who attended the emergency service of our level 1 trauma center were stabilized hemodynamically. Regular blood investigations and radiological assessments were performed after thorough clinical evaluation. Preoperative radiological assessments involved anteroposterior (AP) and lateral radiographs of the hip and pelvis. The fractures were classified according to the Orthopaedic Trauma Association (OTA) classification system (stable/unstable). Age, gender, body mass index (BMI), ambulatory status, and comorbidities details were entered into a predesigned proforma. Bone mineral density (DEXA scan of hip and spine) was also assessed.

Surgical technique: The patients were operated on as soon as they were medically fit. A standard surgical procedure was followed. The fractures were reduced by closed reduction using traction and manipulation in the supine position. The reduction and alignment of fracture fragments were assessed under an image intensifier. Surgical decisions were made based on fracture characteristics. Intraoperative reduction was performed using additional manipulation, such as applying direct pressure on the nail end through the insertion handle or using a bone hook or Hohmann's lever. Close attention was given to accurately reduce the critical posteromedial calcar region. If necessary, percutaneous intervention was performed to reduce the calcar fragment. Once satisfactory reduction was achieved, intraoperative compression at the fracture ends was applied through direct pressure on the nail end via the insertion handle while releasing leg traction simultaneously. A proximal femoral nail anti-rotation II with a helical blade (PFNAII, Synthes, AO) was inserted percutaneously through the trochanter. The tip of the lag screw was kept precisely within the central region or slightly inferior to the femoral head to prevent screw cut-out. Every effort was made to keep the tip-apex distance less than 20 mm. The interlocking bolts were used distally to achieve rotational stability. Patients were mobilized immediately after surgery with weight-bearing as tolerated. Postoperative radiographs were performed to assess fracture reduction and fixation. The quality of fracture reduction was evaluated by comparing the neck-shaft angle of the operated hip to that of the normal hip on the anteroposterior view. A variation of less than 5 degrees from the normal side was considered a 'good' reduction. Between 5 and 10 degrees of variation were deemed 'acceptable', and more than 10 were considered 'poor'. The quality of fixation was assessed using the tip-apex distance described by Baumgaertner et al. and Cleveland et al. [22, 23].

Follow-up and evaluation: The patients were followed up at 6 weeks, 3 months, and 6 months. Clinical evaluation included range of motion, pain, abductor strength, modified Harris hip score (HHS), and the Parker and Palmer mobility score (PPMS). The ROM was measured using conventional Goniometer. The pain was assessed using a Visual Analog Scale. The abductor muscle strength was measured using the Medical Research Council scale which has the following grades: Grade 0: No contraction is visible or palpable; Grade 1: A trace or flicker of contraction is visible or palpable, but there is no limb movement; Grade 2: Muscle movement is possible with gravity eliminated; Grade 3: Muscle movement is possible against gravity; Grade 4: Muscle strength is reduced, but movement against resistance is possible; Grade 5: Normal strength. The Harris Hip score and PPMS scores were calculated by administering the pre-existing questionnaires. Their health-related quality of life was evaluated using the EQ-5D questionnaire at the end of six months. Hip biomechanics were evaluated radiographically (telescopy, TAD, neck-shaft angle, and femoral offset) using SURGIMAP software. Proximal femur shortening was evaluated by telescoping of the lag screw through the lateral cortex and blade tip movement in a medial direction. Similarly, the abductor lever arm and femoral head offset were calculated from the radiograph (**Figure 1**). The measurements were taken on radiographs of the pelvis with both hips (AP view) immediately after surgery, at 6 weeks, 3 months, and 6 months.

Statistical analysis

The outcomes were compiled in Microsoft Excel and analyzed using SPSS software, version 24. Data normality was evaluated using the Shapiro-Wilk test. Qualitative data were com-

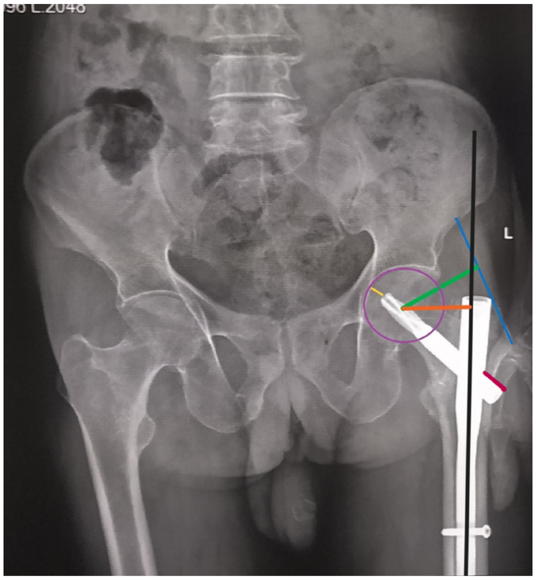

Figure 1. The green line represents the abductor lever arm (perpendicular distance between the center of the femoral head to the abductor path). The blue line represents the path of the abductor muscles. The black line represents the long axis of femur. The orange line (perpendicular distance between the center of femoral head to the long axis of femur) represents the femoral offset. The red line indicates the telescopy of the helical blade (distance between the PFN and the lateralmost end of the helical blade).

pared using the Chi-square test, while non-parametric data were analyzed using the Wilcoxon Signed-Rank test. A *P*-value of less than 0.05 was considered statistically significant.

Results

Of the initial 52 patients who met the inclusion criteria, five were deemed ineligible for surgery due to significant comorbidities. A total of 47 patients subsequently underwent trochanteric fracture fixation using PFNA2. However, 14 patients were lost to follow-up due to the constraints imposed by the COVID-19 pandemic, and three patients passed away within two months of surgery. Ultimately, a cohort of 30 patients was followed up for six months.

The mean age of the cohort was 70 ± 11.7 years, with 25 of the 30 patients aged over 60 years. The group comprised 21 males and 9 females. All but one patient had a BMI below 30, with 11 classified as underweight (BMI < 18.5). The majority of fractures (29 patients) resulted from falls, while the remaining four were caused by road traffic accidents. Based on the Charlson Comorbidity Index, 16 patients had a score of 0, five scored 1-2, seven scored 3-4, and five had a score greater than 5. Hypovitaminosis D was present in all patients, and all but four were osteoporotic, with a T-score of < -2.5.

Radiographic assessment showed that 29 patients had unstable intertrochanteric fractures, while four had stable fractures. Good fracture reduction was achieved in all cases, with nine patients exhibiting mild varus (a reduced neck-shaft angle compared to the contralateral side, but within 5 degrees). All fractures achieved union by the six-month follow-up, with a mean time to union of 2.9 ± 0.8 months.

*Evaluation of TAD, neck-shaft angle, femoral offset, and abductor length in the post-op period (**Figures 2-4**)*

The mean TAD at immediate post-op was 18.8 ± 4.5 mm; at 6 weeks, it was 19.6 ± 4.5 mm; at 3 months, 19.8 ± 4.4 mm; and at 6 months, it was 21.5 ± 6.9. On pairwise comparison of post-op X-rays, immediate post-op with 6 weeks, 3 months, and 6 months post-op follow-up values were not statistically significant with p values of 0.493, 0.387, and 0. 0778, respectively. The medial migration of the blade tip was 1 mm (IQR -1.3 to 4.3) at the end of the 6-month follow-up (**Figures 2-4**).

The mean telescopy at immediate post-op, 6 weeks, 3 months, and 6 months post-op were 16.3 ± 4.7, 16.8 ± 4.0, 17.6 ± 4.1 and 18.6 ± 6.0 respectively. On comparison with immediate post-op values, no statistically significant change was observed at 6 weeks (*P* value = 0.658), 3 months (*P* value = 0.258), and 6 months (*P* value = 0.103) (**Figures 2-4**).

The mean femoral offset at immediate post-op, 6 weeks, 3 months, and 6 months post-op was 39.5 ± 8.8 mm, 43.0 ± 10.5 mm, 41.4 ± 7.8 mm, and 40.3 ± 6.6 mm respectively. In comparison with immediate post-op, there was no statistically significant change observed at 6 weeks (*P*-value = 0.167), 3 months (*P*-value = 0.379), and 6 months (*P*-value = 0.657).

The mean neck-shaft angle (degree) at immediate post-op, 6 weeks, 3 months, and 6 months post-op were 133.3 ± 7.4, 132.4 ± 5.9, 132.3 ± 6.5 and 132.2 ± 6.3, respectively. In compar-

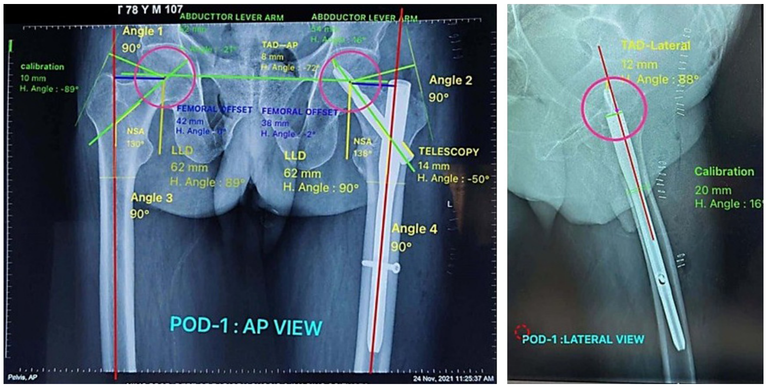

Figure 2. Measurement of hip biomechanics following PFNA fixation for an intertrochanteric fracture in a 78-year-old male was performed using the SURGIMAP software.

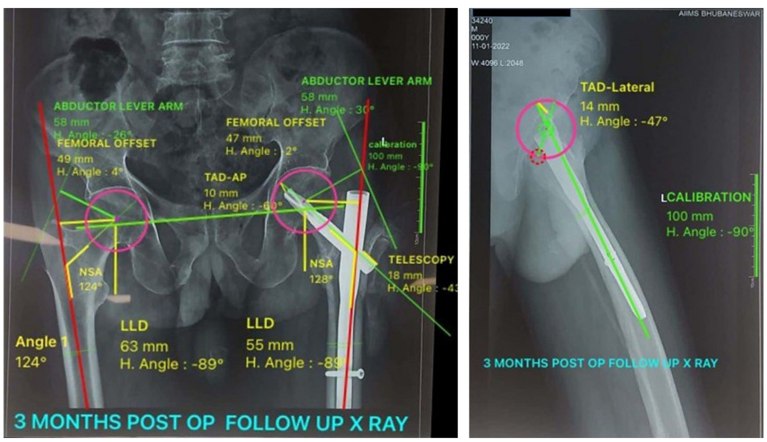

Figure 3. Measurement after 3 months in the same patient.

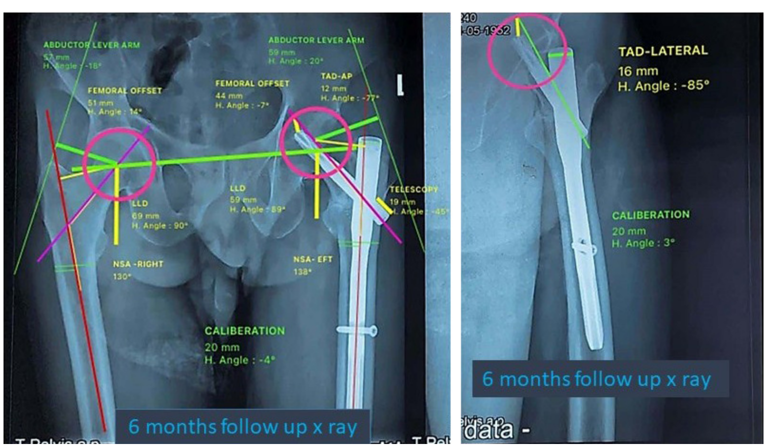

Figure 4. Hip biomechanics changes after 6 months.

ison with immediate post-op, there was no statistically significant change at 6 weeks (*P*-value = 0.604), 3 months (*P*-value = 0.580), and 6 months (*P*-value = 0.537).

No statistical significance was noted when performing subgroup analysis with fracture stability (stable vs unstable) with the abovementioned parameters (P = 0.65).

Functional scores and HRQOL

The average preoperative modified Harris Hip score was 23.5 ± 6.5. The mean Modified Harris Hip score increased steadily over 6 months after surgery to reach the maximum value at 6 months (76 ± 5.7). The rise in modified HHS at every visit was statistically significant (P < 0.05). However, the modified HHS at 6 months was lower than that of preinjury levels despite the appearance of the radiological union. The PPMS scores and HRQOL/EQ5D changes showed similar trends as modified HHS. These findings are summarized in **Tables 1-3**.

Comparison of walking ability and abductor strength in different age groups

At 6 weeks, there is a significant difference in walking ability between these two groups. However, in subsequent follow-ups, these two groups have no significant difference in abductor strength. The findings are summarized in **Table 4**.

Discussion

This study unveiled a significant association between intertrochanteric fractures, osteomalacia, and osteoporosis in the Indian population. Despite poor bone quality, the PFNA 2 nailing system effectively secures fracture reduction and maintains hip biomechanics during healing. While a non-significant helical blade end migration beyond the lateral femoral cortex is frequent, it doesn't

Table 1. Comparison of modified Harris hip score at different follow-ups

Follow-ups (N)	Mean + SD	Median (IQR)	Range
Pre-injuries (33)	84.4 ± 6.6	85 (83-88)	(57-95)
Pre-op (33)	23.5 ± 6.5	25 (23-25)	(10-50)
2 weeks (33)	31.6 ± 8.5	29 (26-35.5)	(21-60)
6 weeks (31)	47.2 ± 7.4	47 (45-50)	(25-70)
3 months (30)	65.1 ± 7.9	67.5 (57.8-70.8)	(50-80)
6 months (30)	76.0 ± 5.7	78 (71-80)	(64-90)

Table 2. Comparison of PPMS at different follow-ups

Follow-ups (N)	Mean + SD	Median (IQR)	Range
Pre-injuries (33)	8.7 ± 0.8	9 (9-9)	(6-9)
Pre-op (33)	2.3 ± 0.9	2 (2-3)	(1-6)
2 weeks (33)	2.2 ± 0.8	2 (2-2)	(0-4)
6 weeks (31)	3.8 ± 0.8	4 (3-4)	(2-5)
3 months (30)	5.1 ± 0.6	5 (5-5.3)	(4-6)
6 months (30)	6.5 ± 0.6	6 (6-7)	(6-8)

Table 3. Comparison of HRQOL (EQ 5D) objective at different follow-ups

Follow-ups (N)	Mean + SD	Median (IQR)	Range
Pre-injuries (33)	91.4 ± 6.5	95 (90-95)	(70-100)
Pre-op (33)	47.6 ± 9.6	50 (50-50)	(20-70)
2 weeks (33)	53.6 ± 8.2	50 (50-60)	(35-70)
6 weeks (31)	65.7 ± 8.1	70 (60-70)	(45-75)
3 months (30)	73.3 ± 10.3	80 (65-80)	(50-85)
6 months (30)	84.0 ± 8.0	85 (75-90)	(65-95)

necessarily lead to femoral collapse due to the preservation of femoral offset until healing. Consequently, a slight non-significant increase in Tip-Apex Distance (TAD) with time is noticeable as the blade tip dislodges from the subchondral bone, resulting in telescopy.

The shortening of the proximal femur, which disrupts the trochanter-hip relationship, can impair abductor muscle strength and perpetuate gait parameter deficiencies. Extensive discussions in hip arthroplasty literature highlight this biomechanical impact. In a study by Paul et al., quantification of this shortening was achieved by tracking lag screw movement through the femoral cortex and displacement within the femoral head [1]. Their findings indicated approximately 3.3 mm of telescoping in unstable fractures and about 1.2 mm in stable fractures within the lateral cortex of the proximal femur. The average migration of the lag screw tip within the femoral head measured 1.7 mm. Their conclusion emphasized the essential role of proper fracture reduction and fixation for restoring optimal hip biomechanics, a prerequisite for positive functional outcomes [1]. We ensured the best possible fracture reduction and fixation to attain good functional outcomes.

In another investigation by Gilat et al. [24], the influence of proximal femur shortening (PFS) on patient functional outcomes was explored. They reported PFS in 43.5% of patients, ranging from 5 to 9.9 mm and exceeding 10 mm in 17%. PFS emerged as a common occurrence following intertrochanteric hip fracture fixation with cephalon-medullary nails (CMNs), tightly linked to unfavorable functional outcomes and early implant failure. Diverging from prior studies, our observations revealed distinct insights. All our patients exhibited compromised bone quality, indicated by hypovitaminosis D (osteomalacia) and osteoporosis (92% of patients). Despite this, the PFNA 2 system effectively resisted varus collapse and prevented significant proximal femur shortening. However, there were common occurrences of helical blade debonding from the subchondral bone and its migration outside the femoral cortex, resulting in telescopy. Consequently, TAD increased over time until fracture healing. Unlike previous research that emphasized inward blade tip migration and telescopy as major contributors to proximal femur shortening, we identified telescopy as a prevalent phenomenon without causing substantial shortening. Helical blade sliding was not linked to bone collapse but was associated with debonding in the subchondral region, leading to a slight increase in TAD during the postoperative period.

McGrory et al. highlighted the positive relationship between restoring femoral offset and preserving the abductor lever arm, positively im-

Table 4. Association of clinical outcomes at different follow-ups with age group

Clinical evaluation at different follow-ups	Walking ability	Age group		Total	Chi-square 'p' value
		≤ 60	> 60		
		No. (%)	No. (%)	No. (%)	
Immediate post-op	Bedridden	8 (100)	25 (100)	33 (100)	
	Total	8 (100)	25 (100)	33 (100)	
	Abductor strength				
	2/5	4 (50)	3 (12)	7 (21.2)	0.220
	3/5	4 (50)	22 (88)	26 (78.8)	
	Total	8 (100)	25 (100)	33 (100)	
2 week	Walking ability				
	Bedridden	3 (37.5)	12 (48)	15 (45.5)	0.780
	Walk with crutches	1 (12.5)	4 (16)	5 (15.2)	
	Walk with walker	4 (50)	9 (36)	13 (39.4)	
	Total	8 (100)	25 (100)	33 (100)	
	Abductor strength				
	3/5	7 (87.5)	19 (76)	26 (78.8)	0.489
	4/5	1 (12.5)	6 (24)	7 (21.2)	
	Total	8 (100)	25 (100)	33 (100)	
6 week	Walking ability				
	Bedridden	1 (12.5)	0 (0)	1 (3.2)	0.003
	Walk with crutches	2 (25)	6 (26.1)	8 (25.8)	
	Walk with walker	1 (12.5)	16 (69.6)	17 (54.8)	
	Independent	4 (50)	1 (4.3)	5 (16.1)	
	Total	8 (100)	23 (100)	31 (100)	
	Abductor strength				
	3/5	0 (0)	3 (13)	3 (9.7)	0.282
	4/5	8 (100)	20 (87)	28 (90.3)	
	Total	8 (100)	23 (100)	31 (100)	
3 month	Walking ability				
	Walk with walker	3 (37.5)	10 (45.5)	13 (43.3)	0.697
	Independent	5 (62.5)	12 (54.5)	17 (56.7)	
	Total	8 (100)	22 (100)	30 (100)	
	Abductor strength				
	4/5	8 (100)	22 (100)	30 (100)	
	Total	8 (100)	22 (100)	30 (100)	
6 month	Walking ability				
	Independent	8 (100)	22 (100)	30 (100)	
	Total	8 (100)	22 (100)	30 (100)	
	Abductor strength				
	4/5	8 (100)	22 (100)	30 (100)	
	Total	8 (100)	22 (100)	30 (100)	

pacting hip abduction strength and range of motion [14]. Significant shortening causing noticeable leg length discrepancy (LLD) could lead to secondary spinal effects, potentially triggering compensatory scoliosis and exacerbating degenerative changes and low back pain. Furthermore, PFS might induce uneven weight and force distribution across the contralateral hip and both knees, potentially contributing to joint degeneration. However, our observations indicated sustained hip biomechanics with the PFNA 2 system.

Functional outcomes after intertrochanteric fractures in older people are typically impaired. A comparative randomized controlled trial demonstrated that intramedullary fixation outperformed sliding hip screws in improving activities of daily living (ADL) and health utility, aiming to restore pre-fracture states [25]. Factors such as younger age, absence of preoperative anemia, higher preoperative albumin levels, and better ADL upon discharge were associated with improved functional outcomes and health-related quality of life (HRQOL). In our study, patients showed improvement in functional outcomes and HRQOL over time as fracture healing progressed. However, the final values remained below pre-injury levels, aligning with findings from other studies. This discrepancy could arise from arbitrary pre-injury score determination timing, as highlighted by Hernefalk et al. and Williamson et al. [26, 27].

Tang et al.'s study involving 303 patients with intertrochanteric fractures revealed that the Harris Hip Score (HHS) decreased in elderly patients due to aging [28]. Those under 70 scored an average of 86.7, those between 85 and 90 scored 79.3, and those over 90 scored 77.1. This aligns with our findings, where older age was an independent, unmodifiable risk factor for hip function decline. Our study demonstrated a strong association between health utility (measured by EQ-5D) and hip function. A systematic review corroborated this, linking mental status, pre-fracture function, comorbidities, female gender, nutritional status, postoperative pain, hospital stay length, and complications to health-related quality of life. Ju et al. [29] identified hip function as a primary predictor for health-related quality of life in elderly patients after intertrochanteric fractures. Enhanced hip function translated to improved mobility and ease in daily activities, influencing health-related quality of life. However, their retrospective analysis lacked data on pre-fracture function and mental status.

Hip abductor muscle function significantly contributes to lateral balance control, particularly in tasks like multidirectional stepping, obstacle walking, and standing balance, becoming more critical with aging [30]. Adequate torque generation by hip abductor muscles is essential for balance recovery and fall prevention. Restoring abductor strength to pre-injury levels is pivotal for gait improvement, reducing reliance on walking aids, and enhancing psychological well-being. Abductor strengthening exercises typically mitigate abductor lurch in the postoperative phase. In our study, all patients regained abductor strength within three months, enabling normal walking. Age influenced the extent of improvement in abductor strength and mobility status.

Several limitations of our study warrant consideration. The small patient sample and the six-month follow-up period may constrain functional outcomes and HRQOL evaluation. Inter-observer and intra-observer variations were not addressed.

In conclusion, poor bone quality, represented by osteomalacia and osteoporosis, is significantly associated with intertrochanteric fractures in Indian populations. The PFNA 2 nailing system effectively maintains reduction and prevents varus collapse. Telescopy emerged as a common blade migration phenomenon in compromised bone quality, contrasting with inward migration observed in previous studies. Functional outcomes and HRQOL improve over time with intramedullary fixation, yet patients seldom return to pre-injury levels, potentially influenced by recall bias.

Disclosure of conflict of interest

None.

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References

[1] Paul O, Barker JU, Lane JM, Helfet DL and Lorich DG. Functional and radiographic outcomes of intertrochanteric hip fractures treated with calcar reduction, compression, and trochanteric entry nailing. J Orthop Trauma 2012; 26: 148-54.

[2] Ganz SB, Peterson MG, Russo PW and Guccione A. Functional recovery after hip fracture in the subacute setting. HSS J 2007; 3: 50-7.

[3] Pajarinen J, Lindahl J, Michelsson O, Savolainen V and Hirvensalo E. Pertrochanteric femoral fractures treated with a dynamic hip screw or a proximal femoral nail. A randomized study

comparing post-operative rehabilitation. J Bone Joint Surg Br 2005; 87: 76-81.
[4] Gardner MJ, Bhandari M, Lawrence BD, Helfet DL and Lorich DG. Treatment of intertrochanteric hip fractures with the AO trochanteric fixation nail. Orthopedics 2005; 28: 117-22.
[5] Eardley WGP; National Hip Fracture Database. Misunderstanding and the trochanteric fracture. Bone Joint J 2024; 106-B: 430-434.
[6] Sivakumar A, Bennett KJ, Pizzolato C, Rickman M and Thewlis D. Hip biomechanics in early recovery following fixation of intertrochanteric fractures: results from a randomised controlled trial. J Biomech 2024; 170: 112169.
[7] Sivakumar A, Rickman M and Thewlis D. Gait biomechanics after proximal femoral nailing of intertrochanteric fractures. J Orthop Res 2023; 41: 862-874.
[8] Wang Z, Liu Y, Li S, Wang X, Liu C and Tang X. How to get better TAD? Relationship between anteversion angle of nail and position of femoral neck guide pin during nailing of intertrochanteric fractures. BMC Musculoskelet Disord 2020; 21: 512.
[9] Singh S. Proximal femoral nail versus proximal femoral nail antirotation: functional and radiological outcome in intertrochanteric fractures of femur. Cureus 2021; 13: e19093.
[10] Bhardwaj S, Sakale H, Agrawal AC, Kar B, Narayan Dash R, Rai A and Garg AK. A comparison of the clinicoradiological outcomes of intertrochanteric fractures treated using proximal femoral nail and proximal femoral nail anti-rotation. Cureus 2024; 16: e60639.
[11] Grønhaug KML, Dybvik E, Matre K, Östman B and Gjertsen JE. Intramedullary nail versus sliding hip screw for stable and unstable trochanteric and subtrochanteric fractures: 17,341 patients from the norwegian hip fracture register. Bone Joint J 2022; 104-B: 274-282.
[12] Song KM, Halliday SE and Little DG. The effect of limb-length discrepancy on gait. J Bone Joint Surg Am 1997; 79: 1690-8.
[13] Lecerf G, Fessy MH, Philippot R, Massin P, Giraud F, Flecher X, Girard J, Mertl P, Marchetti E and Stindel E. Femoral offset: anatomical concept, definition, assessment, implications for preoperative templating and hip arthroplasty. Orthop Traumatol Surg Res 2009; 95: 210-9.
[14] McGrory BJ, Morrey BF, Cahalan TD, An KN and Cabanela ME. Effect of femoral offset on range of motion and abductor muscle strength after total hip arthroplasty. J Bone Joint Surg Br 1995; 77: 865-9.
[15] Gardner MJ, Briggs SM, Kopjar B, Helfet DL and Lorich DG. Radiographic outcomes of intertrochanteric hip fractures treated with the trochanteric fixation nail. Injury 2007; 38: 1189-96.
[16] Guo Y, Yang HP, Dou QJ, He XB and Yang XF. Efficacy of femoral nail anti-rotation of helical blade in unstable intertrochanteric fracture. Eur Rev Med Pharmacol Sci 2017; 21 Suppl: 6-11.
[17] McConnell T, Tornetta P 3rd, Benson E and Manuel J. Gluteus medius tendon injury during reaming for gamma nail insertion. Clin Orthop Relat Res 2003; 199-202.
[18] Dhanwal DK, Siwach R, Dixit V, Mithal A, Jameson K and Cooper C. Incidence of hip fracture in rohtak district, North India. Arch Osteoporos 2013; 8: 135.
[19] Kumar GN, Sharma G, Khatri K, Farooque K, Lakhotia D, Sharma V and Meena S. Treatment of unstable intertrochanteric fractures with proximal femoral nail antirotation II: our experience in indian patients. Open Orthop J 2015; 9: 456-9.
[20] Rath S, Yadav L, Tewari A, Chantler T, Woodward M, Kotwal P, Jain A, Dey A, Garg B, Malhotra R, Goel A, Farooque K, Sharma V, Webster P and Norton R. Management of older adults with hip fractures in India: a mixed methods study of current practice, barriers and facilitators, with recommendations to improve care pathways. Arch Osteoporos 2017; 12: 55.
[21] Parsons N, Griffin XL, Achten J, Chesser TJ, Lamb SE and Costa ML. Modelling and estimation of health-related quality of life after hip fracture: a re-analysis of data from a prospective cohort study. Bone Joint Res 2018; 7: 1-5.
[22] Baumgaertner MR, Curtin SL, Lindskog DM and Keggi JM. The value of the tip-apex distance in predicting failure of fixation of peritrochanteric fractures of the hip. J Bone Joint Surg Am 1995; 77: 1058-64.
[23] Cleveland M, Bosworth DM, Thompson FR, Wilson HJ Jr and Ishizuka T. A ten-year analysis of intertrochanteric fractures of the femur. J Bone Joint Surg Am 1959; 41-A: 1399-408.
[24] Gilat R, Lubovsky O, Atoun E, Debi R, Cohen O and Weil YA. Proximal femoral shortening after cephalomedullary nail insertion for intertrochanteric fractures. J Orthop Trauma 2017; 31: 311-5.
[25] Adams CI, Robinson CM, Court-Brown CM and McQueen MM. Prospective randomized controlled trial of an intramedullary nail versus dynamic screw and plate for intertrochanteric fractures of the femur. J Orthop Trauma 2001; 15: 394-400.
[26] Hernefalk B, Eriksson N, Borg T and Larsson S. Estimating pre-traumatic quality of life in patients with surgically treated acetabular fractures and pelvic ring injuries: does timing matter? Injury 2016; 47: 389-94.
[27] Williamson OD, Gabbe BJ, Sutherland AM and Hart MJ; Victorian Orthopaedic Trauma Out-

come Registry Project Group. Does recall of preinjury disability change over time? Inj Prev 2013; 19: 238-43.
[28] Tang P, Hu F, Shen J, Zhang L and Zhang L. Proximal femoral nail antirotation versus hemiarthroplasty: a study for the treatment of intertrochanteric fractures. Injury 2012; 43: 876-81.
[29] Ju JB, Zhang PX and Jiang BG. Risk factors for functional outcomes of the elderly with intertrochanteric fracture: a retrospective cohort study. Orthop Surg 2019; 11: 643-52.
[30] Lanza MB, Arbuco B, Ryan AS, Shipper AG, Gray VL and Addison O. Systematic review of the importance of hip muscle strength, activation, and structure in balance and mobility tasks. Arch Phys Med Rehabil 2022; 103: 1651-62.