International Journal of Research in Orthopaedics
Abushahot MA et al. Int J Res Orthop. 2024 Sep;10(5):908-913
http://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20242381

Thin lateral wall cortex intertrochanteric proximal femur fractures: a comparative study between past and present

Mohammad Ahmad Abushahot, Fadi Mohammad Rosan, Naser Fuad Shari*, Laith Mohammad Alhseinat, Ala Khaled Al-Qudah

Department of Orthopaedics, Royal Medical Services, Jordan

Received: 11 July 2024
Revised: 07 August 2024
Accepted: 13 August 2024

***Correspondence:**
Dr. Naser Fuad Shari,
E-mail: naser.shari@yahoo.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: There has been a growing recognition of the significance of preserving the integrity of the lateral wall of the proximal femur, in addition to the previously emphasized importance of the posteromedial portion in predicting fracture stability. Consequently, this study aimed to compare the outcomes of various fixation methods employed in treating intertrochanteric proximal femur fractures with a thin lateral wall.
Methods: This retrospective study assessed 225 cases of treated intertrochanteric fractures with a thin lateral cortex, examining radiological outcomes at different follow-up intervals to evaluate the efficacy of different treatments. The study compared Dynamic Hip Screw (DHS), Dynamic Condylar Screw (DCS), and Proximal Femoral Nail (PFN) in terms of healing, mortality, and complications.
Results: The average age of patients was 79.75 years, with 61.3% having comorbidities. The three treatment modalities showed similar healing times, revision rates, and mortality rates. The one-year mortality rate stood at 26%. PFN consistently maintained a favorable position during follow-up assessments. While DHS initially exhibited excellent reduction on postoperative X-rays, less than half of the fractures maintained acceptable reduction during the first follow-up due to shaft medialization (32%) and varus collapse (24%). DHS treatment was also frequently associated with nonunion, with intraoperative lateral wall fractures occurring in 15.4% of cases. DCS was found to be the least effective treatment, being commonly associated with varus collapse.
Conclusions: In treating intertrochanteric fractures with a thin lateral wall component, PFN demonstrated superior outcomes in terms of reduction and lower complication rates compared to other fixation methods. Therefore, PFN should be the preferred choice, while DHS and DCS should be avoided for this fracture pattern.

Keywords: DCS, DHS, PFN, Shaft medialization, Thin lateral wall cortex, Varus collapse

INTRODUCTION

Traditionally, orthopedic surgeons used to focus on Calcar involvement (posteromedial portion of the proximal femur) being the most alarming prognostic indicator for fracture stability.[1-6] Recently, all the concern has been changed towards identifying the significance of integrity of lateral wall, and how implant selection is important to have much better outcomes.[7-11] Therefore, understanding various fracture patterns is critical in order to select the appropriate surgical technique and implant applied.

How to assess lateral femoral wall thickness?

It is commonly measured through an AP radiograph, through drawing a line from the greater trochanter's innominate tubercle on the lateral aspect of the proximal femur, making an angle at 135° going toward fracture line.

Thickness less than 20.5 mm is defined as thin lateral wall.[12,13]

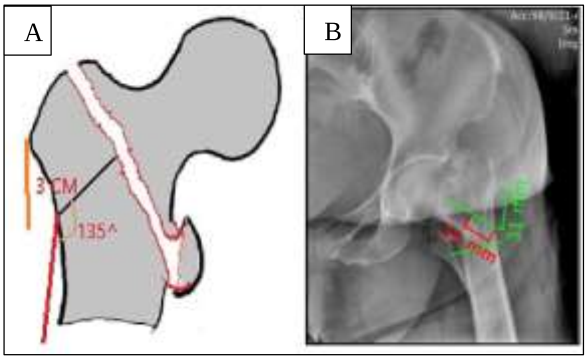

Figure 1: Measuring lateral wall thickness. A) A line extends from the innominate tubercle of the greater trochanter, angled at 135° going cephalic towards fracture on an AP x-ray. The distance between the lateral wall and fracture line is the lateral wall thickness. A measurement less than 20.5 mm indicates a fracture with a thin lateral wall. B) Presents an actual x-ray image of the left hip with thin lateral cortex.[1,9]

The aim of this study was to retrospectively review 225 cases of treated thin lateral wall intertrochanteric fractures to assess outcomes associated with different implant choices and compare various surgical options in terms of complications and healing time. The findings will tailor the surgical decision regarding fracture fixation techniques and best implant to choose then.

METHODS

This is a retrospective study performed through clinical and radiological evaluation for patients' records, emphasizing on patients managed for thin lateral wall cortex intertrochanteric proximal femur fractures between January 2017 and December 2023. Data analysis was performed through retrospective review of patients records managed in military hospitals within the Royal Medical Services in Jordan (Royal rehabilitation center-King Hussein Medical City and Queen Alia Military Hospital). Out of 974 intertrochanteric fractures evaluated, 300 were classified as thin lateral cortex pattern. Inclusion criteria include isolated intertrochanteric femur fractures with thin lateral wall cortex managed by fixation techniques either (PFN, DHS or DCS). Exclusion criteria include insufficiency and pathological fractures, stress fractures, fractures managed by hemiarthroplasty rather than fixation techniques, incomplete data. 75 patients were excluded according the exclusion criteria ending in assessing 225 patients. Sampling technique we applied was nonprobability convenient sampling. Fractures were assessed based on fixation technique and implant choice, with radiological follow-ups conducted at intervals to evaluate outcomes and complications associated with each implant choice.

Follow-up period groups were as the following: immediate post-fixation, early-stage follow-up (up to three months), and subsequent intervals. X-rays were analyzed for multiple parameters including: reduction quality, technique of fixation, related complications (such as varus collapse, medialization of the shaft, cut-out, Z-effect [Figure 2], malunion, nonunion, metal failure and per-prosthetic fractures), and healing process. Accepted degree of fracture healing was evaluated radiologically by the presence of callus on AP and lateral views.

Ethical approval was obtained from the ethical committee of directorate of professional training and planning in Royal Medical Services under the IRB number 19/9/2024.

Figure 2: Showing Z-effect deformity which is a complication unique to PFN (Proximal Femoral Nail). It can be described by migration of screws in opposing directions. a) Describes Reverse Z-effect. b) Shows the typical Z-effect deformity. c) Shows varus collapse of a fracture managed using DHS (Dynamic Hip Screw). d) illustrates lateral wall fracture occurring intraoperatively in thin lateral cortex managed with DHS.

Statistical analysis

Includes descriptive analysis, employing mean and standard deviation for continuous variables, and frequency along with percentages for categorical variables. To assess associations between categorical variables, the chi-squared test of independence (χ2-test) and Fisher exact test were utilized. Additionally, the One-way ANOVA test was employed to compare mean age and healing time among different treatment modalities for any significant disparities. Time-to-event data was analyzed using the Kaplan-Meier (KM) method. The Statistical Package for the Social Sciences (SPSS) IBM Version 21 Chicago facilitated the statistical analysis, with a significance level set at $\alpha = 0.050$.

RESULTS

Starting with demographic analysis, we started analysis for seventy-five patients with intertrochanteric proximal femoral fractures characterized by a thin lateral cortex over a span of six years. Table 1 demonstrates the demographic characteristics of the above-mentioned category of patients. The majority of patients were females, making about 69.3% of the population. The mean age of the patients was 79.75±11.37 years. Left femur was predominantly affected in about 60% of cases. Comorbidities such as diabetes, hypertension, previous cerebrovascular accidents and ischemic heart diseases were noticed to be found in about 61.3% of patients.

Table 1: Descriptive analysis of the patients' demographic characteristics (N =225).

	Frequency	Percentage
Sex		
Female	156	69.3
Male	69	30.7
Age (years), mean (SD)	79.75±11.37 (30 -98)	
Affected extremity		
Right	90	40
Left	135	60
Comorbidity	138	61.3
Comorbidity type		
Hypertension	68	49.3
Diabetes mellitus	54	39.3
Ischemic heart disease	27	20
Cerebrovascular accident	**13**	9.3

After demographic analysis we moved forward to compare between the three treatment options used. This was summarized clearly in Table 2. PFN was the implant applied in 50% of the fractures. There were no discernible differences observed in terms of age, gender, or the affected extremity among the three treatment modalities. Statistical analysis revealed no significant difference in healing time across the three options (p=0.242). Additionally, there were no disparities noted in the one-year mortality rate or the need for revision surgery among the different treatment modalities (p=0.626, p=0.841 respectively). However, among the three fixation modalities, DHS was significantly associated with nonunion (p=0.042). The overall mortality rate within the first year stood at 26%.

Regarding outcomes and complications associated with the three treatment modalities, comparison between the 3 implants used was discussed through Table 3. Patient X-rays were assessed at various intervals, including immediately after surgery, early follow up carried within first three months, between three and six months, and finally between six and twelve months. The sample size decreased over time due to mortality and loss to follow-up, leading to independent statistical analyses for each follow up interval.

Table 2: Descriptive analysis of different treatment modalities (N=225).

Treatment modality	DCS (%)	DHS (%)	PFN (%)	test statistic $\chi 2$	P value
Frequency (%)	33 (14.7)	78 (34.7)	114 (50.7)		
Mean age (years)	78.54±(8.38)	79.42±(9.87)	74.39±(13.39)	F=(2.58)1.257	0.292[b]
Gender					
Male	12 (36.4)	24 (30.8)	33 (28.9)	0.221	0.895 [a]
Female	21 (63.6	54 (69.2)	81 (71.1)		
Side					
Right	15 (45.5)	33 (42.3)	42 (36.8)	0.352	0.839 [a]
Left	18 (54.5)	45 (57.7)	72 (63.2)		
Healing time (months)	3.13±(0.35)	3.75±(1.07)	3.52±(0.83)	F=(2.58)1.454	0.242[b]
Nonunion	3 (9.1)	12 (15.4)	0	6.209	0.042 [a]
Revision	3 (9.1)	6 (7.7)	6 (5.3)	0.756	0.841 [a]
Mortality rate*	6 (18.2)	6 (7.7)	15 (13.2)	1.122	0.626 [a]

*Mortality rate is the mortality rate within the first year of surgical treatment. [a]statistical value of associations using the chi-squared test of independence (χ2-test). [b]statistical value of associations using the One-way ANOVA test.

In the immediate follow up radiographs comprising 225 patients, DHS and PFN exhibited superior reduction results compared to DCS. However, 34 patients treated with DHS (15.4%) experienced intraoperative lateral wall fractures explained due to having thin lateral wall.[13-15] Despite this, Fisher exact test results showed no statistically significant association between treatment methods and complications (X2(4) = 6.237, p = 0.088).

During the follow-up radiographs within the first three months, 18 patients' X-rays were missing, leaving 207 patients for analysis. Although 96.2% of initial DHS radiographs post-op displayed an acceptable reduction, only 44% maintained this accepted position on follow-up x-rays, and this is related to shaft medialization effect (11 cases, 32%) and varus collapse in other patients (8 cases, 24%).[16] Varus collapse was more pronounced and progressive in DCS treatment (initial radiograph: 18.2%, first follow-up: 55.6%). PFN exhibited greater resistance to varus collapse, but three cases showed Z-effect, a PFN-specific complication (X2(8) = 22.213, p = 0.001).

Similarly, the sample size reduced to 200 radiographs during the three to six-month follow-up period. PFN maintained a superior position, although varus collapse occurred in five patients (14.7%), with an additional three patients (8.8%) experiencing the Z-effect. Shaft medialization was more evident in DHS, and varus collapse in DCS (X2(10) = 25.279, p≤0.001).

Findings during the six to twelve-month interval were very similar to those of the previous period, but this was not statistically significant (X2(8) = 9.501, p = 0.224). This could be attributed to the progressive loss of patients from follow-up.

Table 3: Different treatment modalities outcomes.

Treatment methods	Accepted position (%)	Cutout (%)	Medialization of shaft (%)	Varus collapse (%)	Z effect (%)	DF*	Fisher exact test	P value**
Immediate postoperative reduction, n=225								
DCS	27 (81.8)	0	0 (0.0)	6 (18.2)	0 (0.0)	4	6.237	0.088
DHS	75 (96.2)	0	3 (3.8)	0 (0.0)	0 (0.0)			
PFN	108 (94.7)	0	0 (0.0)	6 (5.3)	0 (0.0)			
Radiograph within the first three months, n=200								
DCS	13 (44.4)	0 (0.0)	0 (0.0)	16 (55.6)	0 (0.0)	8	22.213	0.001
DHS	31 (44.0)	0 (0.0)	22 (32.0)	16 (24.0)	0 (0.0)			
PFN	71 (71.4)	6 (5.7)	0 (0.0)	14 (14.3)	9 (8.6)			
Radiograph within three to six months, n=190								
DCS	10 (37.5)	0 (0.0)	0 (0.0)	17 (62.5)	0 (0.0)	10	25.279	0.001
DHS	27 (41.7)	3 (4.2)	21 (32.0)	14 (20.8)	0 (0.0)			
PFN	72 (70.6)	0 (0.0)	0 (0.0)	13 (14.7)	10 (8.8)			
Radiograph within six to twelve months, n=180								
DCS	9 (33.3)	0 (0.0)	6 (22.2)	8 (33.3)	3 (11.1)	8	9.501	0.224
DHS	32 (52.2)	4 (4.3)	13 (21.7)	13 (21.7)	0 (0.0)			
PFN	55 (61.5)	0 (0.0)	3 (3.8)	29 (30.8)	3 (3.8)			

*DF: Degree of freedom. **Statistical value of associations using the chi-squared test of independence ($\chi 2$-test).

DISCUSSION

In this retrospective study, we aimed to evaluate the effectiveness of treatment modalities-DHS, DCS, and PFN-regarding intertrochanteric fractures with thin lateral cortex. One of our main challenges arose was due to patients being lost to follow-up, due to mortality, seeking follow-up care elsewhere, or missing their appointments.

We initiated our cohort study having 225 patients, yet by the six to twelve-month follow-up interval, the sample size had dwindled to 180 patients, leading to a statistical analysis discrepancy.

In our study, PFN emerged as the superior treatment in maintaining reduction position during follow-up despite the fact that there were no significant differences observed among the three modalities concerning healing duration, mortality rates, or the necessity for revision surgery. And this superiority goes back to the factor of PFN implant being more biomechanically stable than DHS and DCS due to the fact that PFN being an intramedullary device in comparison to DHS and DCS which extramedullary implants have a better lateral wall buttress and shorter lever arm leading to lower shearing force and moment over intertrochanteric fracture line. Furthermore, PFN showed to have a lower propensity for varus collapse, shaft medialization due to the same discussed biomechanical issue, and lower intraoperative lateral wall fractures due to lower need to ream lateral wall except for lag screw in comparison to DHS and DCS which need lateral wall reaming for both lag and side plate screws. Pradeep et al, stated similar results to our study results.

On the other hand, occurrence of Z-effect deformity was noted uniquely in PFN treatment. Conversely, although DHS demonstrated favorable initial reduction, over 50% of the fractures experienced reduction loss within the initial three months due to the fact that varus collapse and shaft medialization occurred later on during months of follow up.[16] This loss of maintenance of reduction goes to posteromedial calcar involvement, in which it can't stand the biomechanical shearing force through using DHS over such fracture.

DHS also exhibited a significant risk of lateral wall fractures and a higher incidence of nonunion in thin lateral cortex intertrochanteric fractures, putting it in inferior to PFN in managing such type of fractures with thin lateral wall.[14,15] Guerra et al stated that in his study confirming that PFN is still superior to DHS in thin lateral wall cortex fractures due to the fact that PFN being biomechanically more stable than both DHS and DCS.[15]

Conversely, DCS was associated with a higher incidence of varus positioning from the outset, a trend that escalated markedly during the initial three-month follow-up period.

And by having a look over the literature and the effect of thin lateral wall cortex is so important, Gotfried analyzed twenty-four patients with documented postoperative fracture collapse, they highlighted the importance of the lateral wall's presence on preoperative radiographs prior to selecting the appropriate implant for stabilization of such a fracture.[17,18] Palm et al. in the same way recognized postoperative fracture of the lateral femoral wall after DHS usage as a primary predictor for reoperation following an intertrochanteric fracture, with a fracture incidence of 21%.[10,16]

In our study, lateral wall fractures occurred in 15.4% of DHS-fixed fractures, which advocates for their avoidance for thin lateral wall fractures. This result was comparable to the international results which show higher incidence of lateral wall fracture occurring in DHS managed fractures, Sharma et al stated that as well.[15]

The limitations we faced in our study were sample size which was affected by covid crises since that the study analysis were held over January 2017 and December 2023, during which covid crises has an effect over the sample size. Also, being a retrospective study is another limitation in analysis some factors like comorbidities. Moreover, some factors were not studies like the BMI factor and its effect on each modality of treatment.

CONCLUSION

Awareness of the importance of lateral wall integrity in intertrochanteric fractures is highly increasing among orthopedic surgeons. Higher complications and reoperation rates are being associated when improper implant is used in thin lateral wall fractures. Despite no significant differences were obtained in mortality. healing time, or reoperation rates among DHS, DCS, and PFN, PFN showed much better results in reduction maintenance and lower complication rates. Therefore, PFN should be preferred over DHS and DCS for treating thin lateral wall intertrochanteric fractures.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee of of directorate of professional training and planning in Royal Medical Services under the IRB number 19/9/2024

REFERENCES

1. Baumgaertner MR, Curtin SL, Lindskog DM, Keggi JM. The value of the tip-apex distance in predicting failure of fixation of peritrochanteric fractures of the hip. J Bone Joint Surg Am. 1995;77(7):1058-64.
2. Sheehan SE, Shyu JY, Weaver MJ, Sodickson AD, Khurana B. Proximal femoral fractures: what the orthopedic surgeon wants to know. Radiograph. 2015;35(5):1563-84.
3. Sharma G, Gn KK, Khatri K, Singh R, Gamanagatti S, Sharma V. Morphology of the posteromedial fragment in pertrochanteric fractures: A three-dimensional computed tomography analysis. Injury. 2017;48(2):419-31.
4. Xiong WF, Zhang YQ, Chang SM, Hu SJ, Du SC. Lesser trochanteric fragments in unstable pertrochanteric hip fractures: a morphological study using Three-Dimensional Computed Tomography (3-D CT) reconstruction. Med Sci Monit. 2019;19(25):2049-57.
5. Kauffman JI, Simon JA, Kummer FJ, Pearlman CJ, Zuckerman JD, Koval KJ. Internal fixation of femoral neck fractures with posterior comminution: a biomechanical study. J Orthop Trauma. 1999;13(3):155-9.
6. Liu J, Zhang B, Yin B, Chen H, Sun H, Zhang W. Biomechanical evaluation of the modified cannulated screws fixation of unstable femoral neck fracture with comminuted posteromedial cortex. Biomed Res Int. 2019;2019(1):2584151.
7. Li M, Li ZR, Li JT, Lei MX, Su XY, Wang GQ, et al. Three-dimensional mapping of intertrochanteric fracture lines. Chin Med J (Engl). 2019;132(21):2524-33.
8. Garg B, Malhotra R, Jayaswal A, Kotwal PP. Integrity of the lateral femoral wall in intertrochanteric hip fractures. J Bone Joint Surg Am. 2007;89(8):1868.
9. Hsu CE, Shih CM, Wang CC, Huang KC. Lateral femoral wall thickness. A reliable predictor of postoperative lateral wall fracture in intertrochanteric fractures. Bone Joint J. 2013;95-B(8):1134.
10. Palm H, Jacobsen S, Sonne-Holm S, Gebuhr P, Hip Fracture Study Group. Integrity of the lateral femoral wall in intertrochanteric hip fractures: an important predictor of a reoperation. J Bone Joint Surg Am. 2007;89(3):470-5.
11. Zdero R, Bougherara H, Dubov A, Shah S, Zalzal P, Mahfud A, et al. The effect of cortex thickness on intact femur biomechanics: a comparison of finite element analysis with synthetic femurs. Proc Inst Mech Eng H. 2010;224(7):831-40.
12. Sun LL, Li Q, Chang SM. The thickness of proximal lateral femoral wall. Injury. 2016;47(3):784.
13. Sharma G, Singh R, Gn KK, Jain V, Gupta A, Gamanagatti S, et al. Which AO/OTA 31-A2 pertrochanteric fractures can be treated with a dynamic hip screw without developing a lateral wall fracture? A CT-based study. Int Orthop. 2016;40(5):1009-17.
14. Pradeep AR, KiranKumar A, Dheenadhayalan J, Rajasekaran S. Intraoperative lateral wall fractures during dynamic hip screw fixation for intertrochanteric fractures-incidence, causative factors and clinical outcome. Injury. 2018;49(2):334-8.
15. Guerra MTE, Giglio L, Leite BC. Pantrochanteric fracture: incidence of the complication in patients with trochanteric fracture treated with dynamic hip screw in a hospital of Southern Brazil. Rev Bras Ortop (Sao Paulo). 2019;54(1):64-8.

16. Hsu CE, Chiu YC, Tsai SH, Lin TC, Lee MH, Huang KC. Trochanter stabilising plate improves treatment outcomes in AO/OTA 31-A2 intertrochanteric fractures with critical thin femoral lateral walls. Injury. 2015;46(6):1047-53.
17. Sharma G, Sharma V. Can a trochanter stabilising plate prevent lateral wall fractures in AO/OTA 31-A2 pertrochanteric fractures with critical thin femoral lateral walls? Injury. 2015;46(10):2085-
18. Gotfried Y. The lateral trochanteric wall: a key element in the reconstruction of unstable pertrochanteric hip fractures. Clin Orthop Relat Res. 2004;425:82-6.

Cite this article as: Abushahot MA, Rosan FM, Shari NF, Alhseinat LM, Al-Qudah AK. Thin lateral wall cortex intertrochanteric proximal femur fractures: a comparative study between past and present. Int J Res Orthop 2024;10:908-13.