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Dynamic hip screw with locked plate VRS Proximal Femoral Nail for the management of intertrochanteric fracture: A comparative study

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Abstract
Dynamic hip screw has long been a standard implant for intertrochanteric hip fractures. The inception of intramedullary nails has further revolutionized their management. With a constant evolution in the designs of both these implants, there has always been a conflict concerning the superiority of one over the other.
In this randomized prospective cohort study, 80 patients with intertrochanteric fracture femur were segregated into two groups based on internal fixation with DHS with locking side plate (DHS) (n=40) or Proximal femoral Nail (PFN) (n=40). Clinical and radiological parameters were studied and functional evaluation was done with Harris hip score.
The intraoperative parameters were in favor of PFN with significantly less duration of surgery, length of incision and blood loss but more fluoroscopy time. Postoperatively also, PFN group patients excelled with significantly less postoperative pain, less incidence of deep infection , better range of motion, less mean limb length discrepancy and more patients regaining their pre injury walking capability and also fewer complications.
Average union time was comparable between the groups. Functionally, PFN emerged to be superior to DHS in unstable intertrochanteric fractures while in stable fractures, results were same. We deduce that surgical planning and expertise with rigorous regard to the personality of the fracture are pivotal for outstanding results.

Keywords: Dynamic hip screw, proximal femoral Nail, internal fixation, Harris hip score

1. Introduction
Hip fractures or fractures of proximal femur are one of the most frequent and appalling fractures affecting the elderly population with 90% occurring in >60 years age group [1]. They comprise femoral neck and intertrochanteric fractures [2]. 14% to 36% patients die within 1 year of experiencing them [3]. Last 3 decades have witnessed an expeditious increase in the incidence of these fractures and an estimated 7.3 million individuals are deemed to be afflicted globally by 2050 [4].
Presently, internal fixation is an established treatment modality for them [3]. In a hunt to achieve minimum morbidity and maximum functions, surgical management of these fractures has transformed significantly. It was revolutionized with the inception of the extra medullary sliding hip screw (SHS) in 1950's and SHS was assigned as the standard implant for these fractures [5].
In 1990's, with the blooming interest in intramedullary implants, the cephalo-medullary nail commenced attaining popularity and Proximal Femoral Nail (PFN) pioneered by the AO/ASIF group in 1978 became renowned in recent years [6,7]. With the blooming interest in locking technology, was invented the SHS with a locking side plate. A SHS with fixed angle locking side screws lessens the risk of implant failure and is distinctly valuable in osteoporotic bones and in unstable fracture configurations [8, 9].
Literature is flooded with several systematic reviews and meta-analysis to contrast the efficacy of a PFN and a conventional DHS implants but the results remain unsettled [10, 11]. Studies involving SHS with a locking side plate are scarce. Biomechanically, intramedullary implants

have been unveiled to have an edge by numerous studies [12, 13] but in spite of their escalated Use, outcomes have not evolved [14,15] and technical failure is also customary.

We report here the results of a prospective randomized cohort study designed to elucidate the functional outcomes of patients presenting with intertrochanteric fractures stabilized with either a proximal femoral nail (PFN) or Dynamic Hip Screw (DHS) with a locking side plate.

2. Material and Methods

A total of 80 patients sustaining intertrochanteric fracture of femur between January 2012 to December 2014 satiating the inclusion and exclusion criteria were incorporated in this institutional review board approved randomized prospective study. Close reduction and internal fixation with either a DHS with locking side plate (Group DHS; 40 patients) or PFN (Group PFN; 40 patients) was performed on the basis of block randomization with the random number table. The demographic profile is reflected in Table 1. Radiological and functional outcomes were assessed and compared. The protocol of this study was approved by the relevant ethical committee of our institution. All subjects gave full and informed consent to participate in the study.

Jensen and Michealsen's modification of Evan's classification [16] was utilized to classify them and the number of patients in each subgroup is depicted in Table 2. Functional capability of the patient before sustaining the injury was categorized as per the pre -injury walking ability grades described by Sahlstrand [17] [Table 3] and were comparable between the group. They were again assessed at 3 months follow-up and compared with their preoperative values.

Inclusion criteria

1. Age >18 years.
2. Minimum 12 months follow-up.
3. Less than 1 month old injury.
4. Close or open (Gustilo grade 1,2)
5. Polytrauma without any significant ipsilateral lower limb fractures.
6. Fractures with subtrochantric extensions.

Exclusion criteria

1. Significant concomitant ipsilateral lower extremity trauma.
2. Preoperative significant functional loss or comorbidity in ipsilateral lower extremity.
3. Pathological fractures.
4. Patients on long term corticosteroids.
5. Inability to comply with rehabilitation protocol and to complete the forms.
6. Pure subtrochantric fractures and fractures extending more than 5 cm below the lesser trochanter.

Surgery was performed within 2-12 days of admission. Open fractures were debrided and splinted on admission and taken up for surgery after ensuring a healthy wound.

Operative procedure

The surgeries were performed by the same team of orthopaedic surgeons without ascribing any preference to any implant. All surgeries were accomplished under spinal or general anaesthesia. 1g of 3rd generation injectable cephalosporin was administered prophylactically. Duration of surgery, skin incision length, and blood loss and fluoroscopy time was recorded in all cases to draw a comparison of the means between the groups. The surgical procedure for both the implants involved the use of fracture table. Close reduction was ventured under fluoroscopy guidance and thereafter we advanced for programmed surgery.

For 135 deg. angle DHS with locking side plate, a lateral incision was delivered extending from the level of lesser trochanter downwards. The fascia lata was split and underlying vastus exposed. The fascia of the vastus was opened and the muscle retracted anteriorly to expose the shaft. A head screw of requisite site of was then placed in a center/center position inside the femoral head under AP and Lateral fluoroscopic views. A locking DHS side plate with 2 to 6 holes was then attached to the hip screw. The reduction balanced using bone levers and Lowman's forceps and plate fixed with locking screws with a discretional non-locking screw.

For PFN, a lateral incision extending proximal to the greater trochanter (GT) was administered and gluteus split. Entry was established at the tip of GT with bone awl and a guide wire negotiated from entry site into the canal. The medullary canal was reamed and nail of appropriate thickness and length inserted and secured proximally with double screws (8mm and 6 mm). The nail was locked distally with two locking bolts (dynamic and static) using a zig or free hand technique. All cases involved a 135 degree PFN with 250 mm length.

Patients were discharged 3-7 days following surgery and were followed in office at 2 weeks for suture removal, then 4 weeks, then monthly till minimum 4 months or fractures union and 2 monthly thereafter. Clinic radiological examination was accomplished at each follow-up. AP and Lateral views of fracture were obtained. Osseous healing was designated radio logically as the presence of at least 3 of the 4 cortices with bridging callus formation and crossing trabeculae in AP and lateral radiographs.

Harris hip score [18] was used to assess patient rated outcomes. It takes into account the symptoms of patient like pain and limping, their functional status and a thorough evaluation of the range of motion at hip joint. Results are graded as excellent (90-100), good (80-89), fair (70-79) or poor (<70). Calculations beginning at 1year follow-up were done and repeated at every further follow-up. Latest values were used to compare the groups.

One way ANOVA test was used to analyze the difference of means for different parameters. The test was referenced for a two-tailed p value and 95%confidence interval was constructed around sensitivity proportion using normal approximation method. The Fischers' exact test was used for the comparison of paired categorical variables. Chi square test was employed to calculate the p value with more than 2 variables. SPSS software was used to perform statistical analyses. A value of <0.05 was considered statistically significant.

3. Results

Group DHS was composed of 40 patients (12 males and 28 Females; mean age 59.62 ± 15.61). Group PFN comprised 40 patients (14 males and 26 females; mean age 62.81 ± 13.92). Patients with age >60 years constituted 66% of the total numbers. The sidedness, the number of patients in each subgroup as per the Jensen and Michealsen's modification of Evan's classification and Pre injury walking ability were also statistically insignificant in both the group.

Mechanism of injury was high energy impact in 17.5% in the DHS group and 15.0% in PFN group and low energy injury in 82.5% in DHS group and 85.0% in PFN group. Mean time to surgery and average follow up were comparable between the groups.

The mean time required for DHS (87.25 ± 9.66 min) was calculated to be more than that for PFN fixation (69.50 ± 9.58 min) and the difference was statistically significant(p=.0001 ; Table 4). PFN also demanded an average 8.05 cm shorter incision than DHS which again was statistically significant (p<.0001). Blood loss too was significantly less with PFN but PFN also involved significantly more fluoroscopy exposure**.** [Table 4]

Mean time to bony union was also insignificantly more in PFN group (12.15 ± 1.42) as compared to DHS group. (12.0 ± 1.71). [Image 1-4] Fractures united in all patients without any exception. Patients with PFN appeared significantly well with less post-operative pain at 3 months follow-up and superior range of movements at the final follow-up than those with DHS. Talking in terms of limb length, an average of 0.68 less shortening was discerned in PFN group than DHS group. The number of patients retaining their pre injury walking ability in the PFN group too surpassed those in the DHS group at 3 months in postop. [Table 5] [Image 5, 6]

Deep wound infection was recognized in 4 patients in DHS group and 2 in PFN group .They all healed after surgical debridement and 3rd generation cephalosporin antibiotics. Screw cut out was evident in 2 patients in DHS group and none in PFN group. No other complication like lag screw cut out or the Z effect (in PFN group) or plate loosening were encountered in our series.

Functionally, in unstable fractures, patients with PFN outperformed those with DHS with higher Harris hip scores while no significant difference could be perceived in those with stable fractures configuration. Taken altogether, the PFN group again excelled with a statistically significant difference. As per the Harris hip score, in the DHS group overall, 6 patients had excellent results, 14 patients had good, and 12 patients had fair results and in 8 was recognized as poor. In the PFN group, 8 patients had excellent results, 30 patients had good and 2 patient had fair and none had poor results. [Table 6, 7, 8]

Table 1: Demographic and fracture pattern in two groups.

	Group DHS (40 Subjects)	Group PFN (40 Subjects)
Mean Age ± SD (years)	59.62±15.61	62.81±13.92
Gender		
Male	12	14
Female	28	26
Side		
Right	23	19
Left	17	21
Mode of Trauma		
High Energy	12	15
Low Energy	28	25
Type of fracture		
Close fracture	35	37
Open fracture	05	03
Grade 1	04	03
Grade 2	01	00

Table 2: Types of Fracture as per the Jensen and ichealsen's modification of Evans classification.

Type of Fracture	Method of Fixation		Total
	DHS	PFN	
Type 1	3 (7.50%)	0 (0.0%)	3 (3.75%)
Type 2	16 (40.0%)	24 (60.0%)	40 (50%)
Type 3	15 (37.5%)	8 (20.0%)	23 (28.7%)
Type 4	6 (15.0%)	8 (20.0%)	14 (17.5%)
Type 5	0 (0.0%)	0 (00.0%)	0 (0.0%)
Type 6	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	40 100.0%)	40 (100.0%)	80 (100.0%)

p=0.574

Table 3: Pre -injury Walking Ability grades described by Sahlstrand in both the groups.

		Method of Fixation		Total
		DHS	PFN	
Grade I	Walk without support	32 (80.0%)	30 (75.0%)	62 (77.5%)
Grade II	Walk with a cane or minimal support	8 (20.0%)	10 (25.0%)	18 (22.5%)
Grade 3	Walk with 2 canes, crutches or living support	0	0	0
Grade 4	Confined to bed or wheel chair	0	0	0
Total		40 (100.0%)	40 (100.0%)	80 (100.0%)

Fisher's p = 0.677

Table 4: Intraoperative parameters in both the group.

Parameter	Dhs Group	Pfn Group	P Value
Duration of surgery	87.25±9.66	69.50±9.58	0.0001
Length of incision	16.15±1.34	8.10±0.85	0.0001
Blood loss	380. 00±58	140. 00±34	0. 0001
Fluroscopy time	57.50±3.80	73.75±9.98	0. 0001

Table 5: Postoperative parameters in both the group

Parameter	DHS Group	PFN Group	P Value
Pain	2.5	1.65	0.012
ROM	84.25 ±20.53	98.75 ±10.11	0.070
No. of pt. regaining pre -injury Walking Ability grades	5	14	0.033
Limb length shortening	1.25 ±0.75	0.58 ± 0.56	0. 003
Time to union	12.00 ±1.71	12.15 ±1.42	0.765
Infection (no. of pt.)	4	2	0.675
Screw cut out/ back out (no. of pt.)	2	0	0.493

Table 6: Overall functional outcomes as per the Harris hip scores.

	Method of Fixation		Total
	DHS	PFN	
Excellent	6 (15.0%)	8 (20.0%)	14 (17.5%)
Good	14 (35.0%)	30 (75.0%)	44 (55.0%)
Fair	12 (30.0%)	2 (5.0%)	14 (17.5%)
Poor	8 (20.0%)	0 (0.0%)	8 (10.0%)
Total	40 (100.0%)	40 (100.0%)	80 (100.0%)

p=0.012 S

Table 7: Functional Outcomes in stable fractures in both groups as per the Harris hip scores.

	Method of Fixation		Total
	DHS	PFN	
Excellent	6 (30.0%)	6 (25.0%)	12 (27.272%)
Good	12 (60.0%)	18 (75.0%)	30 (68.181%)
Fair	0 (0.0%)	0 (0.0%)	0 (0.0%)
Poor	2 (10.0%)	0 (0.0%)	2 (4.545%)
Total	20 (100.0%)	24 (100.0%)	44 (100.0%)

$\chi^2 = 3.773$, p=0. 152 ns

Table 8: Functional Outcomes in unstable fractures in both the groups as per the Harris hip scores.

	Method of Fixation		Total
	DHS	PFN	
Excellent	0 (0.0%)	2 (12.5%)	2 (5.55%)
Good	2 (10.0%)	12 (75.0%)	14 (38.88%)
Fair	12 (60.0%)	2 (12.5%)	14 (38.88%)
Poor	6 (30.0%)	0 (0.0%)	6 (16.66%)
Total	20 (100.0%)	16 (100.0%)	36 (100.0%)

p=0.04 S

Figure and Figure Legends

Figure No	Description	
Figure 1	Case 1- Proximal femoral nailing	A- Case 1- Preoperative radiograph of fracture Intertrochanteric
		B- Case 1- Post operative radiograph IT fracture managed by PFN Nail
		C- Case 1- Follow up radiograph IT Fracture managed by PFN Nailing- at 8 weeks
		D- Case 1- Follow up radiograph IT Fracture managed by PFN Nailing- at 20 weeks
Figure 2	Case 2- Proximal femoral nailing	A- Case 2- Preoperative radiograph of fracture Intertrochanteric
		B- Case 2- Post operative radiograph IT fracture managed by PFN Nail
		C- Case 2- Follow up radiograph IT Fracture managed by PFN Nailing- at 8 weeks
		D- Case 2- Follow up radiograph IT Fracture managed by PFN Nailing- at 20 weeks
Figure 3	Case 3- Locked DHS	A- Case 3- Preoperative radiograph of fracture Intertrochanteric
		B- Case 3- Post operative radiograph IT fracture managed by DHS
		C- Case 3- Follow up radiograph IT Fracture managed by DHS- at 8 weeks
		D- Case 3- Follow up radiograph IT Fracture managed by DHS- at 20 weeks
Figure 4	Case 4- Locked DHS	A- Case 4- Preoperative radiograph of fracture Intertrochanteric
		B- Case 4- Post operative radiograph IT fracture managed by DHS
		C- Case 4- Follow up radiograph IT Fracture managed by DHS- at 8 weeks
		D- Case 4- Follow up radiograph IT Fracture managed by DHS- at 20 weeks
Figure 5	Clinical Follow up Results -PFN	A- Case sitting cross legged after PFN
		B- Case squatting in follow up after PFN
		C- Case doing leg raising in follow up after PFN
Figure 6	Clinical Results- DHS case	A- Incision site of DHS in follow up
		B- Case doing leg raising in follow up
		C- Case showing hip rotation during follow up period
		D- Range of hip and knee movements

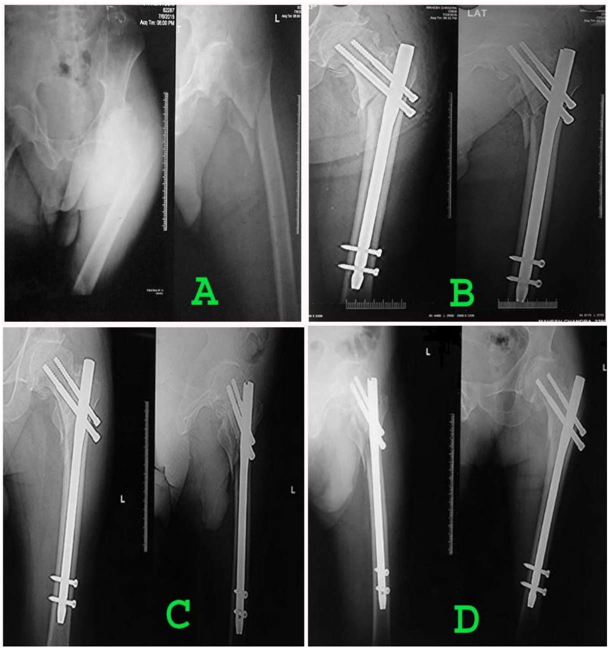

Fig 1

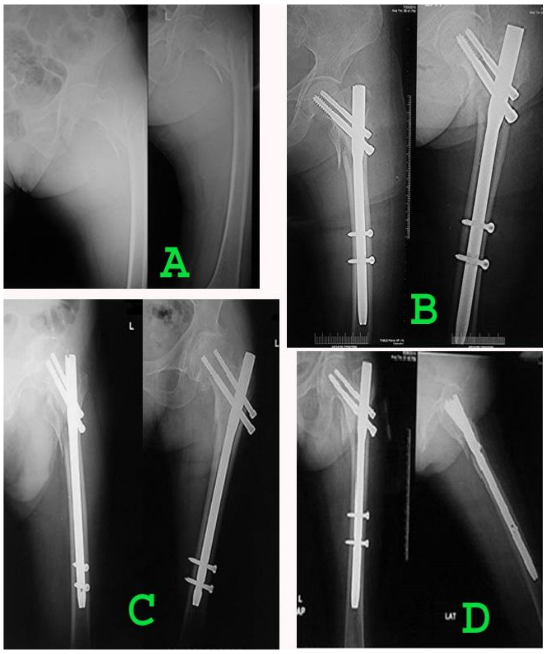

Fig 2

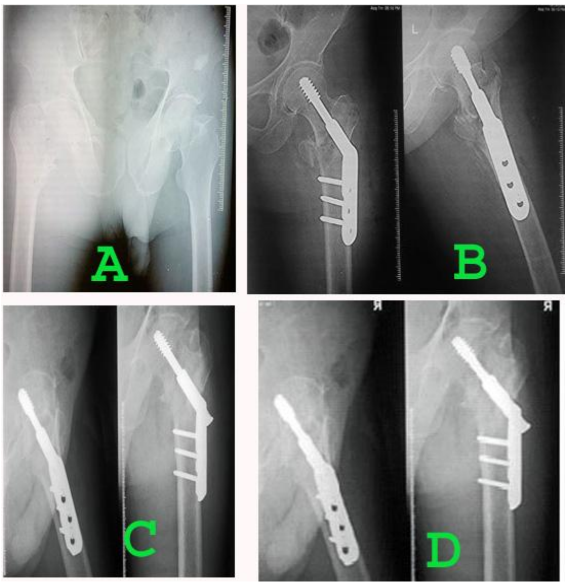

Fig 3

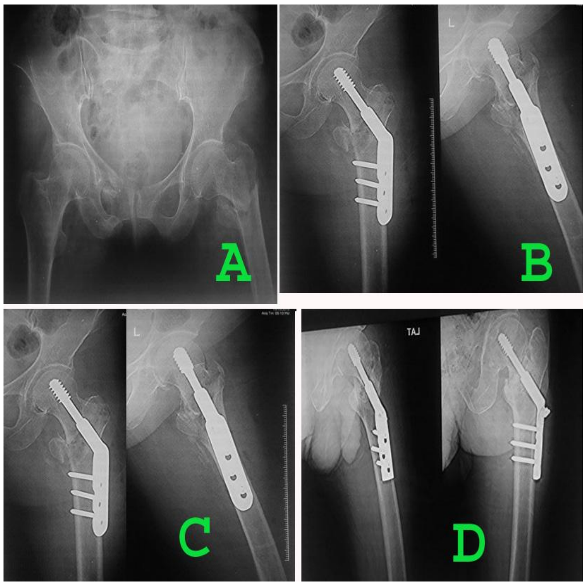

Fig 4

Fig 5

Fig 6

4. Discussion

The optimal treatment modality for intertrochanteric fractures has long been disputed and contentious. Failure rates for these fractures have been recited as 9 – 16% [19] and femoral neck shortening customarily results. Implants designed in past that aimed to reinstate the anatomy of hip have experienced high failure rates [20, 21]. From the biomechanical standpoint, intramedullary nails, being a load sharing device and more closely located to the axis of weight bearing, may offer an audible advantage [12]. Furthermore, the distal cortex of the proximal fragment abuts the more medially located nail thus minimizing the amount of femoral neck collapse. The Gamma nail was introduced in early 80's to conquer the limitations implicit in sliding screw fixation [22].

However the initial enthusiasm for it moderated after a high complication rate like anterior thigh pain and peri-impant fractures were unearthed [22-24]. Nails have evolved over time and contemporary designs have a smaller distal shaft diameter that reduces stress concentration at its tip thus precluding the femoral shaft fractures. Also, the rotational control is ingrained in the nail design and not contingent on the multiple implant parts that heightens the risk of failure. The smaller lag screw diameter no longer necessitates the flaring of proximal aspect of the nail thus precluding mechanical failure of the nail and also entails less reaming of proximal femur, thereby abbreviating the likelihood of iatrogenic femoral shaft fractures [25]. The shift in the entry point from piriform fossa to the GT also plummeted the surgical insult to the tendinous hip musculature. A met analysis which took into account all the studies after 2000, has validated this while alleging equivalent rates of peri-prosthetic fractures with both intra or extra medullary implant [10].

In our study, many of the intraoperative parameters were in favor of PFN with significantly less duration of surgery, length of incision and blood loss except fluoroscopy time as nailing necessitates a strict radiological control intraoperative. This corroborated with the of Baumgaertner *et al* [26] who discovered the surgery duration to be 10% higher and a mean 150ml more of a blood loss in DHS group. Similar observations have been proclaimed by many antecedent studies [27, 28] On the contrary, Huang et al [11], in their recent meta-analysis recited no significant difference in these two parameters between the groups.

Postoperatively also, PFN group patients excelled over the DHS group with significantly less postoperative pain, less incidence of deep infection and better range of motion. Additionally, the number of patients regaining the pre-injury walking ability at fractures union too outstripped in the PFN group significantly. Significantly less limb length shortening was discerned in the PFN group as against the DHS group. This could be ascribed to the inappropriate sliding of the lag screw inside the barrel in the DHS patients.

A shorter incision with less soft tissue damage and a load sharing implant appear attributable. Lately, Reindl *et al* [29] asserted an average 1cm more shortening with DHS than PFN although it did not harmonize with any functional impairment. Earlier in 2002, Sudan *et al* [30] too noted corresponding results with respect to the post-operative ROM but comparable occurrence of postoperative pain. No significant difference with regard to time to union could be perceived in our series between the groups.

In our study, in the DHS group, the lag screw backed out in two patients despite adequate initial reduction and implant position as opposed to none in the PFN group. In both the cases the fractures was an unstable one. Former studies have enunciated varus collapse and failure of femoral head screw to be a constant complication with DHS [30, 31]. Factors such as the type of fractures pattern, stability, osteoporosis and screw position in the femoral head may be accountable. Contrarily, in a meta-analysis, Jones *et al* [32] discovered no statistically significant difference in the lag screw cut out rate between the two and the total failure rate and reoperation rate to be higher with an intramedullary implant. Huang *et al* [11] have revealed alike wound complication, mortality and reoperation rates in the two group.

A comparatively demanding conversion to total hip arthroplasty after failed intramedullary than an extra medullary device is another argument against IMN**.** [33] Further long term follow-ups of patients in our study may probe its authenticity.

Functionally, utilizing the Harris hip scoring system, at the final follow-up, our study affirms PFN to be superior to DHS in unstable intertrochanteric fractures while in stable fractures, functional results are same. This outcome was authenticated by Bhakat *et al* [34] who pronounced parallel results implementing same score. Gadegone et al had asserted good results with both stable and unstable fractures in their analysis of 100 cases with PFN [9]. In unstable fractures, control of axial telescoping and rotational stability is paramount and an intramedullary device placed in a minimally invasive fashion is endured better in elderly [35]. It can also confront higher static and many folds elevated cyclical loading than a surface implant and also provisionally compensates for the work of medial column [36].

Our study being organized with a limited number of patients and a short frame of time could not furnish insight into the long term complications and hurdles with revision surgery. With the continued evolution of both the implants, future trials that are ably outlined and appropriately powered are warranted.

To close, intramedullary implants have less complication rates and superior functional outcomes especially in unstable intertrochanteric fractures. Newer intramedullary implants have unveiled promising results but their elevated costs and a technically demanding surgery with a lengthened learning curve are something to ponder over. Analyzing the personality of fractures, its classification and stability is advocated prior to implant election.

5. Ethical approval

The protocol of this study was approved by the institutional review board. This study was authorized by the local ethical committee and was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki as revised in 2000. The well informed written consent was obtained from every case in this study.

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