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Functional outcome of unstable intertrochanteric fracture treated with proximal femoral nail

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Abstract:

Background: Intertrochanteric fractures are common in elderly with osteoporotic bones. Unstable fractures are the one which cause problem and complication rates are higher with conventional fixation devices. Proximal femoral nail is now the preferred implant for the treatment of intertrochanteric fractures. This study aims to evaluate the functional outcome of proximal femoral nail in unstable intertrochanteric fractures in our setting.

Method: This prospective study conducted at Chitwan Medical College from Jan 2021 to Dec 2022 included 35 patients aged >18 years having unstable intertrochanteric fractures who consented to participate in the study. Excluded were those with open fracture, polytrauma or pathological fracture. All patients were treated with long proximal femoral nail and followed-up for a minimum of one year. Clinical assessment was done using Harris Hip Score along with radiological evaluation for fracture union. Data analysis was done using Statistical Package for Social Sciences. A $p<0.05$ was considered statistically significant.

Result: There were 16 males and 19 females with mean age of 70.7±15.2 years among which 23 had AO Foundation/Orthopaedic Trauma Association type 31A2 and 12 had 31A3 fractures. Majority sustained injury from trivial fall 18(51.4%). All fractures united at a mean of 16.9±3.7 weeks with the final Harris Hip Score as excellent in 10(28.6%) and good in 19(54.3%). Pre-injury ambulatory status was regained by 26(74.3%) patients. The overall complication rate was 9(25.7%).

Conclusion: Proximal femoral nails provide adequate fixation for unstable intertrochanteric fractures with good functional outcome.

Keywords: Harris hip score, Intertrochanteric fracture, Proximal femoral nail, unstable

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Introduction

Intertrochanteric fractures are common in elderly population and pose serious public health problem. Hip fractures occurring in the world each year is projected to rise from 3.9 million in 2025 to 6.3 million by 2050[1] and about half of them will occur in Asia.[1,2] In an epidemiological study done in central Nepal, peritrochanteric fractures were most common fractures in 29.4% in the elderly population.[3] Life expectancy of Nepalese people has increased from 62.6 years in 2000 to 71.1 years in 2024 and thus the population of elderly is also increasing.[4] Furthermore, due to rising incidence of road traffic injuries, peritrochanteric fractures in young adults are also in rise.[5]

Among all intertrochanteric fractures 35-50% are unstable with three and four part configurations along with displacement of posteromedial cortex.[6-8] Stable fractures have better functional outcome irrespective of method of fixation while unstable ones cause problem and have higher complication rates with conventional fixation devices. Added are the problems of osteoporosis and other medical co-morbidities in elderly.[9]

Operative management is the standard of care to achieve stable fracture fixation allowing for early ambulation. Dynamic hip screw is still considered the gold standard for intertrochanteric fractures by many,[10] while others find it biomechanically inferior to intramedullary devices like proximal femoral nail (PFN) in unstable fractures.[8,11] The use of PFN has increased in recent years, having both benefits and technical failures.[12-14] Most of the patients of intertrochanteric fractures are elderly with osteoporotic bone and other co-morbidities, and cannot withstand the stress of second surgery. Hence the fracture needs to be accurately reduced and then fixed with an appropriate implant.

The presence of different treatment modalities itself suggests that none of them is perfect. The aim of this study was to evaluate the functional outcome of PFN in patients with unstable intertrochanteric fractures in our locality.

Method

This was a prospective study conducted in Department of Orthopaedics, Chitwan Medical College, Nepal, from Jan 2021 to Dec 2022. Incidence of intertrochanteric fractures treated in our institution in previous year was 2.1%. Taking this as population proportion, confidence interval 95% and allowable error 5%, estimated sample size was 32. Using convenience sampling, the first 39 patients meeting the inclusion criteria were treated with PFN, however only 35 were available for final analysis, Figure 1.

Approval of the study was taken from Institutional Review Committee of Chitwan Medical College (CMC-IRC/077/078-038) and written informed consent was taken from all the participants. Fractures were classified using Arbeitsgemeinschaft für Osteosynthesefragen (AO) Foundation/Orthopaedic Trauma Association (AO/OTA) classification with types 31A2 and 31A3 being unstable ones.[15]

Surgery was performed under spinal or epidural anesthesia with patient supine in fracture table. Closed reduction was done under fluoroscopic guidance and confirmed in both anteroposterior and lateral views, Figure 2. In 12 patients closed reduction was unsuccessful and they required additional percutaneous or mini-open reduction maneuver using Steinmann pin or reduction clamps. Greater trochanter entry point was made with awl and guide wire was passed followed by sequential reaming of the femoral medullary canal. A long PFN of appropriate diameter and length was passed, and two proximal head-neck screws and distal interlocking bolts were inserted. The final position of the implant was confirmed with the fluoroscopy and wound closed in layers- fascia with polyglactin 1.0, subcuticular polyglactin 2.0 and skin with stapler. Injection cefuroxime 1.5 g was given 30 minutes before surgery and twice daily for 48 hours, followed by oral cefuroxime for five days.

Post-operatively isometric quadriceps exercise and ankle pump exercise were begun on day one with patient made to sit up. Hip range of motion exercises was started and patient mobilized on

walker or crutch toe-touch to partial weight bearing as soon as tolerated. First dressing was done on second day and then every third day, and evaluated for any redness or serous/purulent discharge from the incision site. Patients were discharged after three days with crutch walking training and suture removal was done on 14th day.

Follow-up evaluation was done at six weeks, three months, six months and one year. Clinical evaluation was done using Harris Hip Score (HHS) with scores ranging from zero to hundred, the rating being excellent for 90-100, good 80-89, fair 70-79 and poor <70 points.[16] Radiological assessment was done using anteroposterior and lateral views of affected hip joint including thigh to look for fracture union, collapse or any other complication like cutting out/loosening of screws or breaking of the implant. The fracture was said to be united only when definite trabeculae were present across the fracture in both anteroposterior and lateral radiographs, and no hip tenderness could be elicited clinically.

The SPSS (Statistical Package for the Social Sciences) version 20.0 was used for statistics. Analysis was done using frequencies, descriptive options for mean and standard deviation. Means for repeated measures were compared using Analysis of Variance (ANOVA). Values of $p<0.05$ were considered significant with a confidence interval of 95%.

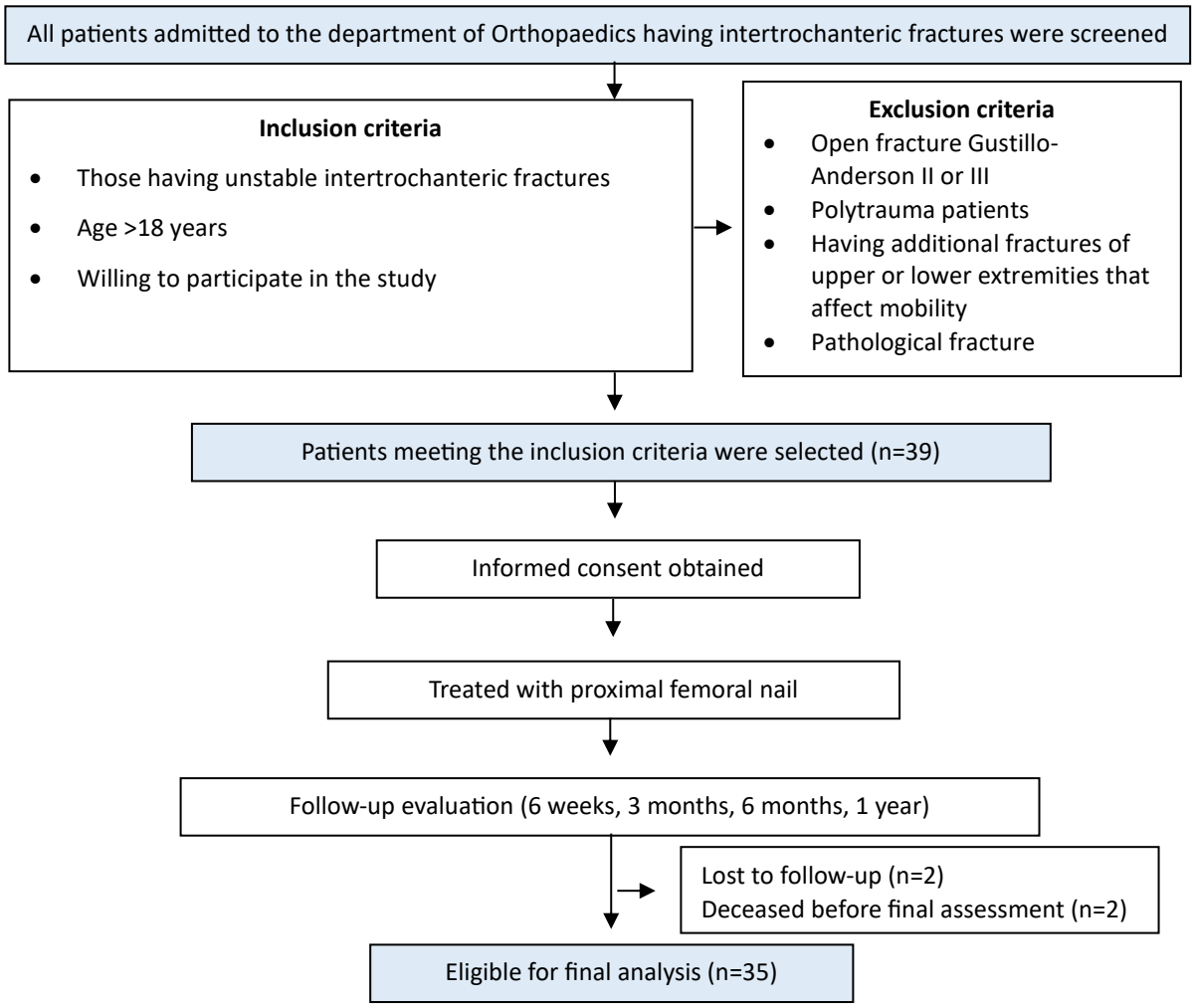

Figure 1. Flowchart of patients with unstable intertrochanteric fracture recruitment for proximal femoral nail

Figure 2. Patient placed in fracture table, painted and draped (a); pre-operative X-rays (b, c); provisional K-wires placed after closed reduction and entry made with awl (d, e); guide wire passed (f, g); final closure (h)

Result

There were 35 patients, among which 16(45.7%) were males and 19(54.3%) females. The mean age was 70.7±15.2 years (range 33-97 years). Majority were elderly with age >65 years, 22(62.9%), and trivial fall accounted for 18(51.4%) injuries sustained. As per AO/OTA classification, there were 23(65.7%) cases of 31A2 and 12(34.3%) cases of 31A3 fractures, Table 1.

The mean Harris Hip Score increased during consecutive follow-up: 48.5±11.5 at six weeks to 87.8±6.8 at one year, Figure 3. A repeated measures ANOVA with a Greenhouse-Geisser correction determined that the mean HHS improved significantly between the time points, F (1.443, 49.062)=354.495, p<0.0005. At the final follow-up, the HHS was rated as excellent in 10(28.6%), good 19(54.3%), fair 4(11.4%) and poor 2(5.7%) cases, Table 2.

Before injury, 4(11.4%) patients were cane dependent, 6(17.1%) used cane occasionally, 24(68.6%) required no aids for walking, whereas 1(2.9%) was unable to walk independently. At final follow-up, 16(45.7%) patients walked independently, 16(45.7%) required walker or crutches for walking and 3(8.6%) were not ambulatory. Twenty-six patients (74.3%) were able to return to their pre-injury ambulatory status.

The mean radiological union time was 16.9±3.7 weeks. Fifteen (42.9%) patients had radiological union at 12 weeks follow-up while all 100% had union at six months, Figure 4. Among 22 elderly patients older than 65 years, 7(31.8%) had union at 12 weeks and the rest took more than 12 weeks for the fracture to unite. Among three patients aged less than 45 years, all (100%) had united at 12 weeks.

Nine patients (25.7%) developed complications. One case had anterior cortex perforation with the nail tip intraoperatively- it was managed with putting a shorter nail, Figure 5. Two patients (5.7%) developed superficial wound infection, which was managed with change of antibiotics and dressing changes. Late complications included 3(8.6%) cases of screw back out, 2(5.7%) screw breakage, and 1(2.9%) varus collapse.

Table 1. Baseline characteristics of patients with unstable intertrochanteric fractures treated with proximal femoral nail, n=35

Variables	n(%)
Gender	
Male	16(45.7)
Female	19(54.3)
Age group	
<45 years	3(8.6)
45-65 years	10(28.6)
>65 years	22(62.9)
Mode of injury	
Trivial trauma	18(51.4)
Fall from height	12(34.3)
RTA*	5(14.3)
Side injured	
Left	17(48.6)
Right	18(51.4)
AO/OTA† fracture type	
31A2	23(65.7)
31A3	12(34.3)
Operative delay, median (days)	2(0-8)
Length of hospital stay, median (days)	7(3-20)
Duration of surgery, mean±SD (minutes)	88.9±24.1
Radiological union, mean±SD (weeks)	16.9±3.7

*Road Traffic Accident
†Arbeitsgemeinschaft für Osteosynthesefragen (AO)/Orthopaedic Trauma Association (OTA)

Table 2. Rating of Harris Hip Score on consecutive follow-ups after proximal femoral nailing in unstable intertrochanteric fractures, n=35

HHS* rating	n(%)			
	6 weeks	3 months	6 months	12 months
Excellent	0	1(2.9)	7(20)	10(28.6)
Good	0	9(25.7)	18(51.4)	19(54.3)
Fair	2(5.7)	15(42.9)	6(17.1)	4(11.4)
Poor	33(94.3)	10(28.6)	4(11.4)	2(5.7)
Total	35(100)	35(100)	35(100)	35(100)

*Harris Hip Score

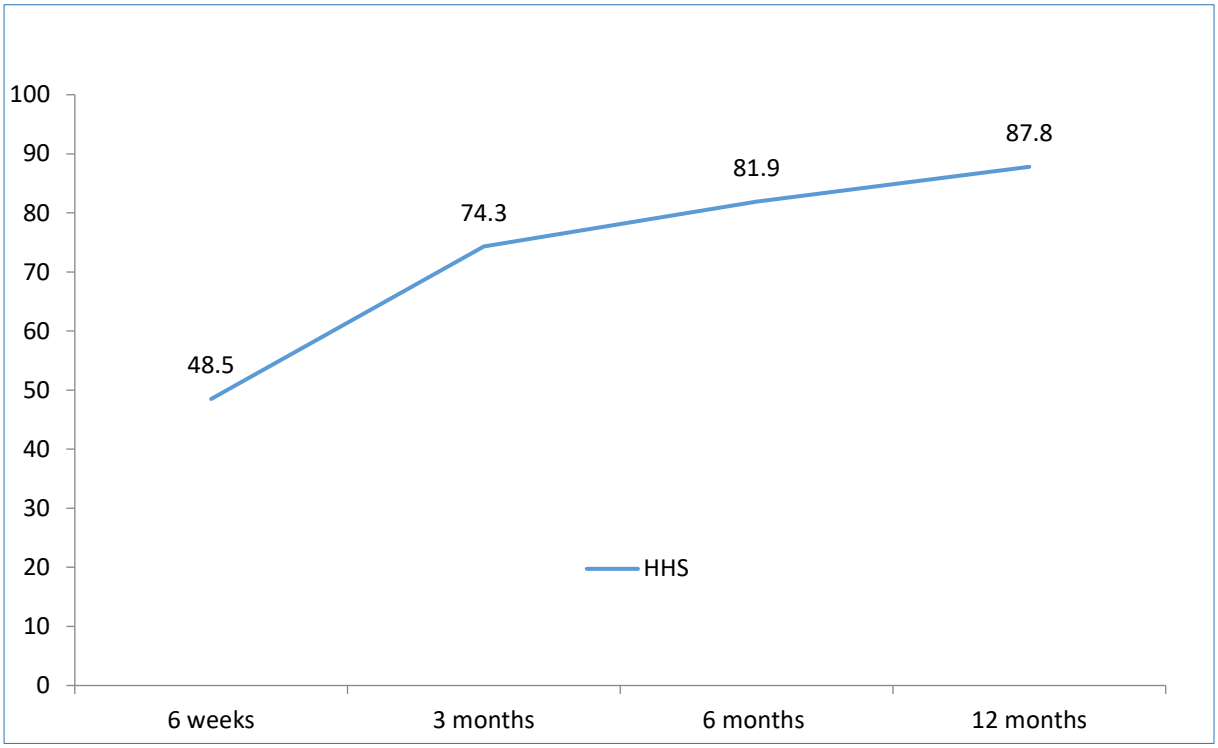

Figure 3. Harris Hip Score at different follow-ups after proximal femoral nailing in unstable intertrochanteric fractures, n=35

Figure 4. Radiographs of a 68 years old male patient with unstable 31A2 intertrochanteric fracture (a, b); immediate post-operative X-rays (c, d); follow-up X-rays at three (e, f), six (g, h) and twelve months (i, j)

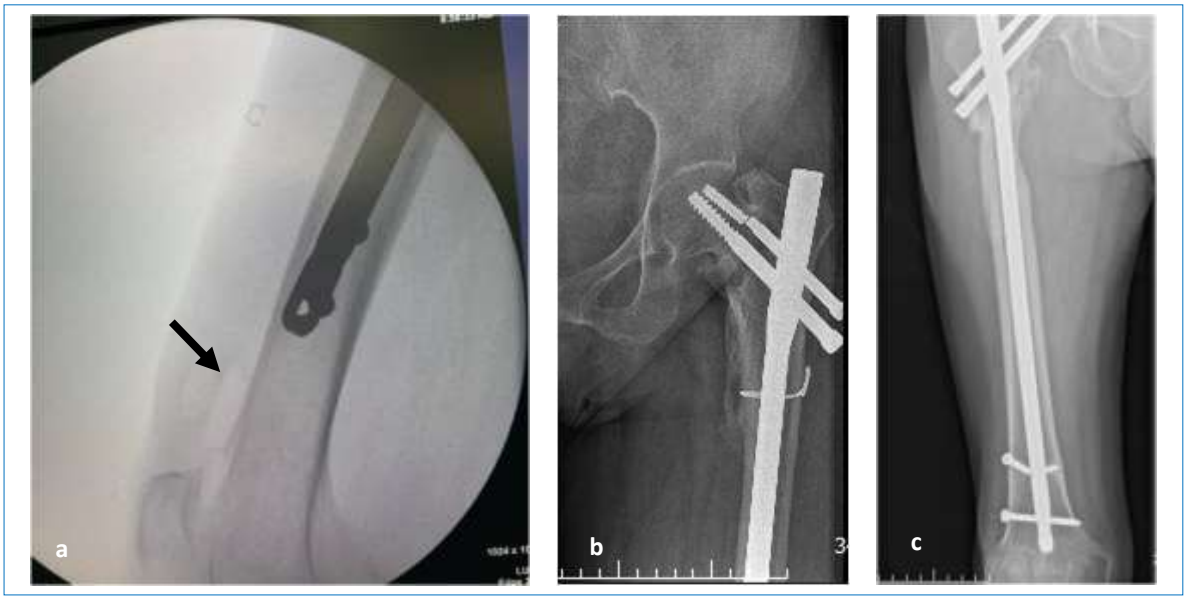

Figure 5. Complications- anterior cortex perforation by nail (arrow) (a), breakage of proximal derotation screw (b), breakage of interlocking bolt (c)

Discussion

In present study, all 35 intertrochanteric fractures treated with PFN united at a mean of 16.9±3.7 weeks with the final HHS as excellent in 10(28.6%) and good in 19(54.3%). Nearly half of all hip fractures are intertrochanteric fractures. The PFN being intramedullary devices share load across the fracture site, have a shorter moment arm, prevent medial migration of femoral shaft, and thus are biomechanically superior to extramedullary devices like DHS. Added advantages are less soft tissue dissection, preserved fracture hematoma, decreased blood loss, early weight bearing and mobilization, reduced hospital stay and decreased risk of infection.[10] We studied PFN as an option in treating complex proximal femur fractures.

We found a progressive increase in HHS during consecutive follow-ups, and the mean HHS at six months was 81.9±9.3, and at one year was 87.8±6.8. The HHS rating was fair to poor in 71.4% at three months, which improved at one year follow-up with 82.9% good to excellent results. This is comparable to different studies with the HHS ranging from 79.3±9.1[17] to 91.2±4.5[18] and good to excellent results reported in 78.5%[19] to 85%[20] cases. However, a similar study showed only 24.4% very good and 42.2% good results with 20% moderate and 13.3% poor outcomes.[21] This shows that the functional outcome of patients treated with PFN in unstable intertrochanteric fractures in our set-up was sufficiently good.

All fractures united at six months follow-up in our study, though only 42.9% united at 12 weeks. The average time for radiological union was 16.9±3.7 weeks. Elderly patients took longer time to unite. Similar to our study, cent percent union was seen in most of the studies.[17,19,21-23] Only few cases of non-union have been reported, a study showing one (3.3%) non-union.[18] Intertrochanteric fractures occurring in metaphyseal region have good healing potential and thus readily unite, though some may take longer time to unite (delayed union). There are not many cases of delayed union and avascular necrosis reported in literature.[24]

Regarding the ambulatory status of our patients, 45.7% walked independently, same percent required support of walking aids and 8.6% were not ambulatory at final follow-up; the pre-injury ambulatory status was regained by 74.3%

patients. A study that compared post-operative rehabilitation among patients treated with DHS or PFN found that restoration of walking ability was achieved more often in the PFN group (76.2%) compared with those treated with a DHS (53.7%), p=0.040. In the PFN group 35.7% walked independently, 57.1% needed crutches or a frame and 7.1% were unable to walk independently at four month follow-up.[25] Patients treated with PFN have an advantage of early weight bearing as tolerated by them. Similarly in other studies, walking ability to preoperative levels were restored in 71%[23] to 85.7%[19] patients. At final follow-up 76.1% were able to walk independently, 19% needed walker/crutches and 4.7% were unable to walk.[19]

Regarding the demographics, the mean age of our patients was 70.7 years with majority (62.9%) being elderly >65 years. People of this age group have osteoporosis and are still ambulatory increasing the chance of fracture even with trivial trauma. This also explains the finding that in majority of the patients (51.4%) the mode of injury was trivial fall, while only 14.3% were injured in RTA. Older people are less commonly involved in RTAs as compared to young individuals. Also, people in villages have to climb trees to collect fodder for their livestock and thus fall from height also accounts for substantial number of cases (34.3%). Many studies have similar mean age as our study for sustaining intertrochanteric fractures,[17,21,24,26] whereas others have higher mean age, probably due to higher life expectancy.[23,25,27] Similarly simple fall at home was the most common cause for injury in most of these studies.[17,20-22,24,27]

We had a female preponderance in our study similar to other studies who found majority intertrochanteric fractures involving elderly females.[18,21,24,25,27] There are few studies where males predominantly sustained intertrochanteric fractures.[17,20] Women in postmenopausal period have osteoporotic bones due to hormonal changes; in addition they are less active outdoors when compared to males leading to decreased bone turnover and senile osteoporosis. They are thus prone to sustain fracture even with minor fall.

The median duration between admission and surgery in our study was two days (range 0-8 days). The current strategy in managing elderly patients with hip fractures is early surgery with early mobilization.[28] We ensured that majority of the patients were operated within one to two days. The median duration of hospital stay was seven days (range 3-20 days). Those patients who were from distant areas or had their expenses covered tended to stay longer till removal of sutures. When compared to other studies, a mean delay of three days (range 0-7 days)[24] to eight days (range 2-21 days)[21] for surgeries have been reported. Regarding the hospital stay, there were few studies that had mean stay similar to us,[17,25] whereas others had prolonged hospital stay for around two weeks or more.[20-22]

In our study the mean duration of surgery was 88.9±24.1 minutes. This is comparable to many studies with time ranging from about 74 minutes to 90 minutes,[17,20,22] whereas others had even shorter operative time (less than half of our study).[19,21,23] The reasons for this could be that only unstable fractures were included in our study, the implant design had two head-neck screws as compared to PFNA (Proximal Femoral Nail Antirotation) which has single helical blade, we used only long PFN which required distal interlocking bolts to be inserted freehand, and probably also due to our learning curve.

The complication rate in our study was 25.7%. The complication rates varied among different studies. We had one intraoperative complication (2.9%) of cortex perforation by nail tip. Most other studies similarly have less than 5% intraoperative complications like fracture of greater trochanter or femoral cortex.[22-24] However, some studies do have reported higher intraoperative complications- 6.7% shaft fractures[21] and about 14-20% greater trochanter fractures.[19,21] These complications depend on various factors like quality of bone, fracture pattern, type of implant used and expertise as well. Superficial wound infections were present in 5.7% of our cases and there were no deep infections. Our infection rate is similar to many studies with infection <5%,[18,21,22] whereas some

have higher[24,27] rates of local wound complications. Late complications were seen in 17.1% cases as screw backout 8.6%, screw breakage 5.7% and varus collapse 2.9% in our study. A prospective study revealed 10.2% late complications- cut out 1.4%, varus collapse 4.1%, calcification at greater trochanter 4.4%, fracture beneath nail 0.4%.[23] Few studies have reported no implant related complications.[17,19]

Our study is not without limitations. The sample size was small with wide variation in age. All the surgeries were not performed by a single surgeon though we tried to follow the same surgical and post-operative protocol. Also, there was no comparison group in our study.

Conclusion

Treatment with proximal femoral nail for unstable intertrochanteric fractures provided good results with the advantage of early mobilization and weight bearing. We did not encounter any major complications requiring revision. The PFN is thus a suitable implant for the surgical treatment of unstable intertrochanteric fractures.

Author contribution

Concept and design: BDS, SRS; Data collection and analysis: BDS, TPD, SKC; Draft: BDS, SR, SKC; Revision: BDS, SRS; Accountability: all authors have read and approved the final manuscript.

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Conflict of interest

None

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Supplementary material

The data and supplementary material that support the findings of this study are available from the corresponding author upon reasonable request.

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