International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2021; 7(4): 431-436

www.orthopaper.com
Received: 25-08-2021
Accepted: 27-09-2021

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Comparative study of extramedullary versus intramedullary fixation for unstable Intertrochanteric femur fracture

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DOI: https://doi.org/10.22271/ortho.2021.v7.i4f.2915

Abstract
Context: Most frequent fractures of proximal femur are intertrochanteric fractures which involve upper end of femur between both trochanters with or without extending into the upper femoral shaft occuring commonly in geriatric patients. Unstable contribute to about 50%-60% of all intertrochanteric fractures.
Aims: Though intertrochanteric fractures unite without surgical intervention, malunion with coxa vara deformity occur with conservative management. The aim of fixation of intertrochanteric fractures is to prevent morbidity and mortality. With this aim of stable surgical reconstruct of intertrochanteric fracture this study was done to evaluate functional, clinical and radiological outcome of unstable intertrochanteric fracture operated with dynamic hip screw with trochanteric stabilization plate (extra meduary fixation) and proximal femoral nailing (intramedullary fixation) and study epidemiology and demographics of intertrochanteric femur fractures in Indian scenario.
Settings and Design: Methods and Material: The study was conducted at New Civil Hospital Surat. 50 patients with unstable intertrochanteric femur fractures admitted between february 2018 to march 2019.
Conclusions: In this study we found that both-extra-medullary or intramedullary fixation were able to provide good clinical result for unstable Intertrochanteric femur fracture. We conclude that there is statistically significant difference between patients operated with DHS with TSP (Extra medullary implant) and Proximal Femoral Nail (Intramedullary implant) in terms of Blood loss, Mean operative time and functional outcome. Harris hip score in patients treated with PFN had better Harris hip score at final follow up which was statistically significant. All patients in both groups had bony union at final follow up. Blood loss and duration of surgery was significantly less with intramedullary Implant.

Keywords: dynamic hip screw, intertrochanteric femur fracture, intramedullary/extra medullary fixation, proximal femur nail

1. Introduction
Most frequent fractures of proximal femur are intertrochanteric fractures which involve upper end of femur between both trochanters with or without extending into the upper femoral shaft [1] occuring commonly in geriatric patients. Since general life expectancy of population has increased in the past two decades incidence of fractures of proximal femur are also increasing. In 1990 of overall hip fractures 26% occurred in Asia. This is expected to rise upto 37% in 2025 and 45% in 2050. [2, 3] Only moderate or minimal trauma is enough to cause proximal femur fractures in geriatric patients.
Simple self-fall causes intertrochanteric fractures in elderly people due to osteoporosis and increased incidence of self-fall with increasing age is due to decreased muscle power, decreased reflexes, poor vision and labile blood pressure. In younger patients it requires high energy trauma. Intertrochanteric fracture line involves along extra capsular basilar neck region to region along the lesser trochanter, Undisplaced fractures and fractures with intact posteromedial cortex are said to be stable [4].
Unstable intertrochanteric femur fracture is defined as comminution of the posteromedial cortex; thinner lateral wall thickness; measured from 3 cm distal from innominate tubercle at 135 degrees to the fracture site; <20.5 mm suggests risk of postoperative lateral wall fracture [5, 6].

Unstable contribute to about 50%-60% of all intertrochanteric fractures [5, 6]. There are five variables described by Kaufer which are found to affect the biomechanical strength of the repair. Bone quality and fracture pattern which are surgeon independent along with Implant choice, quality of fracture reduction and positioning of implant which are surgeon dependent [8]. Main weight bearing bone of lower limb is femur. Intertrochanteric fractures cause patients to be bedridden for prolonged period of time and they are more prone for urinary tract infection, respiratory tract infection, bed sores and joint stiffness etc. To avoid these complications operative treatment is indicated.

Though intertrochanteric fractures unite without surgical intervention, malunion with coxa vara deformity occur with conservative management. The aim of fixation of intertrochanteric fractures is to prevent morbidity and mortality. With this aim of stable surgical reconstruct of intertrochanteric fracture this study was done to evaluate functional, clinical and radiological outcome of unstable intertrochanteric fracture operated with dynamic hip screw with trochanteric stabilization plate (extrameduary fixation) and proximal femoral nailing (intramedullary fixation)

Materials and Methodology

The study was conducted at New Civil Hospital Surat. 50 patients with unstable intertrochanteric femur fractures admitted between february 2018 to march 2019.

After admission, routine pre-operative blood investigations were done. Pre-operative x rays were done. The patient's radiographic results were presented and discussed preoperatively in the daily morning round by orthopedic surgeons to categorize the fracture pattern and suggest proper implant for fixation. Patients were divided into 2 groups: Intramedullary implant group and Extramedullary implant group. Choice of implant was based on surgeon's preference Suture dressing was done on third post-op day and 5th post-op day after which the patient was discharged if the dressing was clean. Suture removal was done on 10th day. Patients were not given any pharmacological DVT prophylaxis. Only mechanical prophylaxis was given.

Patient will be made to sit on 2nd post-op day, active quadriceps exercise started Partial weight bearing started as the wound reaction and patient acceptance improves around one week Full weight bearing depend son radiological evidence of union of fracture and acceptance of the patient

Follow up at 1, 3 and 6 months was done when the patient was evaluated clinically with harris hip score and radiologically with X rays.

25 patients operated with extramedullary implant and 25 patients operated with intramedullary implant were included in this study

Inclusion criteria: patients with Age >18 years; Radiological finding confirming Unstable intertrochantric femur fracture AO/OTA 31A2;31A3; Patients who are Medically fit and willing for surgery were included in the study.

Exclusion criteria: patients with age <18 years; Old neglected nonunion; Pathological fractures; History of surgery in same limb; Patient medically unfit for surgery not willing for surgery; lower limb injuries on ipsilateral side are not included.

Results

In 50 consecutive patients suffering from unstable intertrochanteric fracture 25 were treated with DHS with trochanteric stabilization plate and 25 were treated with proximal femoral nailing. AO/OTA classification system used for patient selection. We included AO31A2 and A3 fractures in our study.

Age distribution

Table 1: Overview of gender distribution, age and fracture type of patients treated with intramedullary and extramedullary implants. Youngest patient was 52 years old and oldest patient was 76 years old.

	Extra-medullary implant group DHS + TSP	Intramedullary implant group PFN
Total	25	25
Mean age	63.52	63.4
Male	17	18
Female	8	7
Fracture type (AO/OTA)		
31A2	17	18
31A3	8	7

Table 2: Age distribution. All patients in the study were between 51-80 years

AGE (years)	Intra medullary implant	Percent	Extra medullary implant	Percent
51-55	0	0%	2	8%
56-60	9	36%	8	32%
61-65	8	32%	6	24%
66-70	6	24%	6	24%
71-75	2	8%	2	8%
76-80	0	0%	1	4%

Gender distribution

Table 3: Gender distribution. Majority of the patients were Male ~70%. However, there is no association between DHS and PFN with gender of the patient

	Male	Percent	Female	Percent	P value
Intra medullary implant	18	72%	7	28%	0.5
Extra medullary implant	17	68%	8	68%	
Total= 50	35	70%	15	70%	

Mode of injury

Table 4: Mode of injury. Majority of the patients had self-fall as the mode of injury. However there is no association between DHS+TSP and PFN with the mode of injury.

Mode of injury	DHS+TSP (Extra-medullary implant group)	PFN (Intramedullary implant group)	Percent	P value
Self-fall	22	19	82%	0.23
Road traffic accident	3	6	18%	

Side of involvement

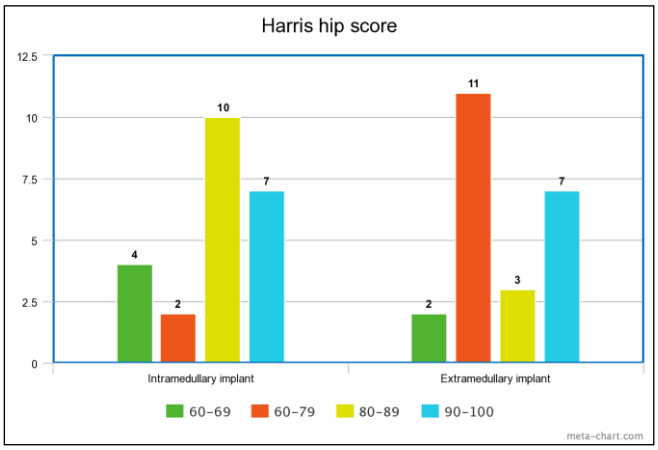
Table 5: Side of involvement: There is almost an equal number of patients in each group with respect to the side of limb involved. Right limb involved in 48 % while left limb involved in 52% cases. There is no association between the side of involvement and the choice of implant

	Right	Left	P value
Intra medullary implant	12 (48%)	13 (52%)	0.61
Extra medullary implant	12 (48%)	13 (52%)	
Total	24 (48%)	26 (52%)	

Comorbidities

Table 6: Comorbidities. 46.7% patients in intramedullary implant group suffered from comorbidities. While 40% of the patients in extramedullary implant group suffered Functional outcome by Harris hip score

	CAD	HTN	DM
Intra medullary implant	2	5	7
Extra medullary implant	0	6	4



Score	Grade
90-100	Excellent
80-89	Good
70-79	Fair
60-69	Poor

Table 7: Harris Hip Score. 7 patients in each group reported excellent Harris hip score. 10 patients from intramedullary implant group and 3 from extra medullary implant group reported good score

Harris hip score	PFN Group (Intramedullary implant group)	Percentage	DHS+TSP group (Extra medullary implant group)	Percentage
90-100	7	30.43%	7	30.43%
80-89	10	43.47%	3	14.28%
70-79	2	9.52%	11	52.38%
60-69	4	19.04%	2	9.52%
Total	23		23	

P value for 2x4 contingency table is 0.013 which suggests a significant association in functional outcome and the choice of implant

Wound complications

2 patients in DHS and 2 patients in PFN had superficial wound infection. These patients were diabetic. The infection controlled with continuation of intravenous antibiotics and regular wound dressings.

Due to varus collapse 2 patients operated with Extra medullary as well as intramedullary implant had shortening of <1 cm. 1 patient in each group had persistent hip pain and 1 patient in each group had persistent thigh pain. Pain was relieved after radiological union. 2 patients had screw cut out in both groups.

Table 8a: Complications in Extra medullary implant group

Serial number	Complication	Extra medullary implant	Percentage
1	Superficial wound infection	2	8.69%
2	Varus collapse with shortening >1cm	2	8.69%
3	Peri implant fracture	1	4.43%
4	Persistent thigh pain	1	4.43%
5	Persistent hip pain	1	4.43%
6	Screw cut out	0	0

Table 8b: Complications in PFN (Intramedullary implant group)

Serial number	Complication	Intra medullary implant n=23	Percentage
1	Superficial wound infection	2	8.69%
2	Varus collapse with shortening >1cm	2	8.69%
3	Peri implant fracture	1	4.43%
4	Persistent thigh pain	2	4.43%
5	Persistent hip pain	1	4.43%
6	Screw cut out	1	4.43%

Table 9: In 1 patient treated with PFN, proximal screw cutout occurred. Proximal screw of size 85 replaced was with 75. Richard screw at calcar was intact

	DHS+TSP (Extra medullary implant group)	PFN (Intramedullary implant group)	P value
Screw cutout	0	1	0.5
No screw cutout	25	24	

Table 10: In extra medullary implant group 48% patients had positive medial cortex support, 36% had neutral reduction, 16% had negative media cortex support. In intramedullary implant group, 44% had positive medial cortex support and neutral reduction, 12% had negative medial cortex support.

	DHS+TSP(Extra medullary implant group)	Percentage	PFN (Intramedullary implant group)	Percentage
Positive medial cortex support	12	48%	11	44%
Neutral reduction	9	36%	11	44%
Negative medial cortex support	4	16%	3	12%

Neck shaft angle

Table 11: There is no association between varus collapse and the type of implant used

Neck shaft angle	No Varus	Varus angle <125*	Total	P value
Intra medullary implant	23	2	25	0.69
Extra medullary implant	23	2	25	
Total	46	4	50	

Table 12: P value for 2x4 contingency table is 0.013 which suggests a significant association in functional outcome and the choice of implant

Harris hip function score	Number	Mean Pre op	Mean Post op	Standard deviation σ	Standard error (95%)
Intra medullary implant	25	75.3	81.8	9.41	3.68
Extra medullary implant	25	74.9	79.28	9.24	3.62

Table 13: All patients in intramedullary implant group had blood loss less than 100 ml there is a significant difference between the blood loss in intramedullary implant vs extra medullary implant

Blood loss (ml)	Intra medullary implant	Percent	Extra medullary implant	Percent	P value
0-50	6	24%	0	0	0.0001
51-100	19	76%	0	0	
101-150	0	0	4	16%	
151-200	0	0	21	84%	

Table 14: Duration of surgery for intramedullary implants is on an average of 58 minutes while it is around 85 minutes for extra medullary implants. There is a significant difference between the type of implant used (intramedullary vs extra medullary) and the duration of surgery.

Duration of surgery (minutes)	Intra medullary implant	Extra medullary implant	P value
<1 Hour	25	0	0.0001
1-2 hours	0	25	
Total	25	25	

Table 15: Time of Radiological union Mean duration of radiological union is 9.04 weeks for PFN and 9.36 for DHS P value calculated using 2x3 contingency table is 0.99 which shows that there is no significant association between the choice of implant and time of radiological union

Time of Radiological union	PFN (Intramedullary implant group)	DHS (Extra medullary implant group)	Percentage
1-6 weeks	8 (32%)	7 (28%)	30%
7-12 weeks	14 (56%)	15 (16%)	58%
13-18 weeks	3 (12%)	3 (12%)	12%
Mean duration weeks	9.04	9.36	

Discussion

Intertrochanteric femoral fractures contribute to more than half of total hip fractures in elderly osteoporotic patients ageing over 60 years. With increasing life expectancy due to advancements in medical care, the incidence of intertrochanteric fractures are also increasing. Fall from standing height is the most common mode of injury in these patients. Diminished vision, reduced reflexes, poor muscle tone and balance also contribute to the increased incidence in elderly.

Various modalities of treatments are available which include dynamic hip screw, cephalomedullary nail, dynamic condylar screw, cemented hemiarthroplasty with or without augmented calcar reconstruction, proximal femoral locking plate and trochanteric stabilization plate.

The ultimate goal of the treatment being early mobilization of the patients preventing the complications of fracture disease.

Sliding hip screw is still most widely used implant for these cases. But in unstable fractures due to posteromedial and lateral wall communition it has the disadvantage of recurring varus collapse and screw cut out. It also has a disadvantage of having only a single point fixation in head and neck.

Table 16: Comparison between DHE and PFN

DHS with TSP (Extramedullary implant)	PFN (Intramedullary implant)
Easy learning curve.	Less operating time and minimal blood loss.
Two point fixation leading to increased rotation stability	Increased rotation stability and less chances of screw cut out in osteoporotic head
Lateral buttress effect	Load sharing device.
Controlled impaction in unstable Intertrochanteric fractures	Shortened lever arm there by less deforming forces at the fracture site.
Prevents excessive collapse and shortening.	Prevents excessive varus collapse and neck shortening

Our study was conducted in Govt. Medical College & New Civil Hospital, Surat. 50 consecutive patients of unstable intertrochanteric fractures were treated with DHS with TSP (Extramedullary implant) and PFN (Intramedullary implant) in equal numbers by random sampling the fractures were classified according to AO/OTA classification and fractures of AO type 31A2 to 31A3 were included in our study.

All patients were followed up at least for a period of 6 months and were assessed for clinical, radiological and functional outcome. We compared the results of our study with 3 other studies: Chun wei *et al.* 2020 [18]; J Pajarinen *et al.* 2005 [19]; Rudolf *et al.* 2015 [20]

Table 17: Mean operative time

Studies	Mean operative time PFN (Intramedullary implant group)	Mean operative time DHS+TSP (Extra medullary implant group)
Chun wei *et al.*	84	96.4
Rudolf *et al.*	81	86
J. Pajarinen *et al.*	45	55
Our study	85	57.62

The results were analyzed and observations of our study are as follows,

Age: Most of patients in our study were in the age of >60 years of age, which is lesser compared to other studies.

Gender: In DHS with TSP (Extra medullary implant) group we had 17 male and 8 female patients. In PFN (Intramedullary implant) group 18 male and 7 female patients.

In study of 358 cases by Chun wei *et al.* 232 were female and 126 were male.

In study of 240 cases by Rudolf *et al.* 116 were female and 88 were male. In study of 108 cases by J pajarinen *et al.* 81 were female and 27 were male

Mode of injury: Fall from standing height (trivial fall) was most common mode of injury which is similar to other studies.

Type of fracture: In DHS with TSP (Extramedullary implant group) 17 patients AO type 31A2, 8 patients were AO type 31A3. In PFN (Intramedullary implant) group 18 patients were AO type 31A2, 7 patients were AO type 31A3.

Side of fracture: In DHS with TSP (Extramedullary implant) group 12 patients had right and 13 patients had left side fracture. In PFN (Intramedullary implant) group had 12 right and 13 patients had left side fracture. Studies conducted by Chun wei *et al.*, Rudolf *et al.*, J Pajarinen *et al.* have not considered the side of the limb involved

Comorbidities: In DHS with TSP (Extramedullary implant) group 4 patients had type 2 Diabetes Mellitus, 6 patients were suffering from systemic hypertension, In PFN (Intramedullary implant) group 7 patients had type 2 Diabetes Mellitus 5 patients were suffering from systemic hypertension. 2 patients were known cases of Coronary Artery Disease

All patients had good pretrauma mobility and were ambulating independently unassisted.

Mean operating time: In DHS with TSP (Extramedullary implant) group was 85 minutes and in PFN (Intramedullary implant) was 57.62 minutes.

In study of 358 cases by Chun wei *et al.* mean blood loss was 230 ml for DHS and 130 ml for PFN.

In study of 108 cases by J pajarinen *et al.* mean blood loss was 357 ml for DHS and 320 ml for PFN.

In our study Mean blood loss in DHS with TSP (Extramedullary implant) group 169.6 ml and in PFN (Intramedullary implant) group was 59.92 ml which suggests a significant association between blood loss and type of implant used.

On 3rd postoperative day partial weight bearing was allowed on the basis of construct stability and bone quality.

In study of 108 cases by J pajarinen *et al.* patients who were treated with PFN regained their pre-operative walking ability at four months, significantly more often than those treated with DHS

Chun wei *et al.* concluded that DHS+TSP were not inferior to PFN in patients with unstable intertochanteric femur fractures

Rudolf *et al.* concluded that irrespective of the implant, there is no significant difference in the clinical and functional outcome

On basis of Harris Hip Score the functional outcome of all patients were assessed: In DHS with TSP (Extramedullary implant) group we had 7 excellent results, 3 good results and 13 fair & 2 poor results. In PFN (Intramedullary implant) group we had 7 excellent results, 12 good results, 2 fair and 4 poor result.

Complications: In study of 108 cases by J pajarinen *et al.* five complications were observed during follow up of four months. There were two cases of displacement of fractures in both groups DHS and PFN. One case of heterotropic ossification. There were no superficial or deep wound infections or deep vein thrombosis observed.

In Study by Rudolf *et al.* two cases of DHS failure were noted due to screw cut out. No wound infections or complications were noted

In our study 2 patients in DHS and 2 patients in PFN had superficial wound infection. These patients were diabetic. The infection controlled with continuation of intravenous antibiotics and regular wound dressings.

Due to varus collapse 2 patients operated with Extra medullary as well as intramedullary implant had shortening of <1 cm. 1 patient in each group had persistent hip pain and 1 patient in each group had persistent thigh pain. Pain was relieved after

radiological union. 1 patient had screw cut out in PFN group 3 Patients were lost to follow up. 1 patient died due to underlying comorbidity (CAD) and 1 patient died within 4 months of operation, cause of which was unknown.

There are several Limitations of this study

We had a Short duration of follow up and a small sample size. Also we had different operating surgeons for both groups and the choice of implant was based on surgeon's preference. The study was not randomized.

Conclusion

In conclusion, as the current literature regarding intertrochanteric femur fracture treatment does not clearly favour one implant over another [21]

To best of our knowledge, this is one of the few studies done to compare outcome of treating unstable Intertrochanteric femur fracture (AO31A2, 31A3) with intramedullary or intramedullary fixation.

In this study we found that both intramedullary and intramedullary fixation were able to provide good clinical result for unstable Intertrochanteric femur fracture.

We conclude that there is statistically significant difference between patients operated with DHS with TSP (Extramedullary implant) and Proximal Femoral Nail (Intramedullary implant) in terms of Blood loss, Mean operative time and functional outcome.

Harris hip score in patients treated with PFN had better Harris hip score at final follow up which was statistically significant.

All patients in both groups had bony union at final follow up.

Blood loss and duration of surgery was significantly less with intramedullary Implant.

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