RESEARCH ARTICLE

Comparison of proximal femoral nail (PFN) and dynamic hip screw (DHS) for the treatment of AO type A2 and A3 pertrochanteric fractures of femur

Khaqan Adeel, Rana Dilawaiz Nadeem, Muhammad Akhtar, Ranjit Kumar Sah, Iftikhar Mohy-Ud-Din

Abstract

Objective: To compare the dynamic hip screw with proximal femoral nail for the treatment of Arbeitsgemeinschaft für Osteosynthesefragen type A2 and A3 per-trochanteric fractures of femur.

Methods: The randomised controlled single-blind study was conducted at the Mayo Hospital, Lahore, Pakistan, from September 2015 to September 2017, and comprised patients aged 40-75 years with Arbeitsgemeinschaft für Osteosynthesefragen type A2 and A3 per-trochanteric fracture. The patients randomised into two equal groups. In Group A, patients were treated by closed reduction and internal fixation with dynamic hip screw, while those in Group B were treated by closed reduction and internal fixation by proximal femoral nail. Follow-up was done at 2nd, 6th and 12th weeks, and at 6th, 9th and 12th month post-operatively. Variables evaluated were frequency of union, surgical time, approximate amount of blood loss and complications. The functional assessment was done by using Harris hip score. SPSS 20 was used for data analysis.

Results: Of the 68 patients, there were 34(50%) in each group. The mean age of patients in Group A was 60.88±12.49 years and in Group B it was 59.32±2.39 years. The mean surgery time in Group A was 58.71±7.84 minutes and in Group B 35.35±5.48 minutes ($p<0.05$). Mean blood loss was 273.82±30.0ml and 149.79±21.3ml in Group A and B respectively ($p<0.05$). The mean Harris hip score after 12 months in Groups A and B were 81.83±23.01 and 87.62±17.28 respectively. Infection was seen in 2(5.9%) patients in Group A and 1(2.9%) in Group B.

Conclusion: Proximal femoral nail provided equivalent functional outcome compared to dynamic hip screw with lesser blood loss and surgical time.

Keywords: Per-trochanteric fractures, Dynamic hip screw, Proximal femoral nail, Harris hip score, Blood loss, Surgical time. (JPMA 70: 815; 2020). **https://doi.org/10.5455/JPMA.295426**

Introduction

Per-trochanteric femur fractures are increasingly prevalent as the population continues to age. Despite advancement in patient care and operative technique, hip fractures pose a huge economic burden and social impact on healthcare systems because of long hospitalisation, increased dependence, co-morbidity and mortality.[1,2]

Per-trochanteric fractures occur as a consequence of trauma by high energy force (as in younger individuals) or spontaneous falls (as in advanced-age females).[3,4] The aetiology of low-energy per-trochanteric fracture is a combination of factors that include increased bone fragility of the per-trochanteric area of the femur.[1]

The fragility of bone is increased due to osteoporosis caused by decreased physical activity and osteomalacia secondary to decreased hormone levels, increased levels of demineralising hormones, reduced intake of calcium and vitamin D, and other aging processes. Benign and malignant tumours, and metastasis can also lead to weakened bony structure. Pert-trochanteric fractures are mostly classified into stable and unstable types. Arbeitsgemeinschaft für Osteosynthesefragen (AO) classification system is the most commonly used for the classification of these fractures. This system divides pert-trochanteric fractures into type A1 stable trochanteric), A2 unstable trochanteric and A3 fractures at the lesser trochanter and sub-trochanteric level.[1] A3 hip fractures account for 2.2% of such fractures and 5.3% of per-trochanteric fractures.[6]

Department of Orthopaedic Surgery and Traumatology, King Edward Medical University, Lahore, Pakistan.
Correspondence: Khaqan Adeel. e-mail: dr_khaqan@hotmail.com

The various treatment options for per-trochanteric fractures include operative and non-operative methods. Conservative treatment for these types of fractures, with prolonged bed rest and traction, has been associated with varus deformity and shortening, along with the general complications associated with prolonged immobilization.[7]

Operative treatment is now the treatment of choice for all trochanteric fracture due to the advantage of early rehabilitation and mobilisation. Dynamic hip screw (DHS) and side plate, for a long time, is the gold standard modality for fixation which allows the proximal fracture fragment to settle on the fixation device, thus acquiring its own stable position, with the shaft usually displacing medially.[8] Failure of fixation in up to 20% of cases are associated with "screw cut through", plate coming out from the shaft, failure of implant and lag screw penetrating the hip joint.[8] Excessive collapse leading to shortening of the limb also occurs with DHS. An intramedullary device (IMD) has some advantages over extra-medullary devices (EMD) theoretically as there is no need to fix the plate to shaft with screws, which can be difficult in osteoporotic bones. In addition, shaft fixation is nearer to the centre of rotation of hip, as the load transmitted to the femur along with a more medial axis, has a shorter moment arm.[7,9] Per-trochanteric A2 and A3 fractures can be treated with either proximal femoral nail (PFN) or DHS.[7]

In literature there is continuous controversy over the advantage of one technique over the other.[1,6]

There is much confusion about when to use IM nails and when load-bearing implants in trochanteric fractures according to fracture comminution and instability.[7] Overall, DHS has some advantages over the PFN, while the results of PFN are better intraoperatively and post-operatively, has less complications, reduced number of dislocations and pain, while chances of early mobilisation are increased.[1,7]

The current study was planned to add to the literature by comparing DHS with PFN for the treatment of AO types A2 and A3 per-trochanteric fractures of femur.

Patients ad Methods

This randomized controlled trial single blinded study was conducted at the Department of Orthopaedic Surgery and Traumatology, Unit-II, Mayo Hospital, Lahore, Pakistan, from September 2015 to September 2017, and comprised patients with AO types A2 and A3 per-trochanteric fractures of femur. After approval from the institutional ethics review board the sample size was calculated using 90% confidence level, 90% power of test and taking the mean Harris hip score (HSS) at 6th month in line with literature (Annexure).[10] patients were randomly divided in two groups Those included were aged 40-75 years presenting with AO type A2 and A3 per-trochanteric fracture femur diagnosed on history, clinical examination and radiograph. Those excluded were patients with anaesthesia risk, pathological fracture, previous surgical intervention on the affected hip and metabolic bone disease diagnosed on history, clinical examination, baseline investigations, electrocardiogram and radiograph. Written informed consent was obtained from all the patient and/or attendants.

All patients were operated by a single surgical team under general anaesthesia (GA) or spinal anaesthesia (SA) while ensuring strict aseptic conditions. Patients were randomly divided in two groups using random allocation number. Randomization was done on the basis of type of implants i.e. dynamic hip screw (DHS) and proximal femoral nail (PFN). In Group A, patients were treated by DHS, and those in Group B were treated by PFN.

For PFN, the nail diameter was determined by measuring diameter of the femur at the level of isthmus on an antero-posterior (AP) X-ray. The neck shaft angle was measured on the unaffected side on AP X-ray using goniometer and a standard length PFN was used. For DHS, the length of compression screw was measured from the tip of the head to the base of the greater trochanter on AP view X-ray subtracting magnification. The neck shaft angle was determined using goniometer on X-ray AP view on the unaffected side and the length of side plate was determined to allow purchase of at

ANNEXURE: Sample size.

Sample size determination in health studies. Total 68 patients were taken in the study (34 in each group) by using 90% confidence level, 90% power of test and by using mean Harris Hip Score at 6th month post operatively with PFN and DHS as 82.8±5.13[3] and 78.8± 7.66.[3]

$$n = \frac{2\sigma^2 (\dot{z}_{1-\alpha} + \dot{z}_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

σ^2 = variance

$\dot{z}_{1-\alpha}$ = confidence level 90%

$\dot{z}_{1-\beta}$ = power of test 90%

μ_1 = population mean I=82.8

μ_2 = population mean II=78.8

least 8 cortices to the shaft distal to the fracture. Pre-operative antibiotic injection ceftriaxone 1gm was given half-an-hour before the surgery and was continued 2gm 24 hourly for three post-operative days. All cases were operated under image intensifier with close reduction internal fixation with (CRIF DHS) in Group A and CRIF PFN in Group B. All drains were removed by 24 hours post-operatively. The wounds were inspected on the 3rd and 6th post-operative day (POD). Stitch was removed on the 14th POD in the out-patient department (OPD). Patients were encouraged to take up ankle and calf exercises from day one and were mobilised non-weight-bearing from the second POD depending upon the physical condition of the patient.

Follow-up was done at 2nd, 6th and 12th week, and 6th, 9th and 12th month post-operatively. The primary outcome variable was taken as union, and the secondary outcome was taken as the operation time, approximate amount of blood loss and complications like infection, non-union, malunion and implant failure. Post-operatively, functional outcome was assessed using HHS and the outcome was graded as excellent, good, fair and poor.

Data was analysed using SPSS 20. Quantitative data like age was described with mean and standard deviation (SD). Qualitative variables like gender, presentation and outcome was described as frequencies and percentages. Comparison of DHS and PFN was done using chi-square test. Independent sample t-test was applied to compare mean or median scores between the groups. P?0.05 was considered statistically significant

Results

Of the 68 patients, there were 34(50%) in each of the two groups. Overall, there were 47(69.1%) males and 21(30.9%) females. Also, there were 32(47.06%) AO type A2 and 36(52.94%) type A3 fractures (Table 1).

Table-1: Demographic data of the gender and fracture type.

Variables	Group A n(%)	Group B n(%)	Total (n=68) (%)
Gender of the patients			
Male	22(64.71)	25(73.53)	47 (69.1)
Female	12(35.29)	9(26.47)	21 (30.9)
AO Fracture Type			
A2	15 (46.88)	17 (47.22)	32 (47.1)
A3	17 (53.13)	19 (52.78)	36 (52.9)

Table-2: Demographic data of the gender and fracture type.

Variables	Group-A	Group-B	*p*-value
Mean age of the patients (Year)	60.88±12.49	59.32±2.39	<0.05
Mean duration of Surgery (Minutes)	58.71±7.84	35.35±5.48	<0.05
Mean Blood Loss (ml)	273.82±30.0	149.79±21.3	<005
Mean Harris Hip Score	81.83±23.01	87.62±17.28	<0.05

Table-3: Independent samples t-test of Harris Hip score in both groups.

Harris Hip score		Study groups		Total (n=68) (%)	*p*-value
		Group A (n=34) (%)	Group B (n=34) (%)		
Harris Hip Score (12 months)	Poor (<70)	8 (23.5%)	3(8.8%)	11(16.2%)	
	Fair (70-79)	0 (0%)	2(5.9%)	2(2.9%)	
	Good (80-89)	1(2.9%)	1(2.9%)	2(2.9%)	=0.217
	Excellent (90-100)	25(73.5%)	28(82.4%)	53(77.9%)	
Total		34(100%)	34(100%)	68(100%)	

In Group A, the mean age of the patients was 60.88±12.49 years, while it was 59.32±2.39 years in Group B (p>0.05). Mean surgery time and mean blood loss were significantly lower in Group B (p<0.05). Mean HHS after 12 months in Group A was 81.83±23.01 and in Group B it was 87.62±17.28 (Table 2).

HHS significantly improved in Group B throughout the follow-up (p<0.05) except after 12 months when no significant difference between the groups (p>0.05). In Group A, 8(23.5%) cases had poor, 1(2.9%) had good and 25(73.5%) had excellent HHS, while in Group B, 3(8.8%) cases had poor, 1(2.9%) had good and 28(82.4%) had excellent HHS (p=0.217) (Table 3).

Union was achieved in 28(82.4%) case in Group A, and in 31(91.2%) cases in Group B (p=0.283). There was non-union in 6(17.6%) cases in Group A and 3(8.8%) cases in Group B (p=0.283).

In terms of complications, there were 2(5.9%) cases of superficial infection in Group A and 1(2.9%) case in Group B (p =0.55). They were managed with dressing and intravenous (IV) antibiotics according to culture and sensitivity till the infection was settled. Also, there was implant failure in 6(17.6%) Group A cases and 3(8.8%) Group B cases (p=0.283).

Discussion

Per-trochanteric fractures are one of the most commonly encountered fractures in clinical practice and can account for nearly 40% of admissions in most orthopaedic wards. These fractures occur predominantly in people >60 years of age and are 3-4 times more common in women than

in men(10). In the current study, the mean age of patients matched the literature, but there were more than twice as many males 47(69.1%) as females 21(30.9%).

Per-trochanteric fractures of the proximal femur should be treated surgically, unless the medical condition of the patient does not allow it. Currently, there are two ways to fix these fractures; either with a sliding hip screw or with an IM nail.[11] However, there is much debate over which implant is the best for per-trochanteric fracture fixation. The sliding hip screw has been used over time with good clinical results. While it was true that with first generation IM nails the risk of complications was higher, there is evidence supporting the superiority of IM nails in these fractures when compared with the sliding hip screw.[11]

A recent study reported that surgery time was significantly lower in the PFN group than the DHS group ($p<0.05$).[12] A meta-analysis on 5 randomised controlled trials (RCTs) also reported that there was less blood loss ($p< 0.0001$) in the PFN group compared to the DHS group.[13] Muzzafar et al., in their study of 80 patients, found that the DHS group required a longer operative time and was associated with greater blood loss than the PFN group, but there was no significant difference in functional outcome.[14] The findings are consistent with our series.

In a study, 90(37.5%) patients in DHS group and 106(66.2%) in PFN group showed excellent HHS result; good results in 130(54.1%) DHS patients and 46(28.2%) PFN patients ; fair results in 16(6.6%) DHS and 8(5%) PFN patients; poor results in 4(1.6%) DHS patients and none in PFN group.[15] In the current study, 8(23.5%) cases had poor, 1(2.9%) had good and 25(73.5%) had excellent HHS in Group A, while in Group B, 3(8.8%) cases had poor, 1(2.9%) had good and 28(82.4%) had excellent HHS.

Sahin et al. reported mean HHS of 77.8 in cases managed with PFN.[16] Mean HHHS in the PFN group in the current study was 87.62.

Similarly, mean HHS at six months was 62 in cases managed with DHS[17] which is lower than the mean HHS of cases managed with DHS in the current study. This is probably due to one-year follow-up in our study.

In a study, infections was observed in 13.72% PFN patients and 30.91% DHS patients.[18] In the current study, 6 weeks after the procedure, 2(5.9%) patients in the DHS group and 1(2.9%) in the PFN group developed infection ($p>0.05$). At 12th week, infection was reported in 2(5.9%) patients in the DHS group and 1(2.9%) in the PFN group ($p>0.05$).

Post-operative complications were reported by a study to be more common in the DHS group (30% showed complications) with 2 patients having a lag screw cut out, and one having varus hip deformity whereas 2 patients had wound infections. In the PFN group, only 1 patient had urinary tract infection (UTI) (not related to the procedure) which was adequately treated; the study favoured PFN over DHS.[12]

In the current study, at 12 months, implant failure was seen in 6(17.6%) and 3(8.8%) patients of Group A and Group B ($p= 0.283$). In the long term, both the implants have almost similar functional outcomes.[19]

The proponents of either technique should consider not just the fracture pattern on X-ray, but also the clinical condition of the patient. As different studies show less surgical time and less amount of blood loss in PFN group, this implant may be used in patients who carry high risk with longer anaesthesia.

However, further large-scale RCTS with longer follow-ups are required to confirm the advantages of PFN over DHS. Another limitation of the study was lack of international randomized controlled trial number, however approval of the advanced study research board of the university was obtained.

Conclusion

Though the functional outcomes are comparable, however PFN provides less blood loss, short surgical time and earlier recovery and mobility compared to DHS.

Disclaimer: None.
Conflict of Interest: None.
Source of Funding: None.

References

1. Avakian Z, Shiraev T, Lam L, Hope N. Dynamic hip screws versus proximal femoral nails for intertrochanteric fractures. ANZ J Surg 2012; 82: 56-9.
2. Bhakat U, Bandyopadhayay R. Comparitive Study between Proximal Femoral Nailing and Dynamic Hip Screw in Intertrochanteric Fracture of Femur. Open J Orthop 2013; 3: 291.
3. Evans PJ, McGrory BJ. Fractures of the proximal femur. Hospital Physician 2002; 38: 30-8.

4. Chen PH, Wu CC, Tseng YC, Fan KF, Lee PC, Chen WJ. Comparison of elderly patients with and without intertrochanteric fractures and the factors affecting fracture severity. Formosan J Musculoskeletal Disord 2012; 3: 61-5.
5. Brinker MR. Review of orthopaedic trauma. Pheldelphia: Lippincott Williams & Wilkins; 2013.
6. Luo F, Shen J, Xu J, Dong S, Huang Q, Xie Z. Treatment of AO/OTA 31-A3 intertrochanteric femoral fractures with a percutaneous compression plate. Clinics 2014; 69: 1-7.
7. Nargesh A, Ashok T, Muhammad S, Mehra A. Comparative study of the management of inter-trochanteric fractures in the elderly: short proximal femoral nail vs dynamic hip screw. Sri Lanka J Surg 2013; 30:13-7.
8. Kumar A. Femoral Neck Geometry and rationale of Placement of the Proximal Femoral Nail and its relation with fracture risk in the Indian Population A Review of 120 Cases. 2011. [Online] [Cited 2018 May 15]. Available from: URL: https://pdfs.semanticscholar.org/d590/62de3192a769ad51a610e5c42c20415960e0.pdf?_ga=2.90577050.1054227188.1576551245-2051051850.1548636294.
9. Zhang S, Zhang K, Jia Y, Yu B, Feng W. InterTan nail versus Proximal Femoral Nail Antirotation-Asia in the treatment of unstable trochanteric fractures. Orthopedics 2013; 36: e288-94.
10. Laros G. Intratrochanteric fractures. Afr J Trauma 1983; 2: 1.
11. Ponce S, Laird M, Waddell J. Intramedullary nailing in pertrochanteric fractures of the proximal femur. Eur J Trauma Emerg Surg 2014; 40: 241-7.
12. Sharma H, Loomba DS. Comparison of outcome of management of unstable pertrochanteric femoral fractures with dynamic hip screw and proximal femoral nail. African J Trauma 2015; 4: 21-6.
13. Shen L, Zhang Y, Shen Y, Cui Z. Antirotation proximal femoral nail versus dynamic hip screw for intertrochanteric fractures: a meta-analysis of randomized controlled studies. Orthop Traumatol 2013; 99: 377-83.
14. Muzaffar N, Malik A, Shikari A. A Comparison Between Proximal Femoral Nail And Locking Compression Plate-Dynamic Hip Screw Devices In Unstable Intertrochanteric Fractures-Which Is Better? J Orthop 2013; 5: 11
15. Gupta SV, Valisetti VS. Comparative study between dynamic hip screw vs proximal femoral nailing in inter-trochanteric fractures of the femur in adults. Int J Orthop 2015; 1: 7-11.
16. Sahin S, Ertürer E, Oztürk I, Toker S, Seckin F, Akman S. Radiographic and functional results of osteosynthesis using the proximal femoral nail antirotation (PFNA) in the treatment of unstable intertrochanteric femoral fractures. Acta Orthop Traumatol Turc 2010; 44: 127-34.
17. Moroni A, Faldini C, Pegreffi F, Hoang-Kim A, Vannini F, Giannini S. Dynamic hip screw compared with external fixation for treatment of osteoporotic pertrochanteric fractures: A prospective, randomized study. J Bone Joint Surg Am 2005; 87: 753-9.
18. Xu Y, Geng D, Mao H, Zhu X, Yang H. A comparison of the proximal femoral nail antirotation device and dynamic hip screw in the treatment of unstable pertrochanteric fracture. J Int Med Res 2010; 38: 1266-75.
19. Kumar R, Singh R, Singh B. Comparative prospective study of proximal femoral nail and dynamic hip screw in treatment of intertrochanteric fracture femur. J Clin Orthop Trauma 2012; 3: 28-36.