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Evaluate the Outcome of Trochanteric Fracture Fixation Concerning Proximal Femoral Lateral Wall Thickness in Suez Canal University Hospitals

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ABSTRACT

Background: *Lateral wall competency of Intertrochanteric fractures has been considered as a mitigating factor to instability, and its incompetency will be associated with high rate of complications.*

Aim: *Improvement of the outcome of Intertrochanteric fracture management.*

Patients and methods: *This cohort prospective study was conducted on 65 patients which had stable intertrochanteric fracture: Evans stable Type 1(two-part fractures AO type*
31-A1.1 to 31-A2.1) with preoperative intact lateral wall and thickness less than 20.5mm in all cases that underwent fixation in Suez Canal university hospitals during the period between March 2020 to March 2022. Evaluating the Role of preoperative assessment of Lateral Wall thickness and its value in choosing fixation method and assessing the relation between Lateral Wall thickness and fixation failure.

Results: *There were 19 cases (54.3%) fixed by DHS reported post operative lateral wall fracture while only 5 cases fixed by PFN reported post operative lateral wall fracture with highly significant P value <0.002.Comparing post operative Harris Hip Score (HHS) regarding methods of fixation showed highly significant difference with P value <0.001 as the mean HHS of cases fixed by PFN 78.37 while 69.17 in DHS cases.The mean pre-injury (HHS) was 91.66± 1.5 with range from 90 to 96 while the mean post-injury (HHS) was 73.42± 8.98 with range from 50 to 86 (p<0.001). Complications reported as 12 cases (18.5%) with varus malunion, 2 patients (3.1%) experienced implant failure due to cut through, 13 cases (20%) reported shortening. Two patients (3.1%) had current need for reoperation. None of the patients reported wound infection.*

Conclusion: *Lateral wall thickness is an accurate predictor of post-operative lateral wall fracture and its integrity should be a major objective during fixation. Determination of pre-operative thickness will help to choose method of fixation thus decrease post-operative complication and improving patient functional outcome. Lateral wall of 20.5 mm is considered a threshold value for the use of DHS and this can be expected to minimize the risk of post-operative lateral wall fracture.*

Keywords: *Lateral wall thickness, Intertrochanteric fractures, Harris Hip Score.*

Abbreviations: *DHS dynamic hip screw, PFN proximal femoral nail, HHS harris hip score tip apex distance (TAD)*

INTRODUCTION

Intertrochanteric fractures are extracapsular fractures of the proximal femur between the greater and lesser trochanter composed of dense trabecular bone (1). The biomechanical function of proximal femur is greatly related to its trabecular structure, vertical trabeculae and horizontal trabeculae; Regarding vertical trabeculae, its biomechanical function is to absorb the compressive forces which pass through the hip and upper femur during standing and walking (2). While the horizontal trabeculae is to deal with the tension forces which oppose the compression forces passing down through the vertical trabeculae during standing and walking (3). Hammer, 2010 stated that both the horizontal trabeculae and the vertical trabeculae both deal with the compression forces generated during an individual's everyday activities (3).

Various methods of fixation of intertrochanteric fractures existed: extramedullary DHS and intramedullary devices PFN. Consequently, the preferred treatment option remains controversial (4).

Swart et al had suggested that DHS fixation is most appropriate for stable fractures, an intramedullary nail

possibly for the unstable fractures and A3 fractures should definitely be treated with an intramedullary nail (5). Previously, the condition of the posteromedial portion was regarded as the most important prognostic factor in the outcome of fixation using DHS but recently is has been demonstrated that integrity of the lateral wall is essential for successful results (6).

PATIENTS AND METHODS

This cohort prospective study was conducted on 65 patients which had stable intertrochanteric fracture: Evans stable Type 1(two-part fractures AO type 31-A1.1 to 31-A2.1) with preoperative intact lateral wall and thickness less than 20.5mm in all cases that underwent in Suez Canal university hospitals during the period between March 2020 to March 2022. All patients were adult from both genders ≥18 years old, mode of trauma was either fall on the ground or road traffic accident, patient didn't have any medical contraindications to surgery and their lateral proximal femoral wall was intact preoperative.

Methods:

Pre-operative assessment was done for all patient in the form of clinical history data with general and local examination.

Assessment of lateral wall thickness was done by adding a template which is a coin 1 LE 2.5 cm in diameter while performing the plane X-ray anteroposterior view this coin acting as a reference to measure lateral wall thickness. Then a reference point 3 cm below the innominate tubercle of the greater trochanter was done and a line angled at 135° upward to the fracture line was done then the distance between the outer layer of the cortex and the fracture line was calculated. Plain X-ray AP pelvis showing both hips, AP and lateral views of the hip together with pelvic CT were done.

Intraoperatively

The patients decubitus were either lateral or supine on traction table. Lateral subvastus approach was used or small lateral incision over tip of greater trochanter in some cases. Fixation method either DHS or PFN under image intensifier. The tip apex distance (TAD) < 25 mm in all fractures whatever the method of fixation.

Postoperatively: All the patients were mobilized from bed to chair from the first or second postoperative day on wards. Bed side exercise and range of motion exercise were done postoperatively while patients on ward or after discharge. Patients were encouraged to walk using walking aid with partial weight bearing as soon as possible according to fixation type, quality of reduction, bone quality and general condition. Standard post-discharge follow-up at 2 weeks,4 weeks ,6 weeks, 3 months and 6 months was done.

Post-operative X-rays were done and assessed for adequacy of reduction, poor fracture reduction was defined as more than 20° angulations at the fracture site on the lateral radiograph, >4 mm of displacement of any fragment and coronal alignment (varus and valgus mal alignment).

Functional outcome was assessed using HHS with evaluation of various hip disabilities and methods of treatment.

RESULTS

A cohort prospective study was conducted to assess cases - 65 patients - which had Stable intertrochanteric fracture : Evans stable Type 1(two part fractures AO type (31-A1.1 to 31-A2.1) that underwent in Suiz canal university hospitals during the period between march 2020 to march 2022.Data was collected, coded then entered as a spread sheet using Microsoft Excel 2016 for Windows, of the Microsoft Office bundle; 2016 of Microsoft Corporation, United States. Data was analyzed using IBM Statistical Package for Social Sciences software (SPSS), (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). The Kolmogorov-Smirnov test was used to verify the normality of distribution. Continuous data was expressed as mean ± standard deviation, median & IQR while categorical data as numbers and percentage. A statistical value <0.05 was considered as significant.

Inferential analyses were done for quantitative variables using independent t- test in cases of two independent groups with parametric data and Mann Whitney U in cases of two independent groups with non-parametric data. Inferential analyses were done for qualitative data using Chi square test for independent groups. The

level of significance was taken at P value <0.05 is significant, otherwise is non-significant.

Assessment of pre-operative data

The mean age in the 45 studied males was 68.2 years with range from 62 years to 76 years while the mean age in the 20 females was 67.9 years with range from 62 years to 73 years .Twenty-five cases (38.5%) were diabetic (15 males and 10 females), 51 cases (78.5%) were hypertensive (38 males and 13 females) and four cases (6.2%) had dyslipidemia (2 males and 2 females) while 10 patients (15.4%) were medically free (6 males and 4 females). The most common cause of fractures was simple fall in 54 cases (83.1%) and these cases were 38 males and 16 females. Road traffic accident (RTA) was the cause in 11 cases (16.9%) and these cases were 7 males and 4 females. According to AO classification,5 cases (7.7%) were type 31A1.1 fracture (4 males and 1 female), 22 cases (33.8%) were type 31A1.2 fracture (14 males and 8 females), 37 cases (56.9%) was type 31A2.1 (26 males and 11 females) and one case (1 male) were type 31A2.2 (Table 1).

Table (1): Classification of fracture among the studied patients.

Classification of fracture	All patients		Males		Females	
	N	%	N	%	N	%
31A1.1	5	7.7%	4	8.9%	1	**5.0%**
31A1.2	22	33.8%	14	31.1%	8	**40.0%**
31A2.1	37	56.9%	26	57.8%	11	**55.0%**
31A2.2	1	1.5%	1	2.2%	0	**0.0%**
Total	**65**	**100%**	**45**	**100%**	**20**	**100%**

Assessment of operative data

35 cases (53.8%) were fixed by Dynamic hip screw (DHS) (23 males and 12 females) and 30 cases (46.2%) were fixed by PFN (22 males and 8 females). 35 cases fixed by Dynamic hip screw (DHS) and they were classified as 31A1.1 fracture type (4 cases), 31A1.2 fracture type (17 cases) and 31A2.1 fracture type (14 cases).

Meanwhile, 30 cases fixed by PFN and classified as 31A1.1 fracture type (one case), 31A1.2 fracture type(5 cases) ,31A2.1 fracture type(23 cases), and 31A2.2 fracture type (only one case)(Table 2).

Table 2: Method of fixation related to classification of fracture.

Classification of fracture	Dynamic hip screw (DHS)		Proximal Femoral Nail (PFN)	
	N	%	N	%
31A1.1	4	11.4%	1	3.3%
31A1.2	17	48.6%	5	16.7%
31A2.1	14	40.0%	23	76.7%
31A2.2	0	0.0%	1	3.3%
Total	35	100%	30	100%

Assessment of post-operative data

Despite all cases have preoperative lateral wall, 24 patients (36.9%) had post operative lateral wall fracture 19 of them were fixed by DHS while 5 patients were fixed by PFN with high statistically significant difference P value< 0.002 between the two methods of fixation regarding post-operative lateral wall fracture. (Table 3)

Table 3: Postoperative lateral wall fracture among the studied patients

Method of fixation				Chi- Square test	
Dynamic hip screw (DHS)		Proximal Femoral Nail (PFN)			
N	%	N	%	X^2	P-value

Post-operative lateral wall fracture	**No**	16	45.7%	25	83.3%	9.82	**0.002 (HS)**
	Yes	19	54.3%	5	16.7%		

The mean post injury HHS was 69.17 in patients fixed by DHS while 78.37 in cases fixed by PFN this relation was statistically significant as P value< 0.001 (Table 4) post injury HHS is not related to fracture type there was No statistically significant difference between fracture type and post injury HHS (p>0.05) (Table 5)

Table 4: Relation between method of fixation and HHS

		Method of fixation								**Mann-Whitney U test**	
		Dynamic hip screw (DHS)				**Proximal Femoral Nail (PFN)**					
		Mean	**SD**	**Range**		**Mean**	**SD**	**Range**		**Z MWU**	**P-value**
Harris Hip Score (HHS)	**Preinjury**	**91.51**	**1.62**	**90.0**	**96.0**	**91.83**	**1.37**	**90.0**	**94.0**	**1.14**	**0.254 (NS)**
	Postinjury	**69.17**	**9.21**	**50.0**	**86.0**	**78.37**	**5.62**	**64.0**	**84.0**	**4.17**	**<0.001 (HS)**

Table 5: Relation between classification of fracture and post-HHS.

		post-HHS							**Kruskal-Wallis Test**	
		Mean	**SD**	**Median**	**IQR**		**Range**		**KW**	**P-value**
Classification of fracture	**31A1.1**	66.80	10.64	70.0	64.0	72.0	50.0	78.0	4.02	0.260 (NS)
	31A1.2	74.59	8.74	75.5	70.0	82.0	54.0	86.0		
	31A2.1	73.81	8.81	76.0	68.0	80.0	54.0	84.0		
	31A2.2	66.0	0.0	66.0	66.0	66.0	66.0	66.0		

The mean pre-injury Harris Hip Score (HHS) was 91.66± 1.5 with range from 90 to 96 while the mean post-injury Harris Hip Score (HHS) was 73.42± 8.98 with range from 50 to 86 that means none of them return to preinjury level of function and activity. There were 16 (24.6%) patients who reported complications related to the operation. A total of 12 cases (18.5%) reported malunion all of them in varus. Two patients experienced implant failure due to cut through. 13 cases (20%) reported shortening. Two patients had current need for reoperation. None of patients reported wound infection or implant failure. (Table 6).

Table 6: Postoperative complications among the studied patients

Complications		**All patients**	
		N	**%**
Malunion	**No**	53	81.5%
	Yes (Varus)	12	18.5%
Implant failure	**No**	v	100.0%
	Yes	0	0.0%
Shortening	**No**	52	80.0%
	Yes	13	20.0%
Wound infection	**No**	65	100.0%
	Yes	0	0.0%
Current need for reoperation	**No**	63	96.9%

DISCUSSION

The importance of the integrity of the lateral femoral wall is increasingly being recognized in the treatment of intertrochanteric fracture (7). Previously, the condition of the posteromedial portion was regarded as the most important prognostic factor in the outcome of fixation using a dynamic hip screw but recently it has been delineated that the integrity of the lateral wall is essential for successful results (6).

Pradeep et al., 2018 stated that Thickness of the lateral wall is a simple and quantifiable parameter for pre-operative evaluation of the anatomical structure. And lateral wall thickness was a reliable predictor of post-operative lateral wall fracture with a threshold value of 20.5 mm (8).

Intact lateral wall plays a key role in the stabilization and fixation of unstable peritrochanteric hip fractures. By providing a lateral buttress for the proximal fragment, fracture impaction is facilitated and followed by rotational and varus stability after fracture spike impaction occurs. If the lateral wall is broken, there will be no lateral buttress for the proximal neck fragment and collapse will occur. Lateral wall fracture may occur during surgery or after surgery (11).

Fracturing preoperative intact lateral wall at the drilling site of a compression hip screw/dynamic hip screw fixation device will convert the stable fracture pattern into an unstable one in which it is considered a complication of surgery and followed by collapse.

Despite intact proximal femoral lateral wall in all cases in this study, 36.9% of cases noted to have postoperative lateral wall fracture. 54.3% of those cases were fixed by DHS and 16.7% were fixed by PFN. It was demonstrated that the rate of post-operative lateral wall fractures was higher in cases fixed by DHS and this relation was statistically significant with a p value of 0.002.

For that it is not recommended to fix stable trochanteric fractures with thin intact proximal femoral lateral wall by using DHS owing to higher post operative fracture rate. There was significant decline in the functional outcome regarding Harris hip score pre and post injury state as the mean pre-injury Harris Hip Score (HHS) was 91.66 ± 1.5 with range from 90 to 96 while the mean post-injury Harris Hip Score (HHS) was 73.42 ± 8.98 with range from 50 to 86. This comparison was statistically significant with a p value of 0.001 giving the conclusion that neither DHS nor PFN will return patients back to pre-injury state. Concerning functional outcome of the patients in this study, it is recommended to fix stable intertrochanteric fractures with intact preoperative proximal femoral lateral wall and thickness less than 20.5 mm with PFN and not recommended to use DHS due to lower post operative functional score as the relation between post injury HHS and fixation method was statistically significant (P value= 0.001) with the mean score for cases fixed by DHS was 69.1 and the mean score for cases fixed by PFN was 78.3.

Deng et al., 2021 stated that lateral wall thickness does not affect the quality of reduction and outcome in patients with intertrochanteric fracture receiving PFN so it is not so important to distinguish the integrity of the lateral wall when intramedullary fixation is decided, evaluating the quality of reduction or prognosis (9) unlike Pradeep et al., 2018 who stated that lateral wall thickness is a reliable predictor of intraoperative lateral wall fracture during DHS fixation and with those <21 mm alternate methods for fixation should be considered. The occurrence of intraoperative lateral wall fracture alone can lead to poor radiological and functional outcome independent of TAD (8).

Sreejith et al., 2017 concluded that preoperative thickness of lateral wall is a reliable predictor for the development of lateral wall fracture in the post-operative When the lateral wall thickness is less than 20.55 mm there is significantly high chance of lateral wall getting fractured if fixed with a DHS alone. Post-operative lateral wall fracture following fixation with DHS alone undergo a very protracted healing and other complications of shortening and deformity (10). Moreover Rajesh et al., 2018 recommended that if the preoperative lateral wall thickness is less than 22.1mm, the surgeon may consider using additional buttressing with TSP or an intramedullary implant like PFN (12). HSU et al., 2013 stated that lateral wall thickness is a reliable predictor of post-operative lateral wall fracture with applying a > 20.5 mm threshold value for the use of a DHS which is expected to minimize the risk of post-operative lateral wall fracture ITF with a lateral wall thickness < 20.5 mm should not be treated with a DHS alone (6).

CONCLUSION

Determination of pre-operative thickness of lateral wall will help choose method of fixation thus decrease post-operative complication specifically shortening and improving patient functional outcome. Lateral wall thickness is an accurate predictor of post-operative lateral wall fracture. 20.5 mm lateral wall thickness is considered a threshold value for the use of a DHS and this can be expected to minimize the risk of post-

operative lateral wall fracture.

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