RESEARCH ARTICLE

Intramedullary Nailing of Subtrochanteric Fractures: Our Experience

Viksheth Basani[1], M Ravi Kumar[2], D Dhanalakshmi[3], TE Ramesh[4]

Abstract

Aim: To study clinicoradiological outcome of subtrochanteric femur fractures following intramedullary nailing.

Materials and methods: This was a prospective study of 22 cases of subtrochanteric fractures admitted and operated by intramedullary nailing at Southern Railway HQ Hospital, Chennai, between June 1, 2017, and May 31, 2018.

Results: The mean age distribution was 65.09 ± 17.84 years with 12 females and 10 males. According to Seinsheimer classification, there were six cases of type II, seven cases of type III, three cases of type IV, and six cases of type V. Intraoperative reduction techniques included closed reduction in 25% of subjects, limited open reduction in 50% and open reduction, augmentation with cerclage wiring in remaining 25%. Radiographic examination using radiological union score of hip (RUSH) was done to evaluate fracture union at monthly follow-up. Our mean time for union was 13.86 ± 3.8 weeks. Functional recovery was evaluated by the Harris hip scoring (HHS) system at 1, 3, 6, and 12 months postoperatively. The mean HHS at 6 months and 12 months were 81.57 ± 12.39 and 87.33 ± 8.2, respectively. Excellent to good functional outcome was seen in 76% of cases. There were two patients with superficial infections, one case of foot drop, and another case of lag screw cut-out. The mean shortening noted at final follow-up was 1.548 ± 0.57 cm.

Conclusion: An intramedullary nail is an efficient device for the treatment of subtrochanteric fractures with high rate of bony union provided optimal reduction of the fracture and good positioning of the nail and screws is achieved.

Keywords: Harris hip score, Hip fractures, Intramedullary nailing, Osteoporosis, Subtrochanteric fractures.

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Introduction

Subtrochanteric femur fractures are defined as fractures occurring within 5 cm of the distal extent of the lesser trochanter.[1] These fractures occur in two specific patient populations: young patients involved in high-energy trauma and older osteoporotic patients involved in low-energy trauma.[2] The incidence of these fractures vary anywhere between 2.8% and 10% of hip fractures.[3]

The subtrochanteric region is predominantly cortical bone, thus these fractures take longer time to heal. According to the Koch's study, the compressive stress on the medial cortex was as high as 1,100 N, so the subtrochanteric fractures were usually comminuted fractures, which also indicated the necessity of reconstructing the medial cortex. The high transmitted stress is mostly concentrated on the subtrochanteric area, which mainly is constituted of the thick cortical bone with poor blood supply. Fixation constructs used to treat these fractures must be able to tolerate these loads cyclically and maintain reduction during fracture healing. These factors, involvement of the cortical bone, and high magnitude of stress are the reasons for high complications that occur.[4]

These fractures present a challenge for the treating surgeon, as the deforming forces on both the proximal and distal segments are high in magnitude and difficult to control, especially given the inherently short length of the proximal segment. The characteristic deformity encountered is a flexed, abducted, and externally rotated proximal segment while the distal segment is often shortened and adducted. These deforming forces need to be overcome to achieve an anatomic reduction.

Two of the fixation options available today are the intramedullary (IM) locked nail and the proximal femoral locking compression plate (PFLCP) systems.[5–9] The locked IM nail was introduced to increase the efficiency of rotational instability and it also has the property of load bearing, sliding with a neck screw. This has been a gold standard for fixation and many clinical studies have shown good results with few intraoperative problems and a low rate of complications. Yet few problems exist when treating comminuted fractures with a deficient lateral wall.[7,8]

In this study, we analyzed 22 cases of subtrochanteric femur fractures treated by IM fixation in our hospital from June 2017 to May 2018.

[1–4]Department of Orthopedics, Southern Railway Headquarters Hospital, Chennai, Tamil Nadu, India

Corresponding Author: Viksheth Basani, Department of Orthopedics, Southern Railway Headquarters Hospital, Chennai, Tamil Nadu, India, Phone: +91 8197128388, e-mail: vikshethraj@gmail.com

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Materials and Methods

Clinical Data

We collected data prospectively from June 2017 to May 2018; a total of 22 cases of subtrochanteric femur fracture participated in the study. Inclusion criteria were the following: the fracture line was located within 5 cm below the lesser trochanter and no anatomic abnormality before fracture. Exclusion criteria were lateral wall comminution, large comminuted fragments, and anatomical variations in hip [like in post-polio residual paralysis (PPRP)].

Statistical Methods

Harris hip score (HHS) and mean time for fracture union as per the modified radiographic union score for hip (RUSH) were considered as the primary functional outcome parameters. Various demographic parameters and clinical parameters were considered as other variables of interest.

Descriptive analysis was carried out by mean and standard deviation for quantitative variables and frequency and proportion for categorical variables. Data were represented using appropriate diagrams like bar diagrams, pie diagrams, and box plots.

All quantitative variables were checked for normal distribution within each category of explanatory variable by using visual inspection of histograms and normality Q–Q plots.

Pearson correlation was used to correlate between two interval level variables and was plotted on the graph for visual analysis. Similarly, the Chi-square test was used for two categorical variable comparison, the *t* test for comparing interval variables in different groups, and the one-way ANOVA if there were more than a single group.

Measurement bias was tackled by having two independent observers calculate the RUSH for assessment of time for fracture union.

p value < 0.05 was considered statistically significant. IBM SPSS version 25 was used for statistical analysis.
All the cases were analyzed as per the following criteria:

- Age distribution
- Gender distribution
- Mode of injury
- Type of fracture
- Time for union
- Limb length discrepancy
- Complications
- Grading of results

Preoperative Protocol

At the time of admission, all patients were evaluated as per the Advanced Trauma Life Support protocol. Priority was given for serious injuries like head injuries, chest injuries, and abdominal injuries and were treated accordingly. After obtaining an informed consent from the patients and explaining them about the study and follow-up required, a thorough clinical examination was performed including detailed history taking related to age, sex, occupation, mode of injury, and past and associated medical illness. Routine investigations were done for all patients. Hip radiographs were obtained in two planes (anteroposterior and translateral views). Fractures were classified according to the Seinsheimer classification system.[1] After obtaining anesthetic fitness, the surgery was usually performed within 5 days of admission by a senior orthopedic consultant.

Surgical Treatment

In a supine position, patients underwent closed reduction in the fracture table. C-arm fluoroscopy was used to evaluate the accuracy of reduction. For the patients with unsatisfactory closed reduction or for complex fractures, limited open reduction assisted by auxiliary devices (such as bone-holding forceps, reduction clamps) was adopted. All operative steps were accomplished under C-arm fluoroscopy until accurate reduction was achieved. If needed, open reduction of the fracture ends and augmentation with one to two cerclages was done. After reduction is achieved, according to the intramedullary nail placement procedure, standard intramedullary fixation was performed.

Postoperative Management

All patients received prophylactic antibiotics for 1 day; for deep vein thrombosis prophylaxis patients were given subcutaneous injection of low-molecular-weight heparin during the hospital stay, followed by oral administration of factor Xa inhibitors, for further 3 weeks. Passive knee and ankle movements started on first postoperative day. Then, patients were encouraged to do active quadriceps and hamstring exercises and start partial weight-bearing gait training with walker till fracture union was noted. After fracture union, most patients tolerated substantial weight bearing, although many patients still required support.
Patients were followed up every month.

- Anteroposterior and lateral radiographs of operated limb were taken every month till clinicoradiological union was attained.
- The course of fracture healing was documented radiologically. The modified RUSH was used to assess the union. The cortex is evaluated in all four planes (anterior, posterior, medial, and lateral) for consolidation/cortical bridging and disappearance of the fracture line, with attention to the medial cortex as this correlate highest with overall impression of fracture healing. Union of each of the four cortices was graded on a three-point scale [(0) fracture line visible with no callus; (1) callus formation but fracture line present; (2) cortical bridging without a clear fracture line). A RUSH score of 6 or greater was considered as radiological union when associated with a nontender fracture site. The RUSH scoring was done by two independent observers to negate any interobserver variables.
- At months 1, 3, 6, and 12, patients were assessed for functional outcome by HHS. Patients were graded at final follow-up as excellent, good, fair, and poor for HHS of >90, 81–90, 71–80, and <71, respectively.
- Evidence of any limb length discrepancy was noted.
- Evaluation of any possible loss of reduction that might have occurred compared to immediate postoperative radiographs.
- Assessment and analysis of any complications was observed.

Results

In our study, we were able to recruit a total of 22 individuals. Twenty-one of them could complete the total study and one patient was lost to follow-up after 1 month. At the end of the study, all the study proformas were meticulously analyzed and tabulated into a master chart. Further analysis was done in terms of descriptive statistics and comparative analysis. Following are our observations from the study.

Demographic Data

See Tables 1 to 11 and Figures 1 to 7.

Table 1: Descriptive analysis of age (in years) in the study population ($n = 22$)

Parameter	*Mean ± SD*	*Min.*	*Max.*
Age (in years)	65.09 ± 17.84	18	89

Table 2: Age group distribution of study participants ($n = 22$)

Age group (in years)	*Frequency*	*Percentage*
<40	2	9.1
41–50	2	9.1
51–60	5	22.7
61–70	1	4.5
71–80	8	36.4
>80	4	18.2
Total	22	100

Table 3: Descriptive analysis of gender in the study population ($n = 22$)

Gender	*Frequency*	*Percentages*
Male	10	45.5
Female	12	54.5

Table 4: Descriptive analysis of the mode of injury in the study population ($n = 22$)

Mode of injury	*Frequency*	*Percentage*
Fall from height <10 ft	2	9.10
Fall from height >10 ft	1	4.50
Road traffic accident	6	27.30
Trivial fall	13	59.10

Table 5: Descriptive analysis of the fracture type in the study population ($n = 22$)

Fracture type	*Frequency*	*Percentage*
I	0	0
IIA	2	9.1
IIB	4	18.2
IIIA	7	31.8
IIIB	0	0
IIIC	0	0
IV	3	13.6
V	6	27.3
Total	22	100

Table 6: Analysis of the mode of reduction used intraoperatively

	Mode of reduction			
Fracture type	*Closed reduction*	*Limited open reduction*	*Augmentation with cerclage wiring*	
IIA	0	1	1	$p = 0.266$
IIB	1	3	0	
IIIA	4	2	1	
IV	0	1	2	
V	1	4	1	
Total	6	11	5	

Discussion

In this study, we documented the functional and radiological outcome of subtrochanteric fracture treated with an IM nail. The study was conducted on 22 patients at Department of Orthopedics at Southern Railway HQ Hospital, Chennai-23. Of all the 22 patients, 21 of them followed up till 12 months and 1 patient was lost to follow-up after 1 month. Following were our observations from the study.

The mean age distribution in our study was 65.09 ± 17.84 years, which was consistent with many studies done in India and Asia. Kim et al.[10] reported mean age at 64.8 years, Zhou et al.[11] at 53.5 years, Kumar et al.[12] at 65 years, and finally Zha et al.[13] at 74 years. As noted by Ballane et al.,[14] countries like India where there is a rapid boom in urban population contributing to ever-increasing life expectancy, decreased physical activity, an increase in hard surfaces, and calcium and vitamin D deficiencies are the reasons for tipping the mean age closer to its Western counterparts. Evidently, Western literature had a higher mean age like 79.8 years reported by Fairbanks et al.[3] and 79 years by Banan et al.[7]

Gender distribution in our study showed a higher number of females who were 12 as compared to males with 10. Another interesting inference was that majority of these women (9 out

Table 7: Descriptive analysis of Harris hip score (HHS) in the study population

Parameter	*n*	*Mean ± SD*	*Min.*	*Max.*
1-month postoperative	22	46.14 ± 11.39	21.00	72.00
3 months' postoperative	21	66.67 ± 12.35	28.00	84.00
6 months' postoperative	21	81.57 ± 12.39	49.00	100.00
12 months' postoperative	21	87.33 ± 8.20	68.00	100.00

Table 8: Descriptive analysis of Harris hip score grade at final follow-up in the study population ($n = 21$)

HHS grade at final follow-up	*Frequency*	*Percentage*
Excellent	9	42.90
Good	7	33.30
Fair	4	19.00
Poor	1	4.80

Table 9: Frequency of Harris hip score grade at final follow-up by gender in the study population ($n = 21$)

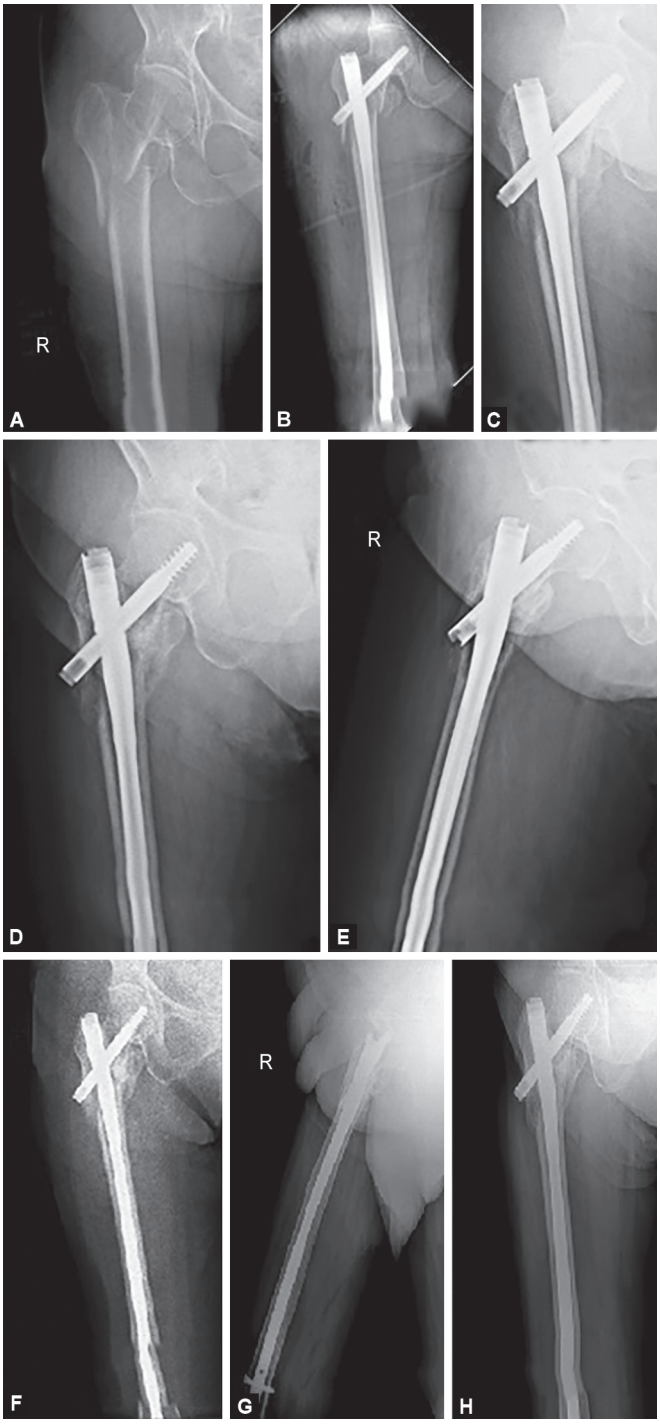
		Excellent	*Good*	*Fair*	*Poor*	*Total*	
Gender	Male	4	4	1	0	9	$p = 0.601$
	Female	5	3	3	1	12	
		9	7	4	1	21	

Table 10: Descriptive statistics for time for fracture union ($n = 21$)

Parameter	*Mean ± SD*	*Min.*	*Max.*
Time for union (in weeks)	13.86 ± 3.8	8	26

Table 11: Distribution of complications among study participants ($n = 21$)

Parameter	*Frequency*	*Percentage*	*Intervention*
Superficial infections	2	9.1	IV antibiotics, debridement, and local antibiotic delivery
Foot drop	1	4.8	Conservative
Lag screw cut-out	1	4.8	Implant exit and revision with PFLCP
Nil	18	85.7	Nil



Figs 1A to H: Case 1. An 86-year-old female with type IIIA right subtrochanteric fracture. With excellent clinical and radiological outcome

of 12) were above the age of 70 years. While 7 out of 10 men were below 70 years. This could be attributed to the prevalence of osteoporosis in postmenopausal women who have greater tendency of sustaining subtrochanteric fractures. Thus, targeting this group for osteoporosis treatment can considerably reduce fracture burden. Only few studies in the literature show a female dominance, notable ones include Banan et al.[7] with 12 males to 48 females and Zha et al.[13] with 4 males to 8 females.

Analyzing the mode of injury and comparing to age and gender of the patients, few interesting conclusions can be drawn, which furthers the scope of understanding the disease. Trivial fall had been the commonest mode accounting for 59.1% of the patients, with 70% of these patients being women. Thus, it is ascertained that this fracture is predominately seen among elderly osteoporotic women who suffer a trivial fall. Road traffic accident (RTA) was the next commonest mode of injury, which was predominately among men aged below 60 years (with five of six men with RTA). Thus, we could conclude with statistical significance that elderly patients who tend to fall often and young patients prone to RTA have increased susceptibility to subtrochanteric fractures.

Fracture pattern distribution in our study is in accord with others that have been dominated by the Seinheimer type V pattern, followed by type III patterns and type II patterns. In our study type III was 31.8%, while type V and type II were 27.3% each. Furthermore, type V was five times more common in women than men, as this pattern with intertrochanteric extension is common in osteoporosis. On the other end, the fracture pattern was evenly distributed among men.

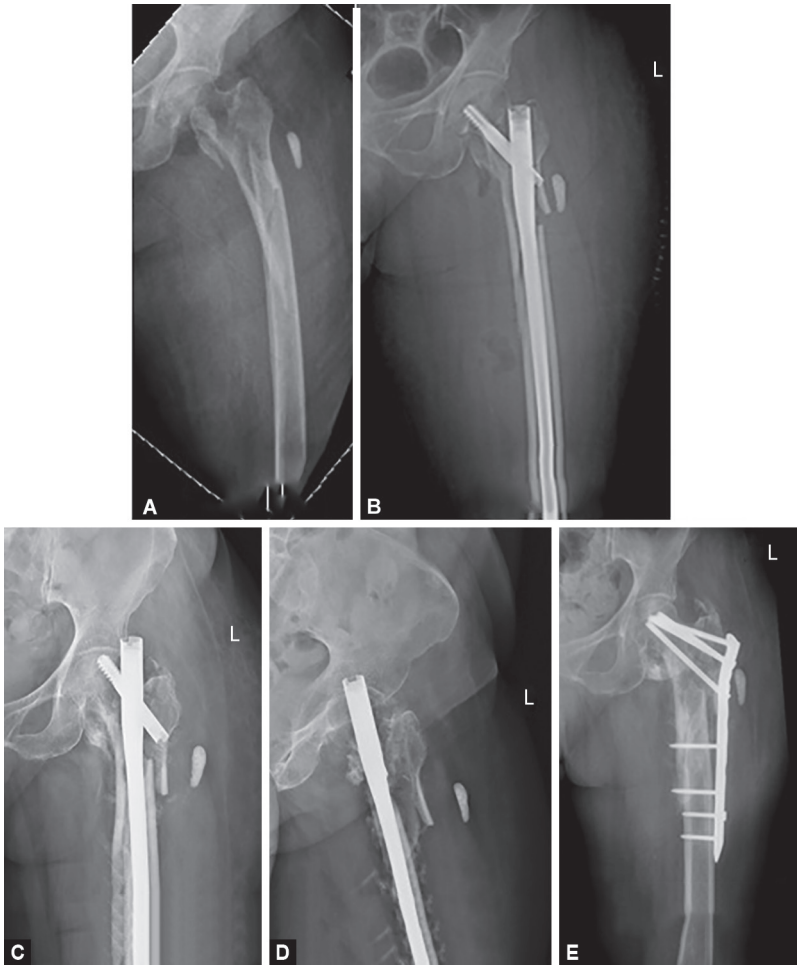
Intraoperatively, different modes of reduction were used; they include closed reduction in 25%, limited open reduction maximally used in 50% and open reduction, and augmentation with cerclage wiring in remaining 25%. But we couldn't find any statistically significant correlation between the fracture type and reduction maneuver. So, it is recommended to have all options of reduction available for all fracture types. This was consistent with Zhou et al.,[11] where two cases of type I and three cases of type III were treated with closed reduction and internal fixation and 71 patients received limited open reduction. On the other hand, Ahmad et al.[15] performed limited open reduction in only 8% cases.

Harris hip score was used to assess the functional outcome of patients. The mean HHSs at 6 months and 12 months were 81.57 ± 12.39 and 87.33 ± 8.2, respectively. We were able to demonstrate a statistically significant ($p = 0.01$) difference of functional improvement over the period of 12 months. About 76% of patients had either good or excellent outcome, which is lower than many studies described. Another observation was that 89% men had good or excellent outcome compared to only 66% women. This can again be explained by the higher mean age among women in the study, which might have lowered the outcome. In other studies by Zhou et al.[11] and Kumar et al.,[16] good and excellent rates were 96 and 96.6%, respectively, following IM nailing.

Another parameter with wide variation in interpreting was time to union. We used a radiological scoring system (RUSH) at monthly follow-up for assessing radiological union; a score greater than 6 was considered as union. Our mean time for union was 13.86 ± 3.8 weeks.

Our findings were consistent with other studies in the literature in terms of bone union, Borens et al.[17] reported 17.2 weeks of mean union time with a long gamma nail. Zhou et al.[11] reported time for union at 18 weeks, Ahmad et al.[15] reported it at 14 weeks, and Banan et al.[7] at 16 weeks.

The complication rate in our study was 15%, which is consistent with complications reported elsewhere. A total of three patients had complications. First was a 56-year-old lady, who had a superficial



Figs 2A to E: Case 2. An 86-year-old female with type IIIA left subtrochanteric fracture. Implant failure at 3 months postoperative. Revision surgery done with proximal femoral locking compression plate

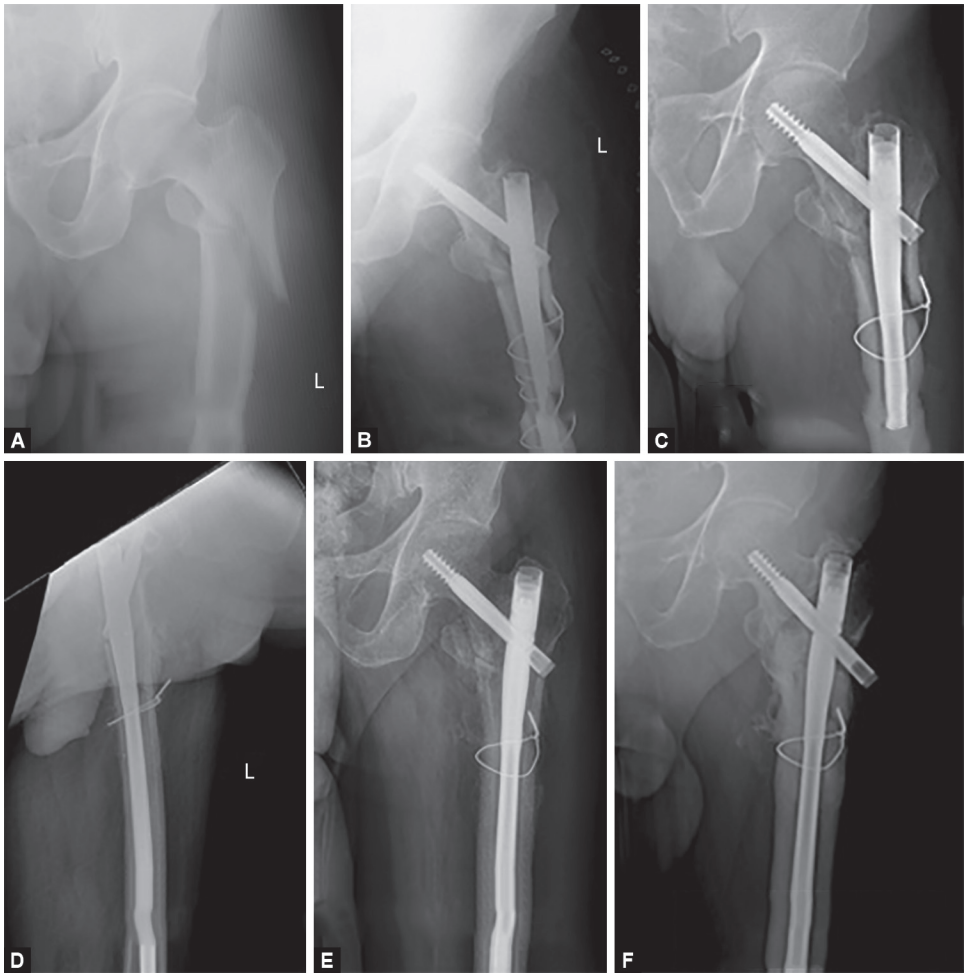
infection with *Pseudomonas aeruginosa* 1 month postoperatively. She was put on negative suction dressing followed by wound debridement and antibiotic-infused bone graft substitute placement. She also developed foot drop postoperatively and was put on conservative treatment. She had partial recovery with grade III power of foot dorsiflexors at final follow-up. Next was a 56-year-old gentleman, an alcohol dependent, who had MRSA-positive superficial infection 1 month postoperatively. He was treated by wound debridement and antibiotic-infused bone graft substitute placement. At final follow-up, patient had a good functional outcome and fracture united within 16 weeks. Finally, an 86-year-old lady (case 2) who had a lag screw cut-out at 3 months postoperatively. She had to undergo revision surgery with PFLCP and at the time of 12 months' follow-up had a poor functional outcome. Implant failure by lag screw cut-out is a dreaded complication of IM nailing, which has been widely reported in the literature.[18]

The mean shortening noted at final follow-up was 15.48 ± 5.7 mm. Borens et al.[17] say that shortening under 20 mm does not matter clinically. Patients never complained about shortening; only the few who complained were prescribed height compensation footwear and resumed normal activity.

Fairbanks et al.[3] reported that the most common discharge destinations were 526 (53.35%) patients to a skilled nursing facility and 303 (30.7%) to a rehabilitation facility. Only 76 (7.7%) patients were discharged home. The in-hospital mortality rate was 1.6% (16). But in our study all patients were discharged to their respective homes and we didn't have any in-hospital mortality. This could be attributed to the close-knit family dynamics prevalent in our country where imparting health education to the family members regarding the nursing care in terms of mobilization protocol, bowel, bladder, and back care does not necessitate need for any expertly skilled facilities or rehabilitation centers. This further alleviates financial and psychological burden.

Conclusion

Subtrochanteric femur fractures have been a huge burden not just on the patient but also the treating surgeon. In our study, the fracture distribution is predominately among older osteoporotic women sustaining trivial fall. Measures to curtail this burden should start from health education in form of anti-fall measures including well-padding around hips or walking sticks for elderly. Calcium and vitamin D supplementation should be judiciously prescribed to patients with early signs of osteoporosis. As with any fracture,



Figs 3A to F: A 61-year-old male with type IIIA left subtrochanteric fracture

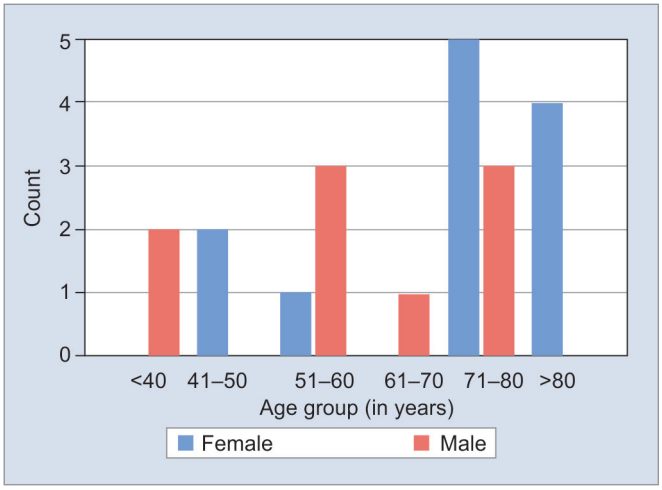


Fig. 4: Clustered bar count of age group by gender

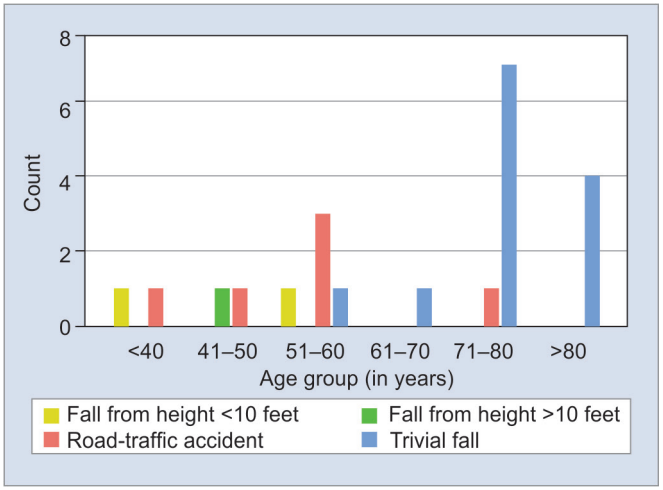


Fig. 5: Clustered bar count of age group by mode of injury

RTA still predominates and as always emphasis on road safety is of utmost importance. Also, prompt health education to patient attenders regarding the postoperative mobilization protocol and patient care is found to be very economical and alleviates the financial and psychological burden. Our study has attempted to fill the paucity in the literature for such similar studies that use the IM nail. Yet we are limited by small sample size, an equally smaller follow-up duration, and heterogeneity of subgroups. Hence the conclusions drawn from this analysis cannot be extrapolated in a generalized manner. Similar studies using similar implants, with longer study period and larger sample size, are required to arrive at a consensus.

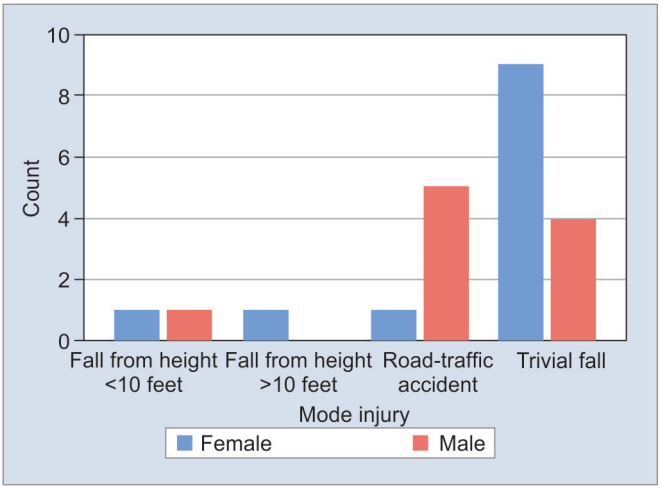


Fig. 6: Clustered bar count of mode of injury by gender

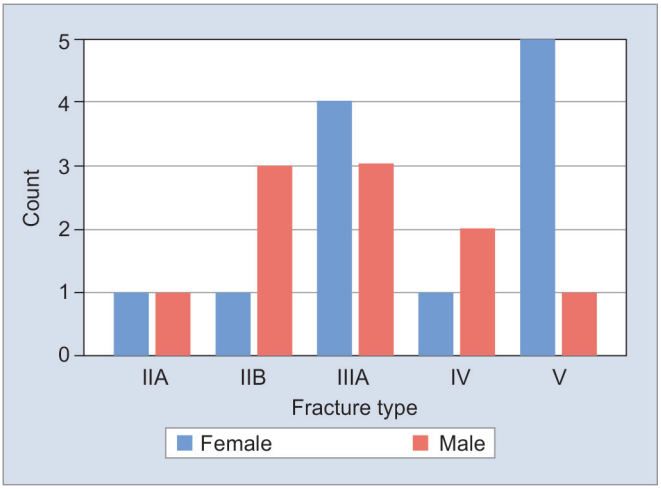


Fig. 7: Clustered bar count of fracture type by gender

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