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## ORIGINAL ARTICLE

# Tip-Apex Distance In Fixation of Intertrochantric Fractures By Dynamic Hip Screw

<sup>(1)</sup>Hossam Mohamed Khairy, <sup>(1)</sup>Ali Tawfik El-Alfy, <sup>(1)</sup>Ahmed Elsayed El-Malt and <sup>(1)</sup>Ramy Nabil Samy\*

<sup>(1)</sup> Orthopedic Surgery Department, Faculty of Medicine – Zagazig University, Egypt.

<sup>(2)</sup> Orthopedic Surgery Department, Faculty of Medicine - Assiut University, Egypt.

### Corresponding Author:

Ramy Nabil Samy.

### Email:

ramy.beskales.ortho@gmail.com

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### ABSTRACT

**Background:** Fixation of Intertrochanteric Fractures with Dynamic Hip Screw allows compression of the fracture when patient starts weighing. Placement of lag screw should be central in head and neck of femur. This study aimed to emphasize the clinical value of the tip apex distance as a reliable predictor of cut-out of lag screw in fixation of stable fractures.

**Methods:** This is a retrospective cohort study included 18 cases, skeletally mature patients with post traumatic intertrochanteric fractures treated with DHS in the period from January 2016 to December 2016 with follow up 6 months at least at Zagazig University Hospital. Intertrochanteric Fractures were internally fixated with DHS, and by follow up postoperatively, we measured TAD index post operatively and after 6 months by summation on x rays, after correction had been made for magnification to detect the importance of TAD on stability of lag screw in the head and neck of femur and reported cases that developed cut through of lag screw.

**Results:** TAD is the main measurement in the study .The rate of implant failure and cut through was (27.8%).the median of TAD postoperative was (2.05).the median of TAD after 6 months was (2.23).

**Conclusions:** TAD of less than 25mm is safe .If TAD is more than 25mm, it may result in penetration of implant, non-union, cut through and other complications. So TAD is a reliable factor and has a great value in DHS operations.

**Keywords:** Value of Tip-Apex Distance (TAD), cut through, dynamic hip screw (DHS).



### INTRODUCTION

Fractures of proximal femur is a common problem seen, among which are the extra capsular fractures such as intertrochanteric and pertrochanteric fractures also known as peritrochanteric fractures, and usually managed by open reduction and internal fixation by dynamic hip screw (DHS) or compression hip screw (CHS)[1]. The dynamic hip screw is based on tension band principle which allows the screw to slide within the barrel, so that the fracture can be compressed when the patient starts to bear weight. This principle only works in the presence of intact medial wall, so that a reverse oblique fractures of the proximal femur can not be effective[2]. However, it is critical that the technique of screw placement is correct and should be central in the femoral neck, on both AP and lateral radiographs. That's why the idea of Tip Apex Distance (TAD) is critical to the outcome of fixation and can accurately predict failure or stability of the screw

[3]. The theory of Tip Apex Distance was introduced by Baumgaertner et al. in 1995, and later in 1997 as they confirmed the importance of good surgical technique in the treatment of trochanteric fractures using the TAD as a clinically useful way to describe the position of the screw [4]. The Tip Apex Distance is the sum of the distance from the tip of the screw to the apex of the femoral head on AP and lateral views. The Tip Apex Distance (TAD) should be less than 25 mm to prevent DHS cut-out or failure, which most often happens if the screw is placed too anterior or too superior [5]. The aim of this study is to emphasize the clinical value of the tip apex distance as a reliable predictor of cut-out of the lag screw in DHS used for fixation of stable intertrochanteric fracture of the hip.

### METHODS

This is a retrospective cohort study included 18 cases, skeletally mature patients with post traumatic intertrochanteric fractures treated with

DHS in the period from January 2016 to December 2016 with follow up 6 months at least at Zagazig University Hospital. ITF were internally fixated with DHS, and by follow up postoperatively, we measured the TAD post operatively and after 6 months to detect the importance of TAD on stability of lag screw in head and neck of the femur and reported cases that developed cut through of lag screw.

**Ethical Clearance:** Written Informed consent was taken from the patient to participate in the study. Approval for performing the study was obtained from Orthopedic Surgery Departments, Zagazig University Hospitals after taking Institutional Review Board (IRB) approval. The work has been carried out in accordance with the code of ethics of the world medical association (Declaration of Helsinki) for studies involving humans.

**Inclusion criteria:** Patients with isolated intertrochanteric femur fracture. Fracture fixation was done by DHS.

**Exclusion criteria:** Pathological fracture. There were pre-existing femoral acetabular deformities such as coxa vara, acetabulum dysplasia or previous malunion. Intertrochanteric Femoral fracture with associated posteromedial comminution and reverse obliquity.

All patients were subjected to complete clinical and Radiological evaluation : x ray was done in anteroposterior, lateral views and anteroposterior pelvis with traction and internal rotation of the lower limb. Beside the routine preoperative investigations that were carried out for all patients, further special investigations were requested by anesthesiologist to complete anesthetic judgment. Two units of blood were prepared for each patient, but their use was according to the individual situation.

All the patients received a single dose of prophylactic antibiotic third generation cephalosporin 1000mg was given 30 minutes before incision as prophylaxis , every 12 hours and continued for 3 days postoperatively

Quality of reduction was measured on the amount of displacement and neck-shaft alignment on immediate postoperative AP and lateral radiographs, as stated by Michael Baumgaertner, Brian D. Solberg[4] , being graded as good, acceptable or bad. A good reduction occurred in usual or slightly valgus neck-shaft alignment on the AP radiograph, under 20 ° angulation on the lateral and less displacement. Acceptable cuts met the alignment or displacement criteria, but not both. Weak reductions meet no requirements at all. Implant size and angle for prospective and retrospective groups have been reported.

**Method of measurement of Tip Apex Distance**

- A line drawing showing the measurement of the tip apex distance (TAD).
- Use of the true diameter of the screw (D true) controlled for magnification.
- (D true) is the known diameter of the lag screw. (D ap) is the measured diameter of the lag screw on an anteroposterior radiograph .( D lat) is the measured diameter of the lag screw on a lateral radiograph. (X ap) is the distance from the tip of the screw to the center of the femoral head on an anteroposterior radiograph. (X lat) is the distance from the tip of the screw to the center of the femoral head on a lateral radiograph.
- Tip Apex Distance is measured by the summation of the distance in millimeters from the tip of the lag screw to the apex of the femoral head as measured on an anteroposterior radiograph and that distance as measured on a lateral radiograph after correction has been made for magnification.
- The Apex of the femoral head is the point of intersection between the subchondral bone and a line in the centre of and parallel to the femoral neck.
- The amount of radiographic magnification shall be determined by dividing the diameter of the projected shaft of the screw as seen on the radiograph by its known diameter and correction will achieve by multiplying the measurement of the distance by this factor. The radiographs will assess union, nonunion and screw cut out as end points.(Figure 1)

$$TAD = X_{AP} \cdot \left( \frac{D_{true}}{D_{AP}} \right) + X_{lat} \cdot \left( \frac{D_{true}}{D_{lat}} \right)$$

**Postoperative Management:**

In the recovery room; the patient pulse and blood pressure was checked. Three patients needed to enter the intensive care unit postoperatively and discharged in the second day .15 patients were admitted to the department without ICU need.

**Follow up:**

DVT prophylaxis was done using oral anticoagulant. Immediate postoperative evaluation of TAD was done before discharging of the patient from the hospital .First Follow up out clinic was done after two weeks from surgery to remove the sutures. Protected weight bearing using crutches advised after 6-8 weeks or until full union detected by x ray. Data collected by immediate postoperative imaging and outpatient clinic follow up after 2, 6 months . Clinically by tenderness, range of motion. uber test. radiologically anteroposterior and lateral, tip apex distance, union callus , bone bridge, malunion, varus deformity, shortening measured by tape, complication of metal as osteolysis , metal failure , cut through and infection.

**STATISTICAL ANALYSIS**

The data Categorical variables were described by number and percent (N, %), where continuous variables described by mean and standard deviation (Mean, SD, Median). Chisquare test used to compare between categorical variables where compare between continuous variables by t-test and Independent-Samples T test. Two-tailed  $p < 0.05$  was considered statistically significant. All analyses were performed with the IBM SPSS 20.0 software.

**Case:** Male patient, 59 years old, fall on ground. X-ray: Non displaced Intertrochanteric fracture in left femur. ORIF was done by DHS. Acceptable quality of reduction.

TAD measurement postoperative was (2.88 cm). After 6 months there was defect union with partial weight bearing on crutches, suffering from pain on left hip and limbing. TAD measurement was (3.7 cm) .there was cut through of lag screw from femoral head.

**RESULTS**

This study was performed on 18 cases , 14 male(77.8%) and 4 females(22.2%).

There were 5 case with cut through complication (27.8% of total cases) and 13 cases without cut through (72.2% of total cases).

The median of postoperative TAD measurement that developed cut through was [2.89(2.57-3.04)], and the median of postoperative TAD measurement that didn't develop cut through was [1.8(1.71-2.22)]. The median of TAD measurement after 6 months that developed cut through was [3.59(2.7-4.11)], and The median of TAD measurement after 6 months that didn't develop cut through was [2.17(1.96-2.27)]. (**Table 1**) TAD is the main measurement in the study that can detect the outcome of DHS fixation especially for cut through of lag screw. The median of TAD postoperative was [2.05(1.72-2.74)] .the median of TAD after 6 months was [2.23(1.98-2.70)]. There is a statistically significant difference between TAD postoperative and TAD after 6 months ( $p$ .value=0.020). There is a highly significant difference between the median of TAD postoperative that developed cut through of lag screw and the TAD postoperative that didn't develop cut through ( $p$ .value<0.001). **Table 2**

**Table 1:** Relation between degrees of quality of reduction and cut through:

Quality of reduction	Cut Through				P. value
	Yes		No		
	No.	%	No.	%	
Good	0	0.0	9	69.2	0.031*
Acceptable	4	80.0	3	23.1	
Poor	1	20.0	1	7.7	

**Table 2:** Comparison between TAD in postoperative and 6 month according to cut through

Cut Through	Yes	No	P. value
	Median (IQ)	Median (IQ)	
TAD - postoperative	2.89(2.57-3.04)	1.8(1.71-2.22)	<0.001**
TAD- 6 month	3.59(2.7-4.11)	2.17(1.96-2.27)	<0.001**

Mann-whitney U,

\* Statistically significant difference ( $p < 0.05$ ),

\*\* Highly statistically significant difference ( $p < 0.01$ ).

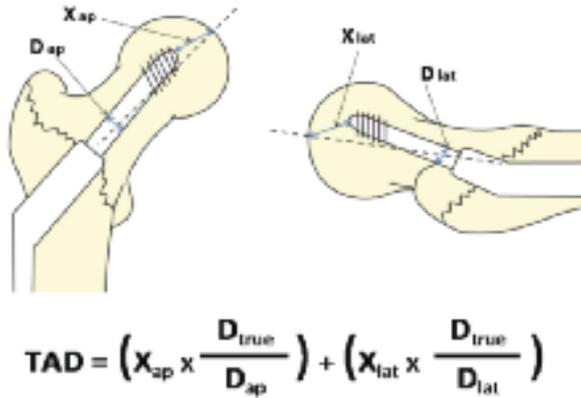
**Table 3:** Comparison between TAD in postoperative and 6 month with significance

	Median (IQ)	P. value
TAD _postoperative	2.05(1.72-2.74)	0.020*
TAD_6month	2.23(1.98-2.70)	

Wilcoxon test

\* Statistically significant difference ( $p < 0.05$ )

\*\* Highly statistically significant difference ( $p < 0.01$ ).

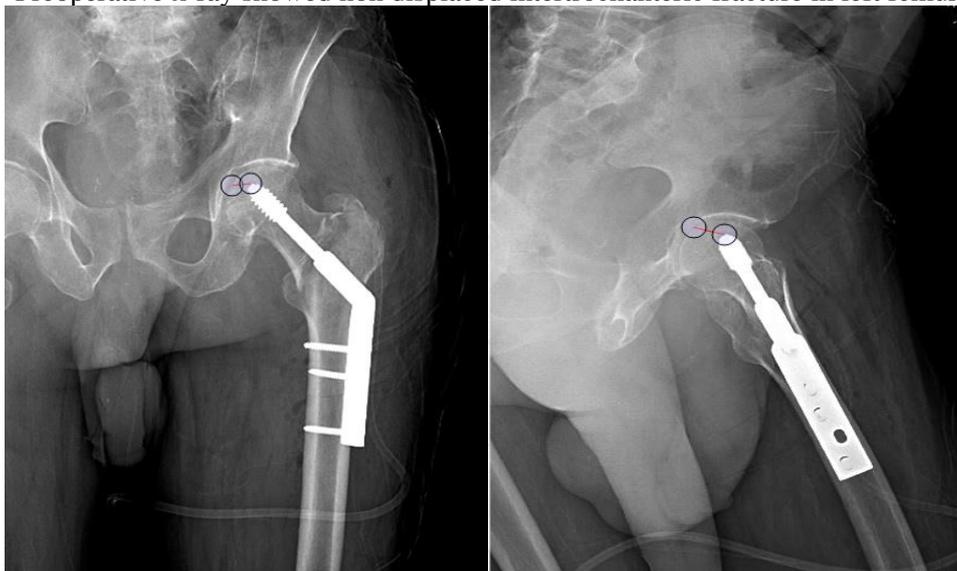


**Figure I:** summation of TAD



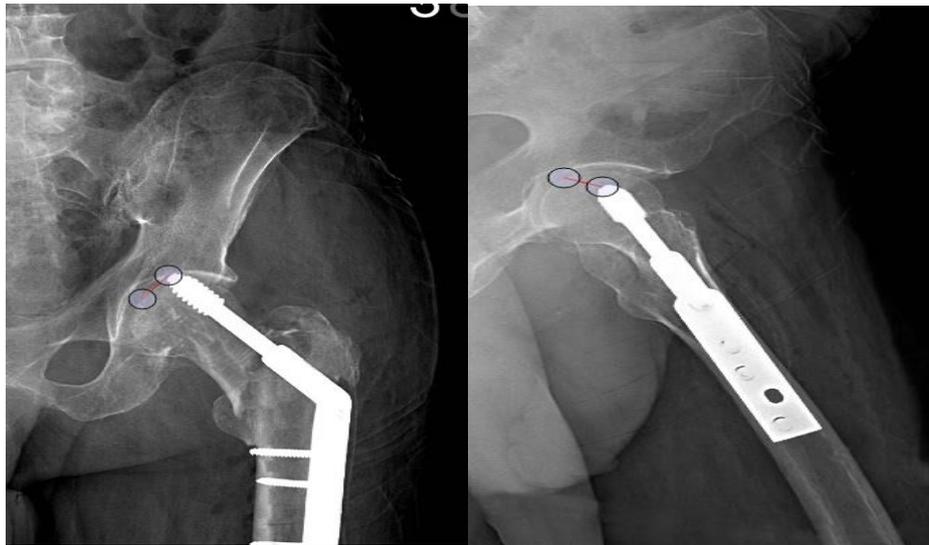
**Figure II:** preoperative x ray AP, lateral view  
Male patient, 59 years old , fall on ground

Preoperative x-ray showed non displaced intertrochanteric fracture in left femur



**Figure III:** postoperative x ray after fixation by DHS

Postoperative study revealed acceptable quality of reduction .TAD measurement summation was (2.88 cm) in AP and lateral view.



**Figure IV:** after 6 months x rays AP and lateral view.

After 6 months there was defect union with partial weight bearing on crutches, suffering from pain on left hip and limbing. TAD measurement was (3.7 cm). there was cut through of lag screw from femoral head.

### DISCUSSION

Proximal femoral fractures are common in the elderly and result in a heavy burden to the affected individuals and on society, increasing the prevalence with more aging population. Early operative management reduces both mortality and morbidity, providing the best chances of early independence and reducing the risk of long time bed rest [6]. Internal fixation enables early mobilisation. Dynamic hip screw has been widely used but is associated with multiple challenges. The ideal implant should be easy in handling, enable full weight bearing in immediate postoperative state and provide sufficient purchase in the femoral head/neck fragment to decrease cut-outs secondary to varus complications and rotation. [7] There were high cut-out, varus-displacement rates, wound problems, and infections, for unstable trochanteric fractures treated with extramedullary devices such as the DHS. In stable fractures, extramedullary devices are considered superior to intramedullary ones. [8]. The value of the position of the screw within the femoral head was recognized in the anteroposterior radiograph and posterior in the lateral radiograph aiming for better bone stock in the femoral head, However by positioning the screw inferiorly and posteriorly, the tip of the screw ended in more cancellous bone and not in the preferred subchondral bone which was shown to cause failure of the implant [9]. However, in most of the studies, the incidence of intertrochanteric fractures in females was high ranging from 1.5 to 12 times more than males as Johnell O Kj has noticed (10). Our study showed male predominance because there is number of patients whose mechanism of injury was RTA were males due to their occupation circumstances.

Quality of reduction was classified into 3 groups as Michael R. Baumgaertner, Brian D. Solberg [4] noted that Reduction was assessed on the amount of displacement and neck-shaft alignment on immediate postoperative AP and lateral radiographs, being categorised as good, acceptable or poor [4]. Agni Sellers. Johnson et al, have shown that there are predictive factors for lag screw cut-out, the most important determining factor is the TAD, as well as other factors including the degree of comminution of the fracture site and quality of reduction .that is demonstrated by our study [11]. But, In our study, we found that TAD of 5 cases were above 25 mm postoperatively .4 cases from them: developed cut through of lag screw from femoral head after 6 month by follow up radiologically ,and 1 case from them : TAD above 25 mm but don't develop cut through that explained by good bone quality intact lateral wall, no technical errors young age thin patient delayed weight bearing these factors also detect presence of cut through beside measurement of TAD .Also, Study include 13 case that TAD measured was below 25 mm , 12 case from them didn't develop cut through , and 1 case from them developed cut through .also this is explained in Hseuh FC, CHEN CM et al study[3]. Therefore , Davies , Mokawem and Guy noted that there are other factors which evaluate incidence of cut through as infection, posteromedial comminution , osteolysis , quality of reduction , severe osteoporosis and The quality of bone for purchase within the head and neck varies from one quadrant to another. The optimal position of a compression screw should be central or slightly central inferior. The bone of poorest quality is in the anterosuperior quadrant of the head and neck [5].

The incidence of screw cut out ranges from 2.0% as reported by Mainds et al., [12] to as high as 12.6%. In the present study, we found another results in that the incidence of screw cut-out was 27.8%. In our study, the patients were allowed up in a chair, the day after surgery. When active straight leg raising became possible, partial weight-bearing with crutches or a walker was allowed, Progressive weight-bearing was based on radiographic evidence of callus formation, and this protocol was explained by AL-Obidi FAA [9] who noticed that restricted weight bearing after hip surgery has no biomechanical justification.

### CONCLUSION

TAD of less 25mm is safe and more than 25mm may result in penetration of implant, non-union, cut through and other complications. So TAD is a reliable factor and has a great value in DHS operations.

**RECOMMENDATION:** We recommend that this TAD principle is emphasized and regularly reinforced to all orthopedic trainees beside other factors that can judge the outcome of intertrochanteric fractures of the hip fixed with DHS. So can improve the safety and quality of life for those patients.

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