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Assessment of lateral femoral wall thickness as a measure to predict postoperative lateral femoral wall fractures in intertrochanteric fractures treated with Dynamic Hip Screw

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ABSTRACT: Background: *Intertrochanteric fracture is defined as the fracture in which the main plane of bony separation passes the tip of the greater trochanter obliquely downwards and inwards to or through the lesser trochanter. Interchanteric fractures occur in the area just distal to the capsule of the hip joint, and above the area of isthmus of the medullary canal. Dynamic Hip Screw is the gold standard in the management of intertrochanteric fractures.*

Aim: *To investigate the reliability of lateral femoral will thickness as a measure to predict postoperative lateral femoral will fractures in AO31A1 and AO31A2 intertrochanteric fractures treated with Dynamic Hip Screw.*

Methods: *A retrospective study was conducted. Data was collected for a period of 2 years. Intertrochanteric fractures AO31A1 and AO31A2 who were treated with dynamic Hip screw were included in the study.*

Results: *Thirty, intertrochanteric fractures of AO31A1 and AO31A2 type were enrolled. The mean age group is 64.3 years among which mostly were males (53%). Most of the patients (60%) had fractures on the left side of which (86%) sustained injury due to trivial fall. Out of 30 cases 12 cases (40%) were AO31A1type and 18 cases (60%) were AO31A2 type. The mean thickness was 27.9mm in AO31A1 group and 21.4mm in AO31A2 group. AO31A1 (40%) and AO31A2 (43%) achieved normal radiological union within 6 months postoperatively without any lateral femoral wall fractures in the postoperative period. The lateral femoral wall thickness is significantly thin in AO31A2 group with lateral femoral wall fractures (P<0.008) when compared with those without lateral femoral wall fractures (AO31A1 and AO31A2).*

Conclusion: *Preoperative assessment of lateral femoral wall thickness is a useful measure to predict postoperative lateral femoral wall fractures in intertrochanteric fractures treated with DHS. From this study, it is recommended that a preoperative lateral femoral wall thickness of less than 22.1 mm is the critical value below which the lateral femoral wall fracture can occur when fixed with DHS alone.*

Keywords: *Intertrochanteric fractures, lateral femoral wall thickness, DHS, prognosis*

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I. Introduction

Intertrochanteric fractures account for nearly 50% of fractures around the hip. They continue to be a major case of disability, leading to increased morbidity and mortality. With increasing life expectancy, intertrochanteric fractures have been marked as one of biggest problems of contemporary civilization. 90% of intertrochanteric fractures of femur in elderly occur commonly in an osteoporotic bon, due to a simple fall, where as in young individuals it may b a result of high energy injury, such as motor vehicle accident or fall from height (1).

The intertrochanteric fractures can be managed by conservative methods and the fracture usually unites. If suitable precautions are not taken the fracture mal-unites, leading to various and eternal rotation deformity at the fracture site and shortening, and limitation of hip movements. It is also associated with complications of prolonged immobilization like bedsores, deep vein thrombosis and co-morbid problems like cardiovascular, renal and respiratory and are further aggravated due to recumbence and immobilization. Hence these fractures result in the substantial morbidity and mortality. The aim of treatment should be to achieve union

in acceptable position and early mobilization. Taking all the factors into consideration, surgery by internal fixation of the fracture is an ideal choice (2).

There are various forms of internal fixation devices used for intertrochanteric fractures of them the most commonly used device is the dynamic hip screw. This controlled collapse fixation device, which permits unidirectional collapse of fragments. This technique is utilized for internal fixation of intertrochanteric fractures in this study (1,3).

The type of implant used has an important influence on complications of fixation. Sliding devices like dynamic hip screw have been extensively used for fixation. However if the patient bears the weight early, especially in comminuted fractures and, band those without support from lateral femoral wall these devices can penetrate the head, bend, break, separate the shaft or fracture the lateral femoral wall and result in excessive collapse which may require an additional buttressing procedure or revision by using an intramedullary implant (4).

The integrity of lateral femoral wall is increasingly being recognized in the treatment of intertrochanteric fractures. Previously, the condition of the posteromedial portion of the fracture anatomy was regarded as the most important prognostic factor in the outcome of fixation of interchanteric fractures. It has been demonstrated that integrity of the lateral femoral wall is essential for successful results. 21% of intertrochanteric fractures with intact lateral wall develop secondary fractures of the lateral wall. 22% of these lateral will fractures need re-operation (5).

In spite of the advances in anesthesia, nursing care and the surgical techniques, intertrochanteric fractures remain a significant cause of postoperative morbidity and mortality if proper preoperative assessment and selection of implant is lacking. The identification of patients at risk of a secondary lateral femoral wall fractures would few greatly improve the outcome of dynamic hip screw treatment. In India, very few studies have been done on predictor of postoperative lateral femoral wall fractures. Thickness of lateral femoral wall is a simple and quantifiable parameter for preoperative evaluation of facture anatomy (6).

In view of these considerations, the present study of 'Assessment of Lateral Femoral Wall Thickness. As a Measure to Predict Postoperative Lateral Femoral Wall Fractures In intertrochanteric Fractures Treated with Dynamic Hip Screw is taken up.

Objectives

1. To evaluate lateral femoral wall thickness by using anteroposterior radiographs of proximal femur as a measure to predict postoperative lateral femoral wall fractures in intertrochanteric fractures treated with Dynamic Hop Screw.
2. To compare the failure rates of Dynamic Hip Screw with or without postoperative lateral femoral wall fractures.

II. Methods & Methodology

A retrospective study was carried out in the department of orthopedics, Kamineni Institute of Medical Sciences, Narketpally, Nalgonda District for the period of October 2015 to October 2017. The study consists of patients of intertrochanteric factures of femur satisfying the inclusion criteria, who are treated with dynamic Hip screw. Each patient was subjected to clinical and radiological examination along with routine investigations prior to surgery. Follow up of the patients included clinical and radiological evaluation.

Inclusion criteria

1. Patients admitted with AO31A1 and AO31A2 intertrochanteric fractures
2. Patients treated with dynamic hip screw and barrel plate
3. Patients with adequate tip apex distance post operatively

Exclusion criteria

1. AO31A3 fractures
2. Fixation other than dynamic hip screw
3. Pathological fractures
4. Previous fractures at trochanteric region

Methodology

A through preoperative assessment of patients was done which include the following.

1. General condition of patient
2. Detailed clinical examination
3. Investigations and
4. Radiological assessment of fracture type and thickness of lateral femoral wall.

Clinical examination

1. Inspection-limp in eternal rotation with outer border of the foot touching the couch with apparent shortening.
2. Palpation – presence of tenderness over greater trochanter
3. Movements – painful and restricted
4. Measurements – limb shortening
5. Associated injuries – ipsilateral and contra lateral lower limb injuries, pelvic injuries and upper limb injuries like distal radius fractures.

Investigations
1. Routine blood examination for ESR, Haemoglobin percentage, Total & Differential count, blood grouping
2. Routine urine examination- proteins, sugar and microscopic examination
3. Blood urea, serum creatinine, random blood sugar.
4. HIV- I & II, HBs Ag an HCV.
5. Echocardiography.
6. Radiographs

Radiological Assessment
1. Pelvis with both hips- Anteroposterior view
2. Hip with femur full length of involved side- AP
3. Lateral View of the affected hip joint
4. Chest – PA view

Below knee skin traction is applied to relieve pain and spasm of muscles. Skeletal traction is applied when there are abrasions, lacerations or skin infections over ipsilateral leg (away from site of pin insertion) or when surgery is delayed due to co-morbid conditions and in senile patients with a thin, inelastic and atrophic skin.

Preoperative Assessment of lateral femoral wall thickness (5)

In patients admitted with suspected hip fractures, anteroposterior radiographs of pelvis with both hips were taken to identify AO31A1 and AO31A2 interochanteric fractures. Preoperative lateral femoral wall thickness was measured using anteroposterior radiograph by taking a reference point 3 cm below the vastus ridge and measuring at an angle of 135 degree to the shaft of femur upwards to the fracture line (midline between the two cortex lines) on anteroposterior radiograph. All assessment were done under the guidance of radiologist and corrected to radiological magnification ratio of 120%.

Fracture fixation:
Fracture fixation was undertaken in a conventional manner using DHS on a fracture-table under C-arm control.

After treatment:

Postoperatively, patients pulse, blood pressure, respiration, temperature were monitored. Antibiotics given intravenously for 5 days covering Gram positive, Gram negative and anaerobic bacteria and then were continued on oral antibiotics for 5 days in the post operative period. Analgesics were given as per patients compliance. Blood transfusion was given depending on the requirement. Sutures removed on 10^{th} postoperative day. Patients were encouraged to sit in the bed after 24 hours after surgery. Patients were taught quadriceps strengthening exercises and knee mobilization in the immediate post operative period. Patient was taught gait training before discharge from the hospital. Patients were encouraged to weight bear with walker depending on the pain tolerability of individual patient.

Discharge:
Patients were discharged from the hospital when independent walking was possible with walking aids.

Follow up:
All patients were followed up at an interval of 1, 2, 3 and 6 months for the purpose of study. At every visit patient was assessed radiologically using anteroposterior and lateral radiographs.

- Postoperative lateral femoral wall fractures were identified as presence of new fracture lines occurring at the site of insertion of barrel plate or lateral displacement of the fracture fragment on radiographs.
- Failure of treatment was identified as

1. Penetration of screw into hip joint or loosening within the femoral head.
2. Breakage of barrel plate or its screws.
3. Patient underwent a second operation due to implant failure.

- Successful treatment was identified as continuous bridging callus seen on anteroposterior and lateral radiographs.
- An assessment was done whether the lateral femoral wall fractures if present are occurring at what thickness.

METHODS OF STATISTICAL ANALYSIS

Statistical analysis was done using Fisher's exact test and student t-tests. Receiver operating characteristics curves were used to investigate the potential relationship between the nominal measures using SPSS software. Findings were considered significant if p-value was <0.05.

III. Observation And Results

AGE DISTRIBUTION: In our series, 12 cases (40%) were AO31A1 type and 18 cases (60%) were AO31A2 type. 10% were in age group 41 – 50, 36% in 51-60, 30% in 61-70 and 24% in age group 71-80yrs. Majority of the cases belong to type AO31A2, of them 23% were in the age group 51-60 years, followed by 20% in age group 71-80 years. The youngest patient was 45 years old and eldest patient was 80 years old. The mean age in AO31A1 group is 60.6 years and 66.9 years in AO31A2 group. The mean age in this study is 64.4years (Table 1).

TABLE 1: Age distribution

S No	Age group (year)	Type of fracture	No of cases (n=30)	Percentage (%)
1	41-50	AO31A1	3	10
		AO31A2	**-**	**0**
2	51-60	AO31A1	4	13
		AO31A2	**7**	**23**
3	61-70	AO31A1	4	13
		AO31A2	**5**	**17**
4	71-80	AO31A1	1	4
		AO31A2	**6**	**20**
Total			30	100

SEX DISTRIBUTION: In this study, 6 males (20%) had sustained AO31A1 fractures, while 10 males (33%) had sustained AO31A2 fractures, while 6 females (20%) accounted for AO31A1 fractures and 8 females (27%) had AO31A2 fractures (Table 2).

TABLE 2: Sex distribution

S No	Sex	Type of Fracture	No. of Patients (n=30)	Percentage%
1	Male	AO31A1	6	20
		AO31A2	10	33
2	Female	AO31A1	6	20
		AO31A2	8	27
3	Total		30	100

SIDE INVOLVEMENT: In this study, it was observed that right side was involved in 12 cases of which 6 cases (20%) were AO31A1 and 6 cases (20%) were AO31A2. Left side was involved in 18 cases of which 6 cases (20%) were AO31A1 and 12 cases (40%) were AO31A2. Left side was more commonly involved than right side (Table 3).

TABLE 3: Side involvement

Side	Type of fracture	No. of Patients (n=30)	Percentage (%)
Right	AO31A1	6	20
	AO31A2	6	20
Left	AO31A1	6	20
	AO31A2	12	40
Total		30	100

MODE OF INJURY: In this study, 26 cases affected were due to trivial fall of which 7 cases (23%) were AO31A1 and 19 cases (63%) were AO31A2. There were 4 cases due to RTA of which 2 cases (7%) were AO31A1 and 2 cases (7%) were AO31A2. Trivial fall was the most common mode of injury (Table 4).

TABLE 4: Mode of injury

Mode of Injury	Type of fracture	No of cases (n=30)	Percentage (%)
Road traffic accident	AO31A1	2	7
	AO31A2	2	7
Trivial fall	AO31A1	7	23
	AO31A2	19	63
Total		30	100

In the study the maximum lateral femoral wall thickness was measured to be 39mm in AO31A1 fractures while the minimum lateral wall thickness was measured to be 9.6mm in AO31A2 fractures (Table 5).

TABLE 5: Preoperative of radiological assessment of thickness of lateral femoral wall

S No.	IP Number	Type of Fracture	Thickness of lateral femoral wall
01	201617095	AO31A1	31.6mm
02	201611991	AO31A2	24.9mm
03	201607571	AO31A2	20.1mm
04	201622162	AO31A2	27.4mm
05	201542199	AO31A2	30.4mm
06	201610363	AO31A2	26.6mm
07	201603052	AO31A2	20.2mm
08	201600266	AO31A1	13.2mm
09	201604700	AO31A2	30.0mm
10	201615891	AO31A1	33.5mm
11	201624698	AO31A2	22.2mm
12	201624517	AO31A2	21.5mm
13	201621505	AO31A2	16.9mm
14	201623786	AO31A1	22.2mm
15	201605773	AO31A1	30.2mm
16	201629218	AO31A1	33.2mm
17	201631277	AO31A2	23.9mm
18	201633681	AO31A2	30.0mm
19	201734638	AO31A1	26.0mm
20	201741239	AO31A1	30.0mm
21	201746892	AO31A2	26.0mm
22	201636772	AO31A2	27.0mm
23	201640772	AO31A2	17.0mm
24	201645131	AO31A2	9.6mm
25	201646608	AO31A1	39.0mm
26	201701992	AO31A1	25.0mm
27	201705491	AO31A1	27.0mm
28	201706919	AO31A2	28.0mm
29	201703529	AO31A2	19.0mm
30	201707230	AO31A2	22.0mm

FAILURE OF TREATMENT EXCLUDES LATERAL WALL FRACTURE

In this study, lateral femoral wall fractures were noted postoperatively in 5 cases of AO3 1A2 fractures with lateral femoral wall fracture (Table 6).

TABLE 6:

S No.	IP Number	AO FRACTURE TYPE	LATERAL WALL THICKNESS (MM)	LATERAL WALL FRACTURE WITH FOLLOWUP MONTH	FAILURE OF TREATMENT
01	201617095	AO31A1	31.6	No	No
02	201611991	AO31A2	24.9	No	No
03	201607571	AO31A2	20.1	No	No
04	201622162	AO31A2	27.4	No	No
05	201542199	AO31A2	30.4	No	No
06	201610363	AO31A2	26.6	No	No
07	201603052	AO31A2	20.2	Present at 1month followup	Implant loosening + collapse + nonunion
08	201600266	AO31A1	13.2	No	No
09	201604700	AO31A2	30	No	No
11	201615891	AO31A1	33.5	No	No
12	201624698	AO31A2	22.2	No	No
13	201624517	AO31A2	21.5	No	No
14	201621505	AO31A2	16.9	No	No
15	201623786	AO31A1	22.2	No	No
16	201605773	AO31A1	30.2	No	No

17	201629218	AO31A1	33.2	No	No
18	201631277	AO31A2	19.6	Present at 1 month follow up	No
19	201633681	AO31A2	30	No	No
20	201734638	AO31A2	26	No	No
21	201741239	AO31A2	25	No	No
22	201746892	AO31A2	27	No	No
23	201636772	AO31A2	17	No	No
24	201640772	AO31A2	9.6	Present at 1 month follow up	No
25	201645131	AO31A2	39	No	No
26	201646608	AO31A2	25	No	No
27	201701992	AO31A2	27	No	No
28	201705491	AO31A2	28	No	No
29	201706919	AO31A2	19	Present at 1 month follow up	No
30.	201703529	AO31A2	22	Present at 1 month follow up	No

In this study, no postoperative lateral femoral wall fractures were noted in 12 patients (40%) with AO31A1 fractures and 13 patents (43%) with AO31A2 fractures. Lateral femoral wall fractures were noted postoperatively in 5 patients (17%) with AO31A2 fractures (Table 7).

TABLE 7: Patients with or without post operative lateral femoral wall fracture

TYPE	NO OF PATIENTS (N=30)	PERCENTAGE (%)
AO31A1 WITH LATERAL WALL FRACTURE AO31A1 WITHOUT LATERAL WALL FRACTURE	0 12	0% 40%
AO31A2 WITH LATERAL WALL FRACTURE AO31A2 WITHOUT LATERAL WALL FRACTURE	05 13	17% 43%
TOTAL	27	100%

In this study, the mean lateral femoral wall thickness measured preoperatively was 27.9 mm in 12 patients with AO31A1 fracture within the range of 13.2 mm to 39 mm and standard deviation of 6.54. The mean lateral femoral wall thickness measured preoperatively was 24.3 mm in 13 patients with AO31A2 fractures without postoperative lateral femoral wall fractures and were within the range of 16.9 mm to 30.4 mm and standard deviation of 6.43. The mean lateral femoral wall thickness measured preoperatively was 18.1mm in 5 patients with AO31A2 fractures within the range of 9.6 mm to 22 mm and standard deviation of 6.75. The mean thickness of the 25 cases (AO31A1 and AO31A2) without lateral femoral wall fractures in this study is 26.1 mm with a range of 13.2 mm to 39 mm (Table 8).

Student's –t-test showed a significant P-value when statistical analysis one between 12 cases of AO31A1 group and 5 cases of AO31A2 group with postoperative lateral femoral wall fractures ($P<0.02$) and also in between 5 cases of AO31A2 with postoperative lateral femoral wall fractures and 25 cases of AO31Alater1 and AO31A2 without postoperative lateral femoral wall fractures ($P<0.008$) based on lateral femoral wall thickness.

TABLE 8: Relation between treatment outcome and lateral femoral wall thickness in different AO fracture patients

	PATIENT (N=30)	MEAN LATERAL WALL THICKNESS (MM)	RANGE OF LATERAL WALL THICKNESS (MM)	STANDARD DEVIATION
AO31A1 WITH ACTURE WALL FRACTURE	0	0	-	-
AO31A1 WITH ACTURE WALL FRACTURE	12	27.9	13.2-39	6.54
AO31A2 WITH ACTURE WALL	5	18.1	9.6-22	6.75

FRACTURE				
AO31A2 WITH ACTURE WALL FRACTURE	13	24.3	16.9-30.4	6.43

Normal fracture union and no lateral femoral wall fractures or failure seen during follow up in all the 12 patients of AO31A1 group and in 13 patients of AO31A2 group. Five patients with AO31A2 fractures had lateral femoral wall fractures out of them 4 patients achieved radiological union within 6 months, 3 patients had collapse at fracture site with varus angulation. One patient had nonunion after lateral femoral wall fracture due to excessive collapse, implant loosening and an associated infection. One patient of AO31A2 group with lateral femoral wall fracture achieved normal radiological union. The failure rate in this study is 20% in AO31A2 group with lateral femoral wall fractures. In this study no failures noted in AO31A1 group and AO31A2 without lateral wall fracture group (Table 9).

TABLE 9: Relationship between treatment outcome and lateral femoral wall fracture in different AO fracture patterns

	PATIENTS (N=30)	NO OF FRACTRES UNITED	NO OF FAILURE PATIENTS	FAILURE (%)
AO31A1 WITH LATERAL WALL FRACTURE	0	0	0	0
AO31A1 WITH LATERAL WALL FRACTURE	12	12	0	0
AO31A2 WITH LATERAL WALL FRACTURE	5	4	1	20
AO31A2 WITH LATERAL WALL FRACTURE	13	13	0	0

IV. Discussion

The aim of surgical management of intertrochanteric fractures is stable internal fixation as early as possible to promote early mobilization of the patient and preventing the complications associated with prolonged immobilization like bed sores, deep vein thrombosis an co-morbid problems like cardiovascular, renal and respiratory problems which are further aggravated due to recumbence and immobilization. Previously the condition of the posteromedial part of the proximal femur was considered as the most important prognostic factor in the outcome of fixation using DHS. DHS works on the principle of controlled concentric collapse. When the support from the medial wall is good and lateral femoral wall does not suffer the problem of excessive fracture collapse. Literature review shows, lateral femoral wall thickness measurement prior to surgery is predictive of lateral femoral wall fractures when DHS is used (5, 7).

AGE DISTRIBUTION

Most of the patients in this study belonged to the age group of 5^{th} to 8^{th} decades. Mean age in years is 64.3. Majority of cases were in age group 51-60 yrs and belong to AO31A2 type. When we compare our study with other available studies, the mean age was 78years in the study by Hsu et al (5) while in another study by Rakesh Kumar (7) the mean age is 60 years which is comparable to our study.

SEX DISTRIBUTION

Most of patients in the present study were males (53%). There was a male preponderance in our patients as they are more outgoing and engaged in activities like agriculture, driving of motor vehicles and are more likely to be involved or prone to accidents/fall. Females are involved more in household activities. When we compare our study with other available studies, the sex distribution in the study by Hsu et al (5) was 103(49.5%) males and 105(50.5%) females while in another, major study by Rakesh Kumar (7), 30(62.5%) were males and 1(37.5%) were females which is comparable to our study.

SIDE DISTRIBUTION

In this study majority cases (60%) sustained injuries on their left side. 40% cases sustained injuries on the right side. When compared with other similar studies, right side was affected in 97 cases (46.6%) and left side was affected in 111 cases (53.4%) in the study by Hsu et al (5). In the study by Barton et al (8), right side was affected in 4 cases (44%) and left side was affected in 62 cases (56%). Both are comparable to our study.

MODE OF INJURY

In this study, majority of cases (86%) were due to trivial fall at home which may be attributed to the inherent weakness of the bones in the elderly due to trivial fall at home which may be attributed to the inherent weakness of the bones in the elderly due to osteoporosis 14% of cases were due to RTA. The following factors as enumerated by Cummings and Nevitt in 1994 may be associated with the injury mechanism during fall i.e., the faller must be oriented to impact near the hip, protective reflexes must fall, local soft tissues must absorb less energy than necessary to prevent fracture and the residual energy the fall applied to the proximal femur must exceed its strength. Kenth J Koval and Joseph D Zuckerman (1996) observed that 90% of hip fractures in the elderly reslt from a simple fall. Hip fractures in young adults were observed to result most often with high energy trauma such as motor vehicular accidents or a fall from height (9). When compared with study by chandra et al (10) RTA / high velocity injury is the mode of injury in 6 cases (20%) and fall / low velocity injury is the cause in 24 cases (80%) which is comparable to our study.

CASE DISTRIBUTION

In our series, 12 cases (40%) were AO31A1 type and 18 cases (60%) were AO31A2 type. Majority of the cases belong to type AO31A2. When compared with other similar studies available, 97 cases (46.6%) were AO31A1 type and 111 cases (53.4%) were AO31A1 type in the study by Hsu et al (5) and 22 cases (45.8%) were AO31A21 and 26 CASES (54.2%) were AO31A2 type in the study by Rakesh Kumar (7).

In this study, 5 cases (17%) of postoperative lateral femoral wall fractures were noted among 30 cases of AO31A1 and AO31A2 interchanteric fractures. When compared with other similar studies, 42 cases (21%) of postoperative lateral femoral wall fractures were noted in the study by Hsu et al (5) and 9 cases (20%) were noted in the study by Rakesh Kumar (7). Both the studies are comparable to or study.

Radiological assessment

In the study out of 12 AO31A1 fractures, no patient sustained lateral femoral wall fracture postoperatively. The preoperative mean level femoral wall thickness was 27.9mm with a range of 13.2mm to 39mm. Out of 18 cases of AO31A2 fracture treated with DHS, 5 patients suffered lateral femoral wall fractures during the first month after the patients started weight bearing. The mean thickness in this group was 18.1 mm with a range of 9.6mm to 22mm. The remaining 13 patients had no lateral femoral wall fractures with a mean of 24.3mm with the range of 16.9 to 30.4mm. The mean thickness of the 25 cases (AO31A1 AND AO31A2) without lateral femoral wall fractures in this study is 26.1 mm with a range of 13.2 mm to 39mm.When compared to other available studies the mean lateral femoral wall thickness in the study by Rakesh Kumar (7) was 20mm in those with lateral femoral wall fractures and 28mm in those without lateral femoral wall fractures the mean lateral femoral wall thickness in the study by Hsu et at (5) is 18.4mm in those with lateral femoral wall fractures and 27mm in those without lateral femoral wall fractures which is comparable to our study.

The patients in AO31A1 group in our study did not suffer any lateral femoral wall fractures in the postoperative period. This may be due to the thicker lateral wall which might have reduced the occurrence of lateral wall fractures in presence of an intact medical wall. Among 12 patients in AO31A1 group all patients achieved radiological union. This may be due the well opposed fracture surfaces and a stable fixation supported by the intact medical buttress and lateral femoral wall.

The patients in AO 31A2 group might have suffered lateral femoral wall fractures in the postoperative period due to the thinner lateral wall in this group (mean thickness is 18mm) in presence of medical wall comminuting were the buttressing effect from the medial wall is lost and lead to more load acting on the lateral femoral wall on weight bearing. This hypothesis is similar to the findings of Barton et al (8). According to them, in patients with stable fractures with an intact posteromedical buttress, the load is shared between the implant and the calcar femoral; however in patients with unstable fractures, the entire load is transmitted through the implant because of the loss of this posteromedical support. But, as the implant is fixed on the lateral femoral wall, the same load acts through this anatomically important structure in the proximal femur, which has more chances of getting fractured when the thickness is less and when the medical buttressing support is lacking.

Among 5 patients of AO31A2 group with lateral femoral wall fracture postoperatively, there is lateral displacement of fracture fragments, excessive sliding of the screw within the barrel leading to collapse at fracture site, lateral displacement of the proximal fragment and medialsation of the shaft leading to various at fracture site. 4 patients achieved radiological union within 6 months, 3 had fracture collapse with various angulations. 1 patient with lateral femoral wall fracture went into nonunion due to excessive collapse, implant loosening and an associated infection. 1 patient in AO31A2 group had normal radiological union as the patient was not bearing full weight on the affected limb. 13 patients of AO31A2 group without lateral wall fracture had normal radiogical union. There is a significant difference in the mean lateral femoral wall thickness in AO 31 A2 group with lateral wall fractures (mean thickness 18.1mm) and AO31A2 without lateral wall fracrtures (mean thickness 24.3mm) Statisitistical analysis was done using student-t-test.

FAILURES NOTED

In this study, out of 5 cases of AO31A2 with lateral femoral wall fractures, 1 patent (20%) had failure due to excessive collapse with implant loosening and non union and an associated infection. No failures noted in AO31A2 without lateral femoral wall fractures and in AO31A1 group. When compared with other available studies, failure in the study by Hsu et al (5) was seen in 19 patients (49%) out of 39 patients of AO31A2 with lateral femoral wall fractures and 6 patients (8.3%) out of 72 patients of AO31A2 without lateral wall fractures and 2 patients (2.1%) out of 94 AO31A1 fractures without lateral femoral wall fractures. The difference in the results may be attributed to the small sample size in this study.

The low failure rate in AO31A1 group may be as a result of the postero medical section of the femur preventing excessive sliding of the screw and proximal fragment. In AO31A2 fractures with a lateral femoral wall fracture after implantation with DHS, the screw and the proximal fragment slide laterally and there is no structure block this movement. Further stress on the femoral head will cause screw penetration or loosening. This suggests that, an intact posteromedial femoral section provides an important support in the event of lateral wall fracture in treatment with DHS. In the absence of a stable postermedial section, the thickness of the lateral femoral wall plays an important role in treatment outcome with DHS.

THRESHOLD VALUE:

In this study, a threshold value or cut-off point of 22.1mm was taken based on ROC curve. This is the minimum thickness below which the lateral femoral wall fractures would occur when treated with DHS. When compared with other available studies, the cut-off point was taken at 20.5mm in the study by Hsu et al (5) and Rakesh Kumar (7). A difference of 1.6mm was noted compared to other studies. This may be attributed to the difference in the values of the thickness of the lateral femoral wall in each case and also the small sample size in our study.

Merits of this study:

- An assessment of the lateral femoral wall thickness can be done preoperatively using radiographs which is a simple method
- Preoperative radiological assessment of lateral femoral wall thickness is a easily quantifiable parameter
- Measures can be taken to prevent postoperative lateral femoral wall fractures by this preoperative radiological assessment
- Cost effective

Limitations of this study:

- The main limitation of this study is having less number of cases included in each group.
- Postoperative lateral femoral wall fracture were not noted in AO31A1 group may be due to the small sample size.
- The measurement is two dimensional using anteroposterior and lateral radiographs. So, chances of missing fractures not seen in these views which can be better visualized on a CT scan.
- Operations were not performed by a single surgeon and the operative skills of surgeons may have been different and could have affected the treatment outcome.
- Confounding effects of bone density and mental status of the patient have not been included.

V. Conclusions

- There is increased failure rate in AO31A2 with postoperative lateral femoral wall fracture group due to thin preoperative lateral femoral wall thickness and being treated by DHS fixation
- By measuring the preoperative lateral wall thickness in AO31A1 and AO31A2 fractures, one can expect the chances of lateral femoral wall fractures in the postoperative period if DHS is used
- 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 to reduce the chances of postoperative lateral femoral wall fractures and its complication
- A larger study is recommended to substantiate this hypothesis

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