Original Article

Risk Factors for Lag Screw Cut Out in Intertrochanteric Hip Fractures Treated with Dynamic Hip Screw (DHS) in a Tertiary Care Hospital: A Case-Control Study

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ABSTRACT

OBJECTIVE: To determine the risk factors for Lag Screw cut out in intertrochanteric hip fractures treated with Dynamic Hip Screw(DHS).

METHODOLOGY: This case-control study was conducted in the orthopedic division of Lady Reading Hospital Peshawar. The medical records of all patients fulfilling the inclusion criteria and operated on between January 2019 and March 2024 were collected from the hospital's Health Management Information System. All patients with DHS lag screw cut-outs were cases, while those without cut-outs were controls in a 1:1 ratio. Lag screw cut-out was tested for any association with other independent variables by calculating the Odds Ratio(OR), Confidence Interval(CI) and *P*-value. Multivariate analysis utilizing logistic regression was performed for all statistically significant independent variables (*P*<0.05) on univariate analysis.

RESULTS: The data of 33 patients with lag screw cut out was compared with 33 patients without lag screw cut-outs. TAD more than 25 mm was associated with a 5-fold increased risk of cut-out (*P*=0.001, aOR=5.32,95% CI=2.10-3.32). Superior and lateral lag screw position was associated with 4-fold (*P*=0.02, aOR=4.33, 95% CI=4.51-7.62) and 3-fold (*P*=0.01, aOR=3.20, 95% CI=0.07-0.08) increased risk of lag screw cut-out respectively. Poor fracture reduction was associated with a 2-fold increased risk of lag screw cut -out (*P*=0.01, aOR=2.40, 95% CI=0.02-0.06).

CONCLUSION: Increase Tip Apex Distance(TAD), superior and posterior lag screw position and poor fracture reduction were the independent risk factors significantly associated with lag screw cut-out in patients of intertrochanteric fractures treated with Dynamic Hip Screw(DHS).

KEYWORDS: Cut out, Dynamic Hip Screw, Intertrochanteric Fracture, Lag Screw, Tip Apex Distance, Risk Factors.

INTRODUCTION

Intertrochanteric hip fractures are one of the most common fractures in the elderly population and account for approximately 55% of fractures of the proximal femur.[1] These fractures have high morbidity, and their estimated one-year mortality rate is 28.2%.[2] Surgical fixation of these fractures is the gold standard, and Dynamic Hip Screw(DHS) is the most commonly used implant to fix these fractures.[3] The most critical and common mechanical complication is the cut out of the lag screw from the femoral head after fixation of intertrochanteric fracture with DHS.[4] The prevalence of DHS lag screw cut-out is approximately 10%.[5] Lag screw cut-out has significant morbidity and mortality and often requires revision surgery.[6] It has been postulated that multiple factors, including the Age of the patient, fracture type, fracture reduction and lag screw depth and position in the head of the femur, all can cause mechanical failure of DHS resulting from lag screw cut out.[7] This information, however, is based upon practical rationale and the association of lag screw cut out. These multiple risk factors, however, have never been assessed formally and in well-designed case-control studies.[8] The lack of consensus on the existing parameters for accurately predicting DHS lag screw cut out and the paucity of case-control studies on this topic are a convincing and strong rationale for conducting this study. Our study will provide clear and complete evidence of risk factors associated with lag screw cut out. A better understanding of risk factors will enable us to avert lag screw cut out and avoid revision surgeries. To the best of our knowledge, this will be the first case-control study in Pakistan to determine risk factors for lag screw cut-out in DHS surgery.

The objective of our study was to determine the risk factors for Lag Screw cut-out in intertrochanteric hip fractures treated with Dynamic Hip Screw(DHS) in Lady Reading Hospital Peshawar.

METHODOLOGY

This Case-Control study was conducted in the

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Orthopedic & Traumatology Division at Lady Reading Hospital. Before conducting this study, we obtained ethical approval from the Institutional Review Board (IRB) at Lady Reading Hospital Peshawar (Ref. No.13/LRH/MTI). The medical records of all patients fulfilling the inclusion criteria and operated between January 2019 and March 2024 were collected from the HMIS of our hospital. The sample size for this study was calculated by considering 73.36% of the cases with exposure and 40% of the control cases with exposure 9, with a 5% margin of error and 95% confidence interval (CI). The total sample size was 66 patients, out of which 33 patients were allocated to cases and 33 to controls in 1:1. Baseline demographic record, including Age, gender, side of the fracture, type of fracture, and reduction quality, was recorded. All adult patients(>18 years) of both genders with closed intertrochanteric fractures classified by AO into stable fractures types including 31A1.2(Two Part Fracture) and 31A1.3(Intact Lateral Wall) and unstable fractures including 31A2.2(One Intermediate Fragment) and 31A2.3(≥ Two Intermediate Fragment) operated within a week of sustaining the fracture, unilateral intertrochanteric fractures treated with 135 degree DHS and those with minimum 12 weeks post-operative follow up with complete radiographic and clinical record were included. Pathological intertrochanteric fractures, patients with revision DHS surgery, DHS with additional fracture stabilization implants and polytrauma patients with other fractures requiring surgery were excluded.

The extrusion or projection of DHS Lag screw > 1mm from the femoral head on the anterio posterior(AP) radiograph was labelled as lag screw cut-out. Fracture reduction was classified as Good reduction if fracture displacement (<4mm fracture on AP or lateral hip Xray) and angulation(normal Neck-Shaft angle or 130 to 150 degree valgus on AP Xray and < 20-degree angulation on lateral hip Xray are noted. The reduction was classified as Acceptable if it fulfilled any of the above criteria of displacement and angulation and Poor if none of the above was noted. The Tip Apex Distance(TAD) was measured on immediate post-operative AP and lateral radiograph in millimetres and from the tip of the head of the femur to the tip of lag screw on AP and lateral hip xrays. The location of the DHS lag screw inside the neck of the femur was noted in any one out of nine zones on the immediate post-operative AP radiograph (Superior, Central, Inferior) and lateral radiograph (Central, Posterior, Anterior). All patients with DHS lag screw cut out were cases, while all patients of DHS without lag screw cut out were controlled and matched to gender and Age with cases in a 1:1 ratio. Lag screw cut out was defined as a failure and the only dependent variable, while all others were termed as independent variables.

The data was analyzed with SPSS version 27. Descriptive statistics were used to calculate mean and standard deviation(SD) for quantitative variables like Age and TAD. Categorical variables like fracture type and side of fracture were reported as frequency and percentages. We tested our outcome variable (lag screw cut out) for any association with other independent variables by calculating Odds Ratio(OR), Confidence Interval(CI) and P value. *P*-value <0.05 was considered significant. Quantitative variables like TAD were compared amongst cases and controls by applying the Independent Sample-t test. We performed multivariate analysis utilizing logistic regression of our dichotomous dependent variable (lag screw cut out) with continuous or categorical independent variables, which were statistically significant(p<0.05) on univariate analysis. Data was presented in tables where necessary. This case-control study was conducted and reported as per STROBE guidelines proposed by Vandenbroucke *et al.*[10]

RESULTS

We compared the data of 33 patients with lag screw cut-outs (cases) with 33 patients without lag screw cut out(controls). There was no statistical difference (*P*>0.05) in the mean Age, gender, side of a fracture and mean follow-up period amongst the two groups, as shown in **Table I**. Lag screw cut-out was more common in AO fracture 31A1.2(30.30%, n=10) but no statistically significant relationship was found between fracture type and lag screw cut-out. (*P*=0.005, OR=1.00). Univariate analysis revealed that four variables, namely poor fracture reduction quality, superior lag screw position on AP radiograph, posterior lag screw position on lateral radiograph and increased TAD were statistically significant (p<0.05) in the lag screw cut-out group(cases). The mean TAD in the case group was 39.2±2.2 mm, while in the control group, it was 25.1±1.5 mm. Multivariate analysis using logistic regression of the four statistically significant variables (**Table II**) showed that TAD more than 25 mm was an independent risk factor for lag screw cut-out and was associated with a 5-fold increased risk of cut-out (*P*=0.001, aOR=5.32, 95% CI=2.10-3.32). Superior lag screw position was associated with an increased risk of cut-out four times (*P*=0.02, aOR=4.33, 95% CI=4.51-7.62). The posterior lag screw position on the lateral radiograph was associated with an increased risk of cut-out three times (*P*=0.01, aOR=3.20, 95% CI=0.07-0.08). Poor fracture reduction was significantly associated with an increased risk of lag screw cut-out two times (*P*=0.01, aOR=2.40, 95% CI=0.02-0.06) in cases than in the controls.

TABLE I: UNIVARIATE COMPARATIVE ANALYSIS OF CASES AND CONTROL FOR LAG SCREW CUT OUT

Variables	Cases (n= 33)	Control (n-33)	P value	Odds Ratio (OR)	95% Confidence Interval(CI)
Gender					
Male	16(48.48%)	16(48.48%)	0.10	NA	NA
Female	17(51.51%)	17(51.51%)			
Age(Years)	64±3.1	64±2	0.51	NA	NA
Side					
Right	14(42.42%)	16(48.48%)	1.33	NA	NA
Left	19(57.57%)	17(51.51%)			
Follow up (weeks)	12.21±2.1	13.11±1	0.32	NA	NA
AO Classification					
31A1.2	10(30.30%)	7(21.21%)			
31A1.3	7(21.21%)	9(27.27%)			
31A2.2	8(24.24%)	10(30.30%)	0.12	1.00	0.01-0.06
31A2.3	8(24.24%)	7(21.21%)			
Fracture reduction					
Good	6(18.18%)	12(36.36%)			
Acceptable	5(15.15%)	12(36.36%)	0.01	2.31	0.02-0.07
Poor	22(66.66%)	9(27.27%)			
Lag screw position on AP radiograph					
Superior	15(45.45%)	5(15.15%)			
Central	9(27.27%)	14(42.42%)	0.02	4.32	3.71-8.41
Inferior	9(27.27%)	14(42.42%)			
Lag screw position on Lateral radiograph					
Anterior	7(21.21%)	14(42.42%)			
Central	9(27.27%)	14(42.42%)	0.03	3.12	0.06-0.09
Posterior	17(51.51%)	5(15.15%)			
TAD(mm)	39.2±2.2	25.1±1.5	0.002	5.21	2.12- 7.23

TABLE II: MULTIVARIATE ANALYSIS USING LOGISTIC REGRESSION FOR LAG SCREW CUT OUT

Variables	P-value	Adjusted Odds Ratio (aOR)	95% Confidence Interval(CI)
TAD	0.001	5.32	2.10- 5.23
Superior Lag screw position on AP radiograph	0.02	4.33	4.51-7.62
Posterior Lag screw position on Lateral radiograph	0.01	3.20	0.07-0.08
Poor Fracture reduction	0.01	2.40	0.02-0.06

DISCUSSION

Our study confirmed that DHS lag screw cut-out is a multifactorial phenomenon, and increased TAD, superior lag crew position on AP radiograph, posterior lag screw position on lateral radiograph, and poor fracture reduction are the four independent risk factors which are significantly associated with DHS lag screw cut out. Selim A *et al.*[11] treated 109 patients (mean Age = 81.61±9.02 years) with intertrochanteric fractures with DHS and reported lag screw cut-out in 13(11.92%) patients. Lag screw cut-out was significantly more in AO fractures A2.2 and A2.3, poorly reduced fractures, and screw placed in Cleveland zone I and TAD>25 mm(P<0.05). Patient age, gender and Singh Osteoporosis Index(SOI) had no significant association with lag screw cut out (P=0.05). In contrast to our study, this study has two findings that are different from ours. First, lag screw cut-out was more in AO fracture types A2.2 and A2.3. Second, the lag screw cut-out was more in Cleveland zone I. The design of this study was, however, not case-control. Aboulebda M et al.[5] conducted a retrospective cohort study including 40 patients with intertrochanteric fractures treated with DHS. The mean Age was 64±20 years. The minimum follow-up period was three months. These authors reported that the screw cut-out rate was 10%(n=4) in their series. Statistically significant risk factors for screw cut-out were fracture reduction in AP radiograph(*P*=0.02) and Lateral radiograph(P=0.024), lag screw position (*P*=0.03) and TAD more than 25mm(*P*=0.02). Other factors like the Age of the patient, Body Mass Index (BMI), fracture type and surgeon experience were not associated with significant lag screw cut-out. In our study, the operating surgeons were different and had different experiences. Still, we were unable to evaluate the experience of operating surgeons as a potential risk factor for lag screw cut-out. Lopes-Coutinho L 2020[12] treated 293 fractures with DHS, and the rate of lag screw cut-out was 5.1%(n=15). He reported that TAD was an independent risk factor for screw cut-out (*P*=0.003, OR=1.10); Age, gender and fracture type, however, were not associated with statistically increased risk factors for cut-out. However, one finding of this study differs from ours and many other studies in the literature, which supports that the optimum traditional TAD value for cut-out is>25 mm. In contrast, the study noted that the risk of screw cut-out was three times when TAD was >20mm (*P*=0.025, OR=3.34, CI=1.16-9.7) and nine times(*P*<0.001, OR-8.79, CI=2.98-25.85) when TAD was >25 mm. This author explained this difference in measurement based on gender-based differences in the diameter of the femoral head. This study further added another independent risk factor for lag screw cut out called Calcar TAD(CalTAD) but noted that it was not superior to traditional TAD in predicting lag screw cut out. Siddiq K et al.[13] conducted a cross-sectional study in Bahawalpur Victoria Hospital Pakistan and treated 273 patients of mean Age 68.6 years with DHS. The lag screw cut-out was 11.2%. TAD<25 mm and inferior and posterior positioning of the lag screw had significantly higher cut-out rates than others(*P*<0.05). Morvan A et al.[14] treated 18 patients with DHS and noted lag screw cut-out in 2(13.33%) patients within three months. The cut-out was significantly higher in males (P=0.021), in poorly reduced fractures (*P*=0.00260) and with a TAD of 32.69 mm

(*P*=0.00305). This study confirmed that TAD (*P*=0.0076, OR=1.101, 95% CI=1.03-1-19), male gender(*P*=0.091), quality of fracture reduction (*P*=0.0149, OR=13.76, 95% CI=2.46-259.9) and lag screw position in AP radiograph measured by Parker's Ratio Method(PRM) are risk factors associated with lag screw cut-out. Lag screw cut-out had no significant association with patient age(*P*=0.955), degree of Osteoporosis(*P*=0.3294) and type of fracture (*P*=0.5915).

In our study, increased TAD was associated with five times increased risk of lag screw cut-out. Andruszkow H et al.[15] treated 188 patients with intertrochanteric fractures with DHS and documented lag screw cut-outs in six (3.2%) patients. These authors reported that the risk of lag screw cut out was 24 times more if TAD was kept more than 25 mm(*P*=0.003, OR=24.1, CI=1.01-1.41). Other risk factors for screw cut out were anteriorly placed lag screw in the head of the femur and improper fracture reduction with varus neck -shaft angle. Age and gender were not associated with significant lag screw cut out in this series. Hsueh KK et al.[16] treated 937 patients and reported screw cut -outs in 64(6.8%) patients. These authors revealed that TAD > 25mm was the most important and statistically significant risk factor for screw cut-out, followed by superior /posterior position of the screw, unstable fracture, poor fracture reduction and patient age (>80 years). De Bruijn K 2012[17] treated 40 patients with DHS Lag screw cut out was noted in 3 (7.5%) patients. It was observed that AO type A3 was the most critical risk factor for screw cut out (*P*= 0.004, OR=14.24, CI=2.29-88.72) followed by TAD >25 mm. (P=0.022, OR=1.11, CI=1.02-121) Central inferior Lag screw position (*P*=0.016, OR=0.08, CI=0.01-0.57). The anterior inferior position (*P*=0.027, OR-=0.07, CI=0.01-0.062) was protective against screw cut-out.

Lag screw cut-out has been associated with multiple risk factors, and the need for an integrated risk prediction model is of paramount importance. This need was fulfilled by Hsu CE et al. [7], who treated 442 intertrochanteric fractures and proposed a scoring system for accurately predicting lag screw cut out. As per Hsu CE et al. [7], posterior placement of lag screw, reduction of fracture in varus, later wall fracture after surgery, and AO type 31A2 fractures were significant predictors of DHS failure. Hsu CE et al. [7] proposed a risk score ranging from 0 to 22 with low risk (0 to 10) and high risk (11 to 22). Based on this scoring system, these authors recommended that Orthopedic surgeons confidently decide which patient would require more frequent follow-up visits and early post-operative intervention than others.

Our study had few limitations. We were not able to analyze BMI, degree of osteoporosis, comorbidities like diabetes, hypertension, ischemic heart diseases and level of competency of the operating surgeon as potential risk factors for lag screw cut-out. We therefore recommend other studies to address these limitations.

CONCLUSION

Increase Tip Apex Distance (TAD), superior and posterior lag screw position, and poor fracture reduction were the independent risk factors significantly associated with lag screw cut-out in patients of intertrochanteric fractures treated with Dynamic Hip Screw (DHS). Good fracture reduction should be obtained with the lag screw placement in the central and anterior portion of the neck of the femur and achieving TAD of less than 25 millimetres to decrease the risk of DHS lag screw cut out.

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Data Sharing Statement: The corresponding author can provide the data proving the findings of this study on request. Privacy or ethical restrictions bound us from sharing the data publicly.

AUTHOR CONTRIBUTION

Shah FA: Conception and design, acquisition of data, analysis and interpretation of data
Naeemullah: Data collection, drafting the article, critical revision for intellectual content
Iqbal MJ: Data collection & analysis
Ali MA: Final approval of the version to be published

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