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Original Article

A comparative study of Proximal Femoral Nail (PFN) versus Dynamic Condylar Screw (DCS) in management of unstable trochanteric fractures

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Abstract: Trochanteric hip fractures have become very common with 35-40% of these fractures being unstable. Trochanteric fractures, especially unstable ones are associated with high rates of mortality and morbidity and thus remain an inordinate challenge for surgeon to treat these fractures with proper choice of implant. Aim of the study was to compare the proximal femoral nail and dynamic condylar screw in the management of unstable trochanteric fractures. Our study was a prospective comparative study which included 26 patients with fresh (≤3 weeks old) unstable trochanteric fractures A0 31A2 and A0 31A3, with age ≥18 years of both sexes. Eleven patients in DCS and fifteen patients in PFN were included. Harris hip score was used to compare functional outcomes. Average age of patients in DCS group was 59.82±11.59 years and PFN was 54.2±16.22 years. A0 31A2 fracture pattern (63.64%) was more common than A0 31A3 in DCS group and A0 31A3 fracture pattern (60.00%) was more common than A0 31A2 in PFN group. Mean operative time for DCS was 96.36±15.51 minutes and for PFN it was 79.67±12.02 minutes with *P*-value of 0.003. Two patients in DCS group and 1 patient in PFN group were lost to follow up. Two patients in DCS group and 1 patient in PFN group died. Seven out of 11 (63.64%) patients in DCS group and 13 out of 15 (86.60%) patients in PFN group were available for final follow up. Union seen in 2 (28.57%) patients with DCS and 12 (92.31%) patients fixed with PFN with *P*-value of 0.007. Mean HHS of 62.29±24.26 in DCS and 86.92±11.65 in PFN with *P*-value of 0.037. Patients with combined excellent and good HHS in DCS group and PFN group were 2 (28.57%) and 11 (84.62%) respectively. Non-union was seen in 5 (71.43%) patients fixed with DCS and 1 (7.69%) patient fixed with PFN. Implant failure was seen in 3 (42.86%) patients in DCS group in which barrel plate was broken in 2 (28.57%) patients and lag screw cut out through femoral head in 1 (14.29%) patient and 1 (7.69%) patient in PFN group due to varus collapse and complete backout of screw. Varus collapse was seen in 3 (42.86%) patients in DCS group and 4 (30.76%) patients in PFN group. Proximal femoral nail is better implant as compared to dynamic condylar screw which was statistically significant in terms of lesser operative time, higher union rate and better functional outcome. So PFN is a better implant choice for unstable trochanteric fractures when compared with DCS.

Keywords: Unstable trochanteric fractures, Harris hip score, dynamic condylar screw, proximal femoral nail

Introduction

Trochanteric fractures are the fractures occurring in the region of proximal femur extending from extracapsular basilar neck to the lesser trochanter and proximal to the medullary canal [1]. It is one of the most common fractures occurring in elderly patients [2]. The incidence of trochanteric fractures has increased due to more life expectancy along with osteoporosis. Studies done by Cooper [3] and Gullberg [4] in 1990s predicted that approximately 4.50-6.26 million of hip fractures will occur all over world by 2050 and 50% of them will occur in Asian subcontinent. Unstable fracture patterns are those fractures with fracture line extending to sub-trochanteric area, lateral wall blow out, comminuted posteromedial wall, reverse oblique (femoral shaft displaced medially) and variant of reverse oblique fractures [2, 6]. Trochanteric fractures (irrespective of the fracture geometry) are often operated on, unless some contraindication is present for operative treatment (severe comorbidities endangering the life of patient in intraoperative or perioperative period). However, unstable trochanteric frac-

ture patterns pose a great challenge in management with high post-operative complications including mortality. They have also become a health resource issue due to the high cost of care required following injury [5]. Extramedullary (e.g., DHS, Dynamic hip screw; CHS, Compression hip screw; DCS, Dynamic condylar screw; PFLCP, Proximal femoral locking compression plate) and intra-medullary (e.g., IMHS, Intramedullary hip screw; PFN, Proximal femoral nail; PFNA, Proximal femoral nail anti-rotation) fixation are the contemporary treatment options and both of them have received empirical support [7]. Although the extramedullary sliding screw (e.g., DHS, Dynamic hip screw) was once regarded the gold standard in the treatment of trochanteric hip fractures, intramedullary devices are now outnumbering extramedullary devices [8, 9]. Several studies had found that intramedullary devices are more effective than extramedullary devices for fixation of unstable trochanteric femoral fractures, and that extramedullary fixation should be used with caution due to greater complication rates and poor functional outcomes. Other studies, on the other hand, found no significant difference in outcomes when intramedullary and extramedullary fixations were used [10-13]. Furthermore, most previous studies for unstable intertrochanteric fractures were retrospective or non-specific with respect to fracture pattern, demanding more research [14-18].

Methods

Study design

This study was done between November 2019 to December 2021 at Jawaharlal Nehru Medical College and Hospital, Aligarh Muslim University, Aligarh, India as a randomized prospective study, and was conducted after approval from institutional ethical committee (D. No-189/FM/IEC). All the study participants were briefed about the study and written informed consents were obtained.

Inclusion and exclusion criteria

Skeletally mature (age ≥18 years) patients of both gender with fresh (≤3 weeks old) trochanteric fractures with unstable fracture geometry as per AO classification (AO 31A2 and AO 31A3) were included in the study. Stable fracture pattern (AO 31A1), pathological fractures (other than osteoporosis), patients on chemo-radiotherapy, compound fractures and polytrauma patients were not included.

Patient randomization and group allocation

Twenty-six patients, who satisfied the inclusion criteria, were randomized for inclusion in the study. Out of 26 patients, 11 patients were allocated group A (dynamic condylar screw group) and 15 patients were allocated group B (proximal femoral nail group). All study participants were thoroughly examined both clinically and radiologically as per the predetermined study protocol. In group A, two patients were lost to follow up and 2 patients died. While in group B, one patient was lost to follow up and one patient died. Therefore, seven out of 11 patients in group A (DCS) and 13 out of 15 patients in group B (PFN) were available for final follow up. Hence, at the end of study, 20 out of 26 patients were available for final follow up assessment and evaluation.

Surgical intervention and implant used

Open reduction was done in Group A (DCS) through lateral approach. Closed reduction was done by axial traction and internal rotation of the fractured hip in Group B (PFN) and in 3 cases reduction was done by minimal invasive technique through incision of proximal screw site of PFN. **Figures 1**, **2** are representing fixation of unstable trochanteric fractures with DCS and PFN respectively. All patients received injectable antibiotics, 30 minutes before surgical incision. Type of anaesthesia was given as per decision by the anaesthetist.

Postoperative protocol & outcome evaluation

Injectable antibiotics were continued for 2-3 days. Static quadriceps drill exercises along with non-weight bearing walk were started on the second post-operative day. Sutures were removed after 10 to 12 days. Weight bearing was started depending upon fracture stability and fixation adequacy and it was delayed in patients with inadequate fixation. The patients were followed up every 6 weeks till union of fracture, then every 3 months with check X-rays to assess fracture union and complications. Harris hip score was used to evaluate the functional outcome [26]. Harris hip scoring

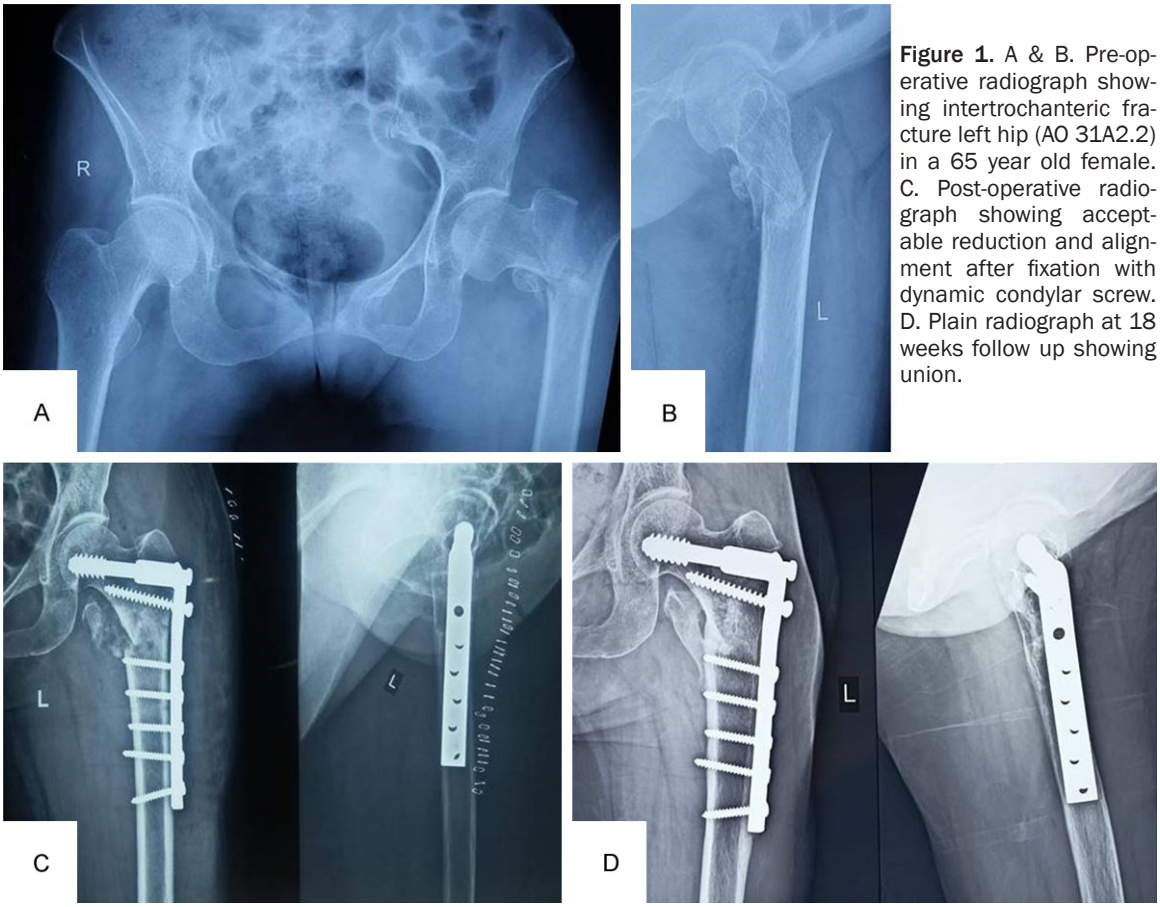

Figure 1. A & B. Pre-operative radiograph showing intertrochanteric fracture left hip (AO 31A2.2) in a 65 year old female. C. Post-operative radiograph showing acceptable reduction and alignment after fixation with dynamic condylar screw. D. Plain radiograph at 18 weeks follow up showing union.

system takes into account discomfort, function, deformity and hip range of motion. A patient's maximum possible score is 100. Radiological assessment done for union, varus collapse (change in neck shaft angle of >5 degree), non-union, screw cut-out, femoral head perforation into the hip joint, symptomatic back out of the screws and other complications.

Statistical analysis

The categorical variables were presented in the form of numbers and percentages. The quantitative data, on the other hand, were presented as means with standard deviations and as a median with 25th and 75th percentiles (interquartile range). The data normality was checked by using Kolmogorov Smirnov test. Non-parametric tests were employed in the circumstances where the data was not normal. The following statistical tests were applied for the results.

1. The comparison of the variables which were quantitative and not normally distributed in nature were analyzed using Mann-Whitney Test (for two groups) and Independent t test was used for comparison of normally distributed data between two groups.

2. The comparison of the variables which were qualitative in nature was analyzed using Fisher's exact test as at least one cell had an expected value of less than 5. The data was entered into a Microsoft EXCEL spread sheet, and the final analysis was performed using IBM's Statistical Package for Social Sciences (SPSS) software (Chicago, USA), version 21.0. A *p* value of less than 0.05 was considered statistically significant.

Results

Study population and demographic characteristics

Total 26 patients of unstable intertrochanteric fracture were included in the study of which 11 patients were fixed with dynamic condylar screw (group A) and 15 patients were fixed

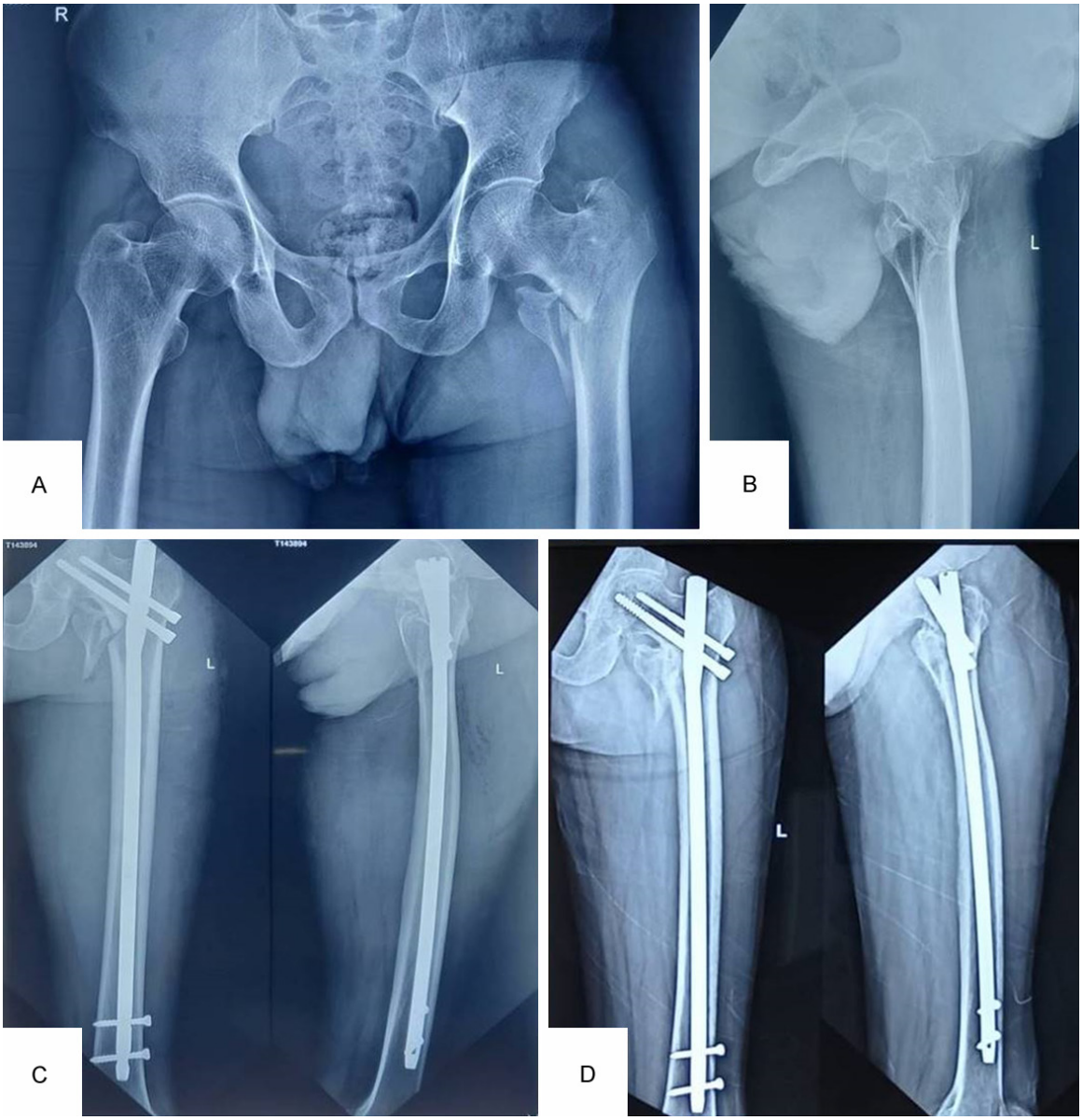

Figure 2. A & B. Pre-operative radiograph showing intertrochanteric fracture left hip (AO 31A2.3). C. Post-operative radiograph showing acceptable reduction and alignment after fixation with proximal femoral nail. D. Plain radiograph at 18 weeks follow up showing union.

with proximal femoral nail (group B) with the purpose to compare radiological and functional outcome. The distribution of age, sex, mechanism of injury, fracture pattern, and time from injury to operation was not significantly different between the two groups according to preoperative data (**Table 1**). In group A (DCS) majority 54.55% patients lies between age 61 to 80 years with mean age of 59.82±11.59 years ranging from 35 to 70 years and in group B (PFN) 40.00% patients lies between age 41 to 60 years with mean age of 54.2± 16.22 years ranging from 22 to 80 years. In group A (DCS) male patients were more (54.55%) than female patients and in group B (PFN) female patients were more (73.33%) than male patients. Trivial fall was the most common mode of injury in both the groups, group A (DCS) 72.73% and group B (PFN) 66.67%.

Distribution of AO fracture type and operative details

AO 31A2 fracture pattern (63.64%) was more common than AO 31A3 in group A (DCS group), while AO 31A3 fracture pattern (60.00%)

Table 1. Preoperative patient characteristics between group A (dynamic condylar screw) & group B (proximal femoral nail) patients

Patient variable	Dynamic condylar screw (Group A)	Proximal femoral nail (Group B)	*P*-value
Age			
Average (years)	59.82±11.59	54.2±16.22	0.338*
Range (years)	35-70	22-80	
Sex			
Female	5 (45.45%)	11 (73.33%)	0.228‡
Male	6 (54.55%)	4 (26.67%)	
Mode of injury			
FFH	1 (9.09%)	4 (26.66%)	0.81‡
RTA	2 (18.18%)	1 (6.67%)	
Trivial fall	8 (72.73%)	10 (66.67%)	
Evans classification			
Type 1c	1 (9.09%)	1 (6.67%)	0.597‡
Type 1d	6 (54.55%)	5 (33.33%)	
Type 2	4 (36.36%)	9 (60%)	
AO/OTA classification			
AO 31A2	7 (63.64%)	9 (60%)	0.416‡
AO 31A3	4 (36.36%)	6 (40%)	
Duration from injury to operation (days)			
<5	3 (27.27%)	9 (60%)	0.208‡
5 to 10	5 (45.45%)	3 (20%)	
>10	3 (27.27%)	3 (20%)	

*Independent t test, ‡Fisher's exact test.

Table 2. Intraoperative assessment between group A (dynamic condylar screw) & group B (proximal femoral nail) patients

Variable	Dynamic condylar screw (Group A)	Proximal femoral nail (Group B)	*P*-value
Duration of operation (minutes)			
Average	96.36±15.51	79.67±12.02	0.003†
Range	75-135	65-110	

†Mann Whitney test.

was more common than AO 31A2 in group B (PFN group). The mean time taken from the injury to operation in group A (DCS) was 8.91±6.89 days ranging from 1 to 21 days and in group B (PFN) was 5.8±3.8 days ranging from 1 to 13 days. The mean operation time (**Table 2**) in group A (DCS) was 96.36±15.51 minutes ranging from 75 to 135 minutes and in group B (PFN) was 79.67±12.02 minutes ranging from 65 to 110 minutes which was found to be statistically significant (*P*-value <0.05). Mean duration of hospital stay (**Table 3**) in group A (DCS) was 8.91±2.43 days ranging from 4 to 13 days and in group B (PFN) was 8.73±4.3 days ranging from 4 to 20 days.

Follow up, fracture union and complications

Two (18.18%) patients were lost to follow up and 2 (18.18%) patients died in group A (DCS) and 1 (6.67%) patient was lost to follow up and 1 (6.67%) patient died in group B (PFN). Cause of death was unrelated to surgical procedure in both the groups. Seven out of 11 (63.64%) patients in group A (DCS) and 13 out of 15 (86.66%) patients in group B (PFN) were available for final follow up. Fracture union was seen in 2/7 (28.57%) patients in group A (DCS) and 12/13 (92.31%) patients in group B (PFN). The mean union time was 18 weeks in group A (DCS) and 17.5±4.76 weeks ranging from 12 to 24 weeks in group B (PFN) (**Table 3**). Non-union with or without implant failure was seen in 5 (71.43%) patients in group A (DCS) and 1 (7.69%) patient in group B (PFN). In DCS group, implant failure was observed as breakage of barrel plate in 2 cases (28.57%) (**Figure 3**) and

Table 3. Complications and post-operative assessment in group A (dynamic condylar screw) & group B (proximal femoral nail) patients

Parameters	Dynamic condylar screw (Group A)	Proximal femoral nail (Group B)	*P*-value
Duration of hospital stay (days)			
Average	8.91±2.43	8.73±4.3	0.904*
Range	4-13	4-20	
Union	2 (28.57%)	12 (92.31%)	0.007‡
Union time (weeks)			
Average	18	17.5±4.76	0.692‡
Range	18	12-24	
Complications			
Varus collapse	3 (42.86%)	4 (30.76%)	0.638‡
Non-union	5 (71.43%)	1 (7.69%)	0.007‡
Implant failure	3 (42.86%)	1 (7.69%)	0.088‡
Lag screw break	0 (0%)	1 (7.69%)	1‡
Symptomatic screw backout	1 (14.29%)	2 (15.38%)	1‡
Anterior thigh pain	4 (57.14%)	2 (15.38%)	0.122‡

*Independent t test, ‡Fisher's exact test.

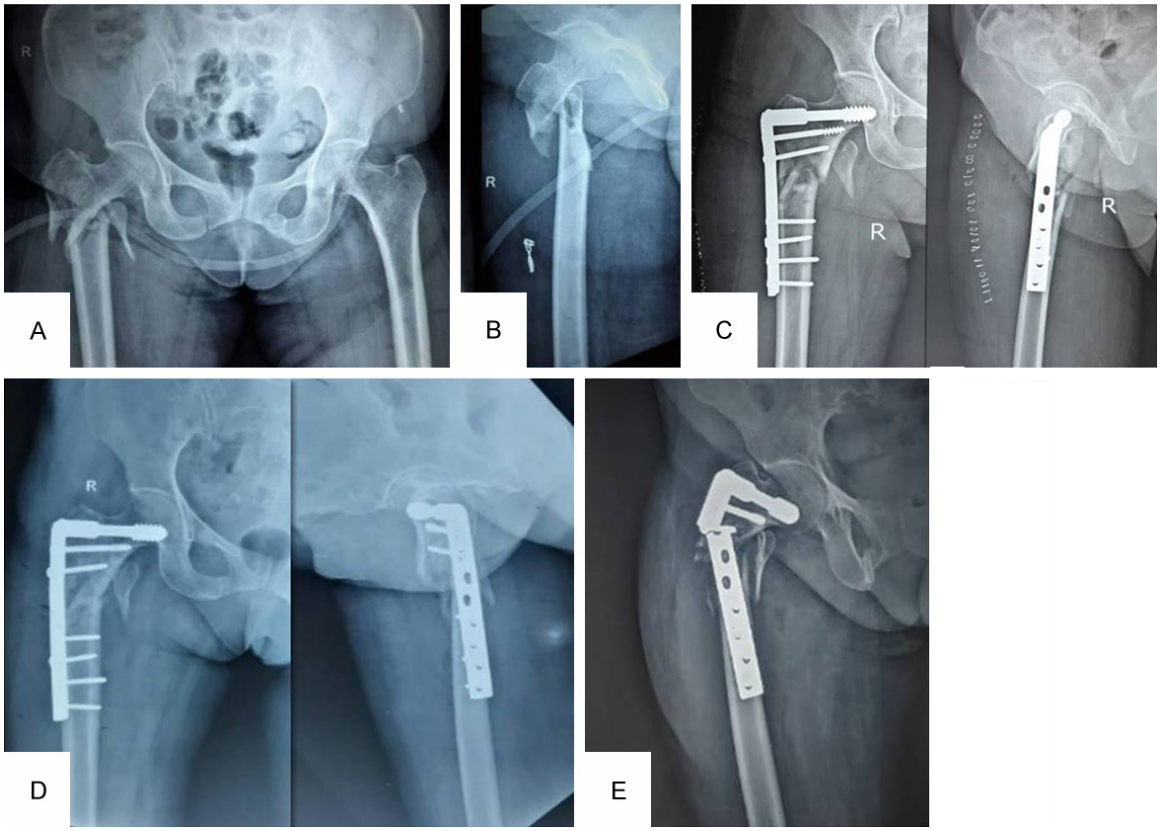

Figure 3. A & B. Pre-operative radiograph showing intertrochanteric fracture right hip (AO 31A2.3). C. Post-operative radiograph showing acceptable reduction and alignment after fixation with dynamic condylar screw with femoral neck shaft angle of 127.5°. D. Plain radiograph at 6 weeks follow-up showing barrel plate bending and femoral neck shaft angle of 119.5°. E. Radiograph at 10 weeks follow-up showing implant failure (barrel plate breakage) and loss of reduction and alignment.

lag screw cut out through femoral head in 1 (14.29%) patient. While in PFN group varus collapse with backing out of hip screws was noted (**Figure 4**) in one patient (7.69%). Lag screw

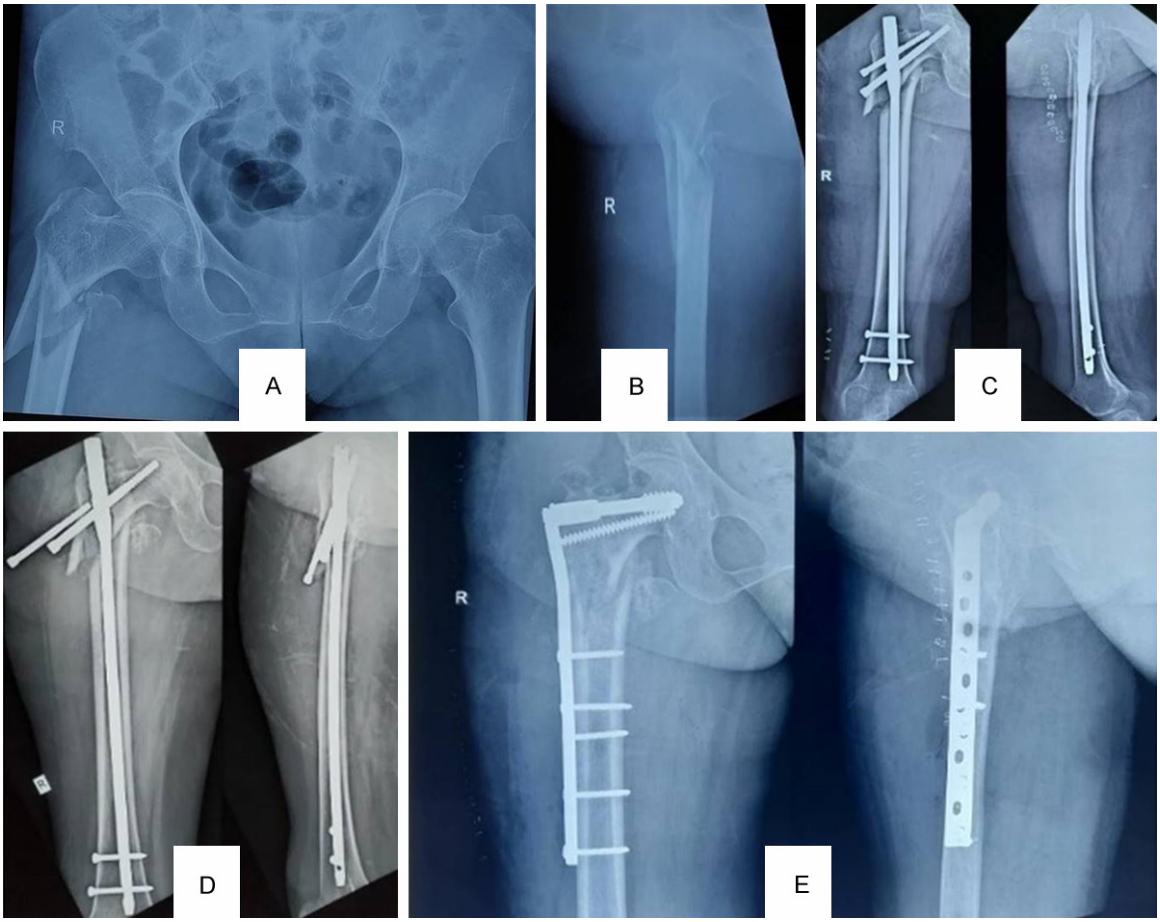

Figure 4. A & B. Pre-operative radiograph showing intertrochanteric fracture right hip (AO 31A3.3). C. Post-operative radiograph showing fixation of fracture in varus with femoral neck shaft angle of 117°. D. Plain radiograph at 6 weeks follow-up showing implant failure with backing out of hip screws and further varus collapse with femoral neck shaft angle of 110°. E. Radiograph showing revision with dynamic condylar screw.

Table 4. Harris Hip Score as indicator of functional outcome in group A (dynamic condylar screw) & group B (proximal femoral nail) patients at final follow-up

Harris hip score	Dynamic condylar screw (Group A)	Proximal femoral nail (Group B)	*P*-value
90-100 (Excellent)	1 (14.29%)	7 (53.85%)	0.027‡
80-89 (Good)	1 (14.29%)	4 (30.77%)	
70-79 (Fair)	0 (0%)	1 (7.69%)	
<70 (Poor)	5 (71.42%)	1 (7.69%)	

‡Fisher's exact test.

breakage was seen in 1 (7.69%) patient in group B (PFN). With respect to varus collapse, 3 (42.86%) patients in group A (DCS) and 4 (30.76%) patients in group B (PFN) were noted. Symptomatic screw backout was seen in 1 (14.29%) patient in group A (DCS) and 2 (15.38%) patients in group B (PFN). Four (57.14%) patients were having anterior thigh pain in group A (DCS) and 2 (15.38%) patients in group B (PFN).

Discussion

The purpose of this study was to compare patient's functional and radiological outcomes fixed with dynamic condylar screw and proximal femoral nail and determine the implant of choice for managing unstable trochanteric fractures. We were able to construct a more homogeneous group by precisely defining the inclusion criteria.

Functional outcome

Functional outcome was assessed according to Harris Hip Scoring System (**Table 4**). Mean

Harris hip score in group A (DCS) was 62.29±24.26 ranging from 30 to 100 and in group B (PFN) was 86.92±11.65 ranging from 60 to 100, with *P*-value of 0.037† (†Mann Whitney test) which was statistically significant with better outcome in patient fixed with proximal femoral nail. In our study, group A (DCS) showed 1 (14.29%) patient with excellent (90-100) score, 1 (14.29%) patient with good (80-89) score and 5 (71.42%) patients with poor (<70) score while group B (PFN) showed 7 (53.85%) patients with excellent (90-100) score, 4 (30.77%) patients with good (80-89) score, 1 (7.69%) patient with fair (70-79) score and 1 (7.69%) patient with poor (<70) score. Combining the excellent and good scores this comprises 2 out of 7 (28.57%) patients in DCS group and 11 out of 13 (84.62%) patients in PFN group. In the study done for DCS by Ninad [22] (100%) patients and Hameedullah [19] (86.39%) patients lies in excellent and good score group which is much higher than in our study. The studies done for PFN by Tribhuvan [21] (92%), C. Joney [23] (91.66%) and Vishal [25] (80%) had shown excellent and good score almost comparable to that for PFN in our study.

Radiological outcome

Fracture union was seen in 2 (28.57%) patients in group A (DCS) while 12 (92.31%) patients in group B (PFN). In the previous comparative study done by Christophe [20] union was seen 16 out of 17 (94.12%) patients in DCS group which was much higher than we observed in our study and 17 out of 18 (94.44%) patients in PFN group showed union which was almost comparable to that of PFN in our study. In the study done for DCS by Ninad [22], 18 out of 18 (100%) patients achieved union and Hameedullah [19] study showed 144 out of 147 (97.96%) patients achieved union which was much higher than our DCS group. In the study done for PFN by Tribhuvan [21] and C. Joney [23] showed 100% union while Vishal [25] showed union in 38 out of 40 (95%) patients and Siddiqui [24] showed union in 40 out of 42 (95.24%) patients, almost comparable to that of PFN group in our study.

Mean union time in group A (DCS) was 18 weeks and in group B (PFN) was 17.5±4.76 weeks ranging from 12 to 24 weeks. Previous studies done for DCS by Ninad [22] showed mean union time of 14.6 weeks ranging from 9.2 to 20 weeks and Hameedullah [19] showed mean union time of 6.3±1.4 weeks which showed early union as compared to that in our study. In the study done for PFN by C. Joney [23] mean union time was 11.12 weeks ranging from 8 to 22 weeks which showed early union while Siddiqui [24] with mean union time of 24 weeks showed longer union time as compared to that for PFN group in our study.

Complications

When compared to the proximal femoral nail, the overall incidence of complications was greater in the dynamic condylar screw group. In our study non-union was seen in 5 out of 7 (71.43%) patients in group A (DCS) while 1 out of 13 (7.69%) patient in group B (PFN). In the previous comparative study done by Christophe [20] non-union was seen in 1 out of 17 (5.88%) patient in DCS group which was much less than we observed in our study and 1 out of 18 (5.56%) patients in PFN group showed non-union which was almost comparable to that of PFN group in our study. In the study done for DCS by Ninad [22], none of the patients showed non-union and Hameedullah [19] study showed 3 out of 147 (2.04%) patients with non-union which was very less than that in our study for DCS group. In the study done for PFN by Tribhuvan [21] and C. Joney [23], none of the patients showed non-union, while Vishal [25] showed 2 out of 40 (5%) and Siddiqui [24] showed 2 out of 42 (4.74%) patients with non-union, almost comparable to that for PFN group in our study. Implant failure was seen in 3 (42.86%) patients in group A (DCS) in which barrel plate was broken in 2 (28.57%) patients and screw cut out through femoral head was seen in 1 (14.29%) patient. While one (7.69%) patient in group B (PFN) showed varus collapse and complete backout of screw. Christophe [20] while comparing DCS and PFN, showed DCS failure in 6 (35.29%) patients which was comparable to the DCS failure in our study. Furthermore, no failure was reported in PFN group in that study [20]. While Ninad [22] and Hameedullah [19] reported none of the patient with DCS failure. In the study done for PFN by Vishal [25] implant failure was seen in 1 (2.5%) patient and in the study done by Siddiqui [24] lag screw cut-out was seen in 2 (4.76%) patients. Varus collapse was seen in 3 (42.86%) patients in group A

(DCS) and 4 (30.76%) patients in group B (PFN). In previous studies done for PFN by C. Joney [23] (25%) and Vishal [25] (25%) varus collapse was seen which was almost comparable to that in our study and study done by Siddiqui [24] (9.52%) showed relatively less percentage of varus collapse.

Strengths, limitations and future recommendations

Our study compares the functional and radiological outcomes of unstable trochanteric fractures fixed with dynamic condylar screw and proximal femoral nail. The strengths of the study are prospective nature of study, inclusion of unstable fracture patterns and definite treatment protocol. However limited sample sizes with short follow-up are the limitations of current study. We also admit the effect of differential mortality and lost to follow up in both the groups' limits the strength of conclusions derived from current investigation. Hence, future research comparing the two modalities with better stratification of age groups, equal distribution of sex ratio and long follow-up are required for defining the criteria for implant selection in management of unstable trochanteric fractures.

Conclusion

In our study, proximal femoral nail had shown less operative time, higher union rate, less duration for fracture union, better functional outcome and fewer complications than dynamic condylar screw. Proximal femoral nail is statistically significantly better implant as compared to dynamic condylar screw in terms of less operative time, higher union rate and better functional outcome. Based on our study results and existing literature we recommend PFN as better implant for managing unstable trochanteric fractures. Even if PFN is also associated with implant failure and other complications with proper execution of techniques and following principles of PFN fixation, the complications can be reduced to an acceptable rate. Furthermore, more RCT are required to be done in future for establishing superiority of PFN over DCS in managing unstable trochanteric fractures.

Disclosure of conflict of interest

None.

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