Assessing the Initial Response: Intertrochanteric Fractures Managed with Proximal Femoral Nail

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ABSTRACT
Background: The current investigation involved 41 patients diagnosed with intertrochanteric fracture, all of whom underwent surgical management with Proximal Femoral Nail (PFN). These patients were then monitored for a duration of 12 weeks post-operation, with 17 being male and 24 females. Aim & Objective: This observational and follow-up study took place within the Department of Orthopaedics at the Himalayan Institute of Medical Sciences, Dehradun, spanning a period of one year. Materials and **Methods**: A longitudinal analytical study was carried out in Orthopaedics department (HIMS). Patients with trochanteric fracture classified by AO classification were included in this study. Patients were followed up at 6th week, and 12th week. They were assessed clinically on the basis of Harris hip score and radiologically on the basis of femoral neck shaft angle and union Harris hip score is a tool used to calculate functional outcome in patients undergoing hip surgeries. **Results**: Intertrochanteric fractures was more common in old age group with most of patients in age group of 60-80 years. It was also concluded that Inter-trochanteric fractures are more commonly seen in females as compared to males. According to AO classification, AO31A2 was the most common type of fracture seen followed by AO31A1. The mean value of neck shaft angle in immediate post op was 127.68 + 4.94 and at 12 weeks post-operatively was 124.72 + 5.86 which was found to be a significant change. Average Harris hip score was found to 61.95 + 14.93 with approximately half of patient having poor grade of functional outcome with rest having fair to good grad. Union rate at 12 weeks of follow up in present study was found to be 61%. **Conclusion**: Complication rates in this study seen after intertrochanteric fractures treated with PFN was found to be 21.9% which included infection, screw backout, Limb length discrepancy and joint stiffness.

1. Introduction

Hip fractures represent a substantial global public health concern, encompassing two primary categories: extracapsular fractures (trochanteric and subtrochanteric) and intracapsular fractures (cervical). With demographic projections indicating a significant rise in the elderly population, it's estimated that hip fractures may reach 500,000 by 2040. Among these fractures, intertrochanteric fractures stand out as the most common type, accounting for nearly half of all hip fractures worldwide [1, 2].

An intertrochanteric fracture is described as a fracture occurring along the line that is connecting the lesser and greater trochanters [3]. The aging population correlates with a rise in intertrochanteric fractures, frequently culminating in the loss of the patient's functional independence. The most

common cause of the intertrochanteric fractures in the younger age group is the high velocity trauma, whereas in the elder age group is often a trivial trauma [4].

Females are more prone to the Intertrochanteric fractures compared to the males which are more common in Postmenopausal age because of hormonal changes. The early mobilization is the main goal of hip fracture treatment as the risk of postoperative complications is decreased and long-term mortality rate is improved. For a very long time, the most common surgical treatment choice was Dynamic Hip Screw (DHS) but was replaced by Proximal Femoral Nail (PFN) due to certain disadvantages. DHS was considered as the most common treatment for trochanteric femur fracture for almost 40 years while producing excellent results in the stable fractures [5].

DHS was associated with significant shortening of limb resulting in a limb length discrepancy which in return causes abductor lever arm's mal-adaptation. The patient outcomes are negatively influenced by the functional limitations. This was overcome by PFN which is a near-normal restoration of gait parameters and it helped in achieving satisfactory outcomes. A more bio-mechanically stable construct is provided by PFN which reduces the distance between implant and hip joint [6]. Moreover, PFN is overall superior to DHS in that Intraoperatively it lead to less blood loss, incision size was smaller in case of PFN and lag Screw cut out rate was also found to be lower in PFN. Considering all these factors PFN was found to be superior than DHS in treating Intertrochanteric fractures [6].

1.1 Aims and Objectives

The aim of present study was to evaluate the patient's early outcome in intertrochanteric fracture fixed with PFN.

- Primarily to evaluate early outcome of Intertrochanteric fractures treated with PFN.

2. Review of Literature

The trochanteric fractures were treated in a very conservative manner upto 1930s. Conservative treatment regimens included, splinting to the opposite limb or simple support with pillows, plaster spica immobilization, well-leg traction, Buck's (skin) traction, balanced traction of Russell and upper tibial or lower femoral skeletal traction. The use of Jewett nail-plate and Smith Peterson nail were the preferred surgical treatment options during the early 1950s. The treatment of IT fractures was revolutionized by Schumpelick et al. by presenting "the sliding neck screw" results in the Dyanamic Hip Screw in 1955 [4].

Sharma and Sethi et al in 2018, concluded that there is significantly shorter surgery provided by Proximal femoral with a small incision leading to less complications associated with wound. However, the PFN had significantly higher incidence of technical errors compared to DHS because it is relatively difficult surgery technically which results in increase rate of implant failures eventually leading to re-operations [6].

Naja et al., in 2018 performed a study on "Predictors of mechanical failure rate in reduction of intertrochanteric fracture of the femur using PFN with helical blade" explained that to "reduce orthopedic and non-orthopedic complications associated with implant and quality of reduction, PFN with helical blade is superior to other devices" irrespective of the quality of reduction, including factors such as the position of the helical blade, neck-shaft angle (NSA), and displacement of the lesser trochanter and femoral shaft, the implant design of the PFN with a helical blade diminishes rotational mobilization and provides greater stability, potentially averting

mechanical failure. Furthermore, regardless of the reduction quality, employing PFN with helical blades can decrease both the duration and cost of surgery [7].

In a study conducted by Bhandari and Deane in 2018, they found that the mean neck-shaft angle (NSA) of the normal side was 122.39 degrees, and after DHS fixation, it was restored to 129.81 degrees. Additionally, the mean NSA of the normal side was 119.45 degrees, and after PFN fixation, it was restored to 119.42 degrees. They observed that even after surgical management there is a tendency for these pertrochanteric fractures to collapse and the NSA achieved at the time of surgery may be lost, therefore the final NSA at the time of fracture union might be quite different from the one achieved at surgery [8].

Duramaz and İlter in 2019 concluded that PFNA-II is a better option in the treatment of Intertronchaetric femoral fractures than Profin and Inter TAN only When evaluating surgical parameters alongside functional and radiological outcomes as a whole, the study provided a comprehensive understanding of the effectiveness of the procedures in restoring function and anatomical alignment [9].

Gurger in 2019 analysed that post-operative complications and delayed surgery may be the most primary risk factors increasing 1-year mortality in elderly patients with hip fractures after treatment with primary arthroplasty and PFN. Proper precautions can be used to prevent these two risk factors, hence increasing the rate of 1-year survival for these patients [10].

3. Materials And Methods

The research was carried out at the Department of Orthopaedics, Himalayan Institute of Medical Sciences, Swami Ram Nagar, Dehradun, spanning a duration of one year. Subjects were selected from among patients seeking treatment at the Orthopaedics Department, HIMS, Dehradun, with a primary diagnosis of intertrochanteric fractures.

3.1 Study design:

Type of study: Longitudinal Analytical study

Sample size: Minimum 30 cases

3.1.1 Selection of subjects:

Inclusion criteria:

- All skeletally mature patients.
- All trochanteric fracture classified by AO classification

Exclusion criteria:

- All skeletally Immature patients
- Previous malunited fracture
- Open fractures
- Patients with pathological fractures due to causes other than osteoporosis
- Patients with previous wound or bone infections.

3.1.2 Study Tools

All adults with intertrochanteric fractures admitted to Orthopaedics Department, HIMS, were included in the study.

1. Case recording form
2. Pelvic x-ray with bilateral hip AP view in the supine position with hips rotated in 15-20 degree internal rotation and standard lateral views after surgery using digital X – ray machine (CR system).
3. Fracture classification was done on the basis of AO classification for intertrochantric fractures.
4. Morphometric measurements were done on Digital X-ray with help of Bersoft image measurement software trial version 8.49.
5. Harris Hip Score

3.2 Study protocol:

Patients were followed up at 6th week, and 12th week. They were assessed clinically on the basis of Harris hip score and radiologically on the basis of femoral neck shaft angle and union Harris hip score is a tool used to calculate functional outcome in patients undergoing hip surgeries. It mainly evaluate pain, activity and function after hip surgeries. Maximum score achieved can be 100 and higher score indicates better functional outcome. We calculated Harris hip score at 3 months of follow up. The data was subjected to standard statistical analysis.

3.3 Data Management and Statistical analysis

The data was collected and inputted into MS Excel 2016. Various statistical analyses were conducted using SPSS software version 22. The one-sample Kolmogorov-Smirnov test was utilized to assess whether the datasets deviated from a normal distribution. Parametric tests were employed for normally distributed data. Descriptive statistics were computed for quantitative variables, while frequencies and percentages were calculated for qualitative and categorical variables. Graphical representations of variables were utilized for clearer comprehension of the results, and categorical data were analyzed using the Chi-Square test. A p-value of less than 0.05 indicated a statistically significant hypothesis, while a p-value greater than 0.05 suggested a statistically insignificant hypothesis.

4. Results

In this study, 76 patients were included, out of which 3 died due to other ailment and 32 were lost to follow up due to COVID-19 Pandemic, So, complete follow up of only 41 Patients was done.

Table 1: Age Distribution

Age Groups(Years)	Number of Patients (N=41)	Percentage
20-40	04	9.8%
41-60	05	12.2%
61-80	25	60.1%
>80	06	17.9%
Total	41	100%
Mean $\pm$ SD	66.70 $\pm$ 16.28	

Min - Max	22 - 92
Median (IQR)	73.00 (63.00 – 82.00)

In the present study, the age range of the patients was 22-96 years. The mean age was found to be 66.70 ± 16.28 years. Majority of the patients belonged to 60-80 years age group (60.1%) and very few (9.8%) patients were below the age of 40 years as depicted by Table-1.

Table–2 shows that there were more female patients (58.5%) in this study. The male : females ratio was approximately 3:2.

Table 2: Sex wise distribution

Sex	**Number of patients (N=76)**	**Percentage**
Males	17	41.5 %
Females	24	58.5 %
Total	41	100 %

Table 3: Fracture Type according to AO classifications

Fracture sub group	**Number of Patients (N=41)**	**Percentage**
AO31-A1	14	34.1%
AO31-A2	24	58.5%
AO31-A3	03	7.4%
Total	41	100%

According to AO Classification, Majority of the patients, 24 (58.5%) were AO31A2 Category as shown by table-3.

Table-4 shows that majority of patients reported injury during household activity as the mode of injury (75.6%) followed by road traffic accident (12.5%).

Table 4: Mode of Injury

	Number of Patients (N=41)	**Percentage**
Injury during household activity	31	75.6%
Fall from Height	03	7.3%
Fall from Stairs	01	2.4%
Road Traffic Accident	05	12.5%
Animal Assault	01	2.4%

Table 5: Duration between injury and surgery

	Number of patients	**Percentage**
1-5 days	21	51.2%
6-10 days	13	31.7%
>10 days	07	17.1%
Total	41	100%
Mean $\pm$ SD	6.34 $\pm$ 4.60	
Min – Max	1 – 22	
Median	6 (4 - 9)	

The average duration between injury and surgery was found to be 7.28 days, ranging from 1 day to 35 days as depicted by table 5.

Table 6: Post operative neck shaft angle distribution

Neck shaft angle	**Number of patients (N=41)**	**Percentage**
$< 125^0$	10	24.4%%
$125^0 – 135^0$	30	73.2%
$>135^0$	01	2.4%
Mean $\pm$SD	127.68 ± 4.94	
Min-Max	$114^0 – 138^0$	

Table-6 depicts the neck shaft angle distribution in immediate post operative patients. Majority of Patients (73.2%) had their neck shaft angle in the range of 125^0 and 135^0.

Table 7: Neck shaft angle distribution at 3 months follow up

Neck shaft angle	**Number of patients (N=41)**	**Percentage**
$< 125^0$	16	39%
$125^0 – 135^0$	25	61%
$>135^0$	0	0%
Mean $\pm$ SD	124.72 $\pm$ 5.86	
Min – Max	$113^0 – 134^0$	

Table-7 depicts the neck shaft angle distribution at 3 months follow up post operatively. Majority of Patients (61%) had their neck shaft angle in range of 125^0 and 135^0.

Table 8: Neck Shaft angle deviation

	Number of patients	**Percentage**
No Change	11	27%
Varus $1\text{-}4^0$	19	46%
Varus $\geq 5^0$	10	24%

Valgus 1-4^0	01	3%
Total	41	100%

At 3 months follow up, Neck shaft angle (NSA) compared with immediate post operative findings. It was seen that almost half of the patients (46%) had varus change between 1-4 degree, while 27% patients had no change in neck shaft angle deviation as depicted by table-8.

Table 9: Statistical comparison of mean neck shaft angle of normal side and of operated side

Side	N	Mean NSA ± SD	Mean difference ± SD	p value
Normal side	41	128.41 ± 4.73	0.73 ± 0.21	0.008
Operated side	41	127.68 ± 4.94		

Table 9 shows mean change in value of normal side to operated side with p value 0.008 which is significant.

Table 10: Statistical comparison of mean neck shaft angle at immediate post operative and 3 months follow up

Neck shaft angle	N	Mean ± SD	Mean ± SD	p value
Immediate post op	41	127.68 ± 4.94	2.95 ± 3.58	<0.001
At 12th week	41	124.72 ± 5.86		

Table-10 shows that change in mean value of NSA in the study population during immediate post op, and at 12 weeks. It shows there is a significant change in the value of NSA at 12 weeks.

Table 11: Union Rate

Union at 3 months follow up	Number of patients	Percentage
Complete Union	25	61%
Union in progress	14	34%
No sign of callus formation	02	5%
Total	41	100%

At 3 months follow up, Patients were evaluated for union of fracture. In most of the patients (61%), complete union was seen, while 34% had union in progress. However, in 2 patients (5%) no sign of callus formation observed radiologically as depicted by Table-11.

Table 12: Functional assessment on basis of Harris Hip score

	Number of patients	Percentage
Poor (< 70)	21	51%
Fair (70-79)	14	34%
Good (80-89)	06	15%
Excellent (90-100)	00	0%

Total	41	100%
Mean ± SD	61.95 ± 14.93	
Min – Max	23 – 81	
Median	61 (50 – 73)	

On functional assessment of patients at 3 months (using Harris hip score), most of the patients had poor grading (51%). Rest of the patients had fair to good score as depicted by table-12.

Table 13: Complications

	Number of Patients	**Percentage**
Surgical site infection	01	2.4%
Limb Length Discrepancy (> 1 cm)	04	9.75%
Screw cutout	02	4.9%
Joint stiffness	07	17%

Table-13 shows that out of 41 patients, overall complications were seen in 9 patients (21%) which included surgical site infection, limb length discrepancy of more than 1 cm, screw cut out and joint stiffness. Joint stiffness was seen in total 7 patients, 2 of which were associated with limb length discrepancy, 1 had screw cut out, 1 was associated with SSI and 1 was associated with both limb length discrepancy and screw cut out.

5. Discussion

The current study aimed to assess the early outcomes of intertrochanteric fractures treated with PFN. Initially, 76 patients who underwent surgery at the Himalayan Institute of Medical Sciences were enrolled. However, only 41 patients could be fully followed up. Thirty-two patients were lost to follow-up due to the COVID-19 pandemic and were consequently excluded from the study. Additionally, three patients passed away from unrelated causes before completing the 12-week follow-up period and were also excluded. Therefore, the final analysis included 41 patients who underwent complete follow-up and were included in the study.

All the patients were evaluated on the basis of functional and radiological outcome. Functional evaluation was done based on Harris hip score which was calculated at 12 weeks of follow up. Radiological evaluation was done on basis of neck shaft angle immediate post operative and at 12 weeks follow up and radiological union at the end of 12 weeks.

In the present study, age group of patients ranged from 22 years to 96 years with an average age of 66.70 ± 16.28 years with majority of patients having age between 60 years to 80 years i.e 60.1%. This was comparable with various studies conducted. In a study by Sinha et al., [11] on Indian population, the study population had a mean age of 69 years. Similarly, Purohit et al also reported that majority of patients (84%) in their study were more than 60 years [12].

In the current study, intertrochanteric fracture was found to be more common in females i.e 24 (58.5 %) Patients were female and 17 (41.5 %) were male. Sharma, Sethi and Sharma, found in their study that intertrochanteric is more common in females as compared to males which is comparable to our study. This is because females are more prone to osteoporosis in post menopausal age due to hormonal changes [6]. Adeyemi and Delhougne [2] gave various reasons for

female being more prone to intertrochanteric fractures one being females have a wider pelvis and tend to have coxa vara deformity. Other factors like females are less active and therefore, more prone to senile osteoporosis also contributes to this [2].

All preoperative radiographs were classified as per AO classification in the present study. It was seen that 58.5% had unstable (31.A2) fractures, 34.1% had stable fracture (AO31A1) and 7.4% had reverse oblique type fracture (AO31A3). This can be explained by the fact that most of the patients in the current study (78%) were more than 60 years of age, so the chances of unstability of fracture are more due to high fragility of bones. Similarly, in their study on Indian population, Mudgal et al., [13] also reported that 60% patients had unstable intertrochanteric fractures [24]. This was also reported by [8] where they found 67% patients with unstable intertrochanteric fractures. In their study they concluded that unstable intertrochanteric fractures were common in patients over the age of 60 and more common in severely osteoporotic bone [13].

In the present study, mode of injury in 75.6% patients was fall at home which was also reported as the most common mode of injury by Kumar et al., [14]. Purohit et al also reported slip and fall on floor to be the most common mode of injury in their study [12]. This was attributed to the factor that majority of patients in current study were old age patients. Various factors have been described and why fall is the more common cause of fracture in this age group. These include inadequate protective reflexes, minimal shock absorbers during fall like fat and muscles and low bone strength in view of osteoporosis [9].

The mean neck shaft angle of 127.68 was calculated postoperatively with 73.4% patients ranging between 125 and 135 degrees which is comparable to study conducted by Sinha et al., who found mean value of 128.5 and reported mean neck shaft angle to be 130 degrees [11].

The functional outcomes of patients were evaluated using the Harris Hip Score at the 12-week follow-up. The mean value of the Harris Hip Score in the study population was 61.95 ± 14.93. In a study by Purohit et al., the mean Harris Hip Score at 12 weeks was reported to be 57.75 ± 1.92. In their study, had 3-month Harris hip score as 53.572 $\pm$1.586 and 58 $\pm$5.6 respectively. These values were comparable to the study. In the present study, Harris hip score of our patients were mostly in range of poor and fair value. This was because our study was conducted only upto 3 months of follow up and majority of our patients were old age patients in which it was difficult to assess Harris hip score.[11]

During follow up, 1 (2.4%) patient had surgical site infection. The infection was managed through debridement and administration of suitable antibiotics based on culture and sensitivity testing. Gürbüz et al., [15] in their study had 2% infection rate and found infection rate of 1.3% (2 out of 152 Patients) which is comparable to the current study.

It was further found that 4 (9.75%) patients had limb shortening of more than 1cm. Kumar et al., [16] also reported limb shortening of more than 1 cm in 8.5% (6 in 70) patients in their study. In their study [14] explained that femoral shortening after surgical treatment is attributed to secondary collapse and impaction of stabilized fractures which depends on factors like bone quality, fracture type, method of fixation and early postoperative mobilization. Unstable fracture with poor bone quality contributes to more incidence of femoral shortening. In this study, femoral shortening was observed in old age patients with poor bone quality and unstable fractures which correlates to the findings of [5].

Furthermore, there were 2 (4.9%) patients who had their lag screw cut out. Bhandari and Deane [8] reported in their study, lag screw cut out rate in their study in 8.7% (4 out of 48) patients. Sinha et al., found frequency of screw cut out to be 8.6 % [11] and Siddiqui et al., found that 4.7% (2 out of 42) patients in their study had lag screw cut out [17]. He described the reason for screw cutout to be inadequate reduction and osteoporotic bones which may be reason for screw cut out in the present study.

6. Conclusion

In the present study titled "Early outcome of inter-trochanteric fractures treated with PFN" we have concluded the following:

- The Neck shaft angle (NSA) in patients of intertrochanteric fractures treated with PFN changes significantly during first 12 weeks of post operative follow up, which can be prevented by delayed full weight bearing till the bony union is achieved.
- Harris hip score is not a very valuable tool to assess the early outcome in elderly age group in intertrochanteric fractures treated with PFN because of physical limitation that are part of the old age.

The information provided on the basis of present study is that the neck shaft angle changes significantly during first 12 weeks of postoperative period. However longer follow up would have further validated these findings.

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