Intertrochanteric fracture fixation with Dynamic Hip Screw: Is tip-apex distance measurement useful for predicting fixation failure?

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ABSTRACT

Introduction: Application of dynamic hip screw (DHS) implant for the treatment of unstable intertrochanteric fractures continues to raise concern related to risk of lag screw cut-out with or without subsequent damage to the acetabulum. Measurement of tip-apex distances (TAD) has been recommended to guide the optimal placement of lag screw and to predict subsequent risk of screw cut-out. In this study, the value of TAD was evaluated to verify its usefulness. **Methods:** This is a retrospective study of 33 consecutive patients with intertrochanteric fracture treated with DHS. Demographic data of the patients were traced from their case notes. Post-operative radiographs were reviewed by focusing on measurement of TAD on anteroposterior and lateral radiographs. Radiographs at one year follow-up were reviewed to depict any fixation-related failure or complication. **Results:** Fifty two percent of patients did not achieved the recommended TAD of ≤ 25mm. The mean post-operative TAD was 25.9mm and elderly patients were likely to achieve TAD of ≤ 25mm. The overall complication rate of 6% was attributed to screw cut-out in two cases. The unstable left-sided fracture was identified to be a potential risk for screw cut-out or migration. **Conclusion:** TAD is a valuable measurement to guide optimal placement of lag screw during DHS fixation of intertrochanteric fracture.

KEYWORDS: *Intertrochanteric fracture, dynamic hip screw, tip-apex distance, screw cut-out.*

INTRODUCTION

Intertrochanteric fractures represent the commonest proximal femoral fractures encountered in orthopaedic practice. In Malaysia, elderly subjects are commonly afflicted with a prevalence of 90 per 100,000 population.[1] Dynamic hip screw (DHS) fixation is currently the gold standard treatment as this fixation device has been reported to have low complication rate when properly used for fixation of stable intertrochanteric fractures.[2] However, its application for the unstable subset of intertrochanteric fractures remains controversial with concern related to high-risk of fixation failures: lag screw cut-out with subsequent damage to the acetabulum, lateral back-out of lag screw, implant disengagement, malunion and non-union.[3] The tip-apex distance (TAD), which is a measurement of the position of the tip of the lag screw in femoral head, has been shown to be a reliable predictor of screw cut-out when the threshold value is more than 25mm.[4] The objective of this study is to determine whether the TAD has a significant influence on the outcome of intertrochanteric fractures in a local population.

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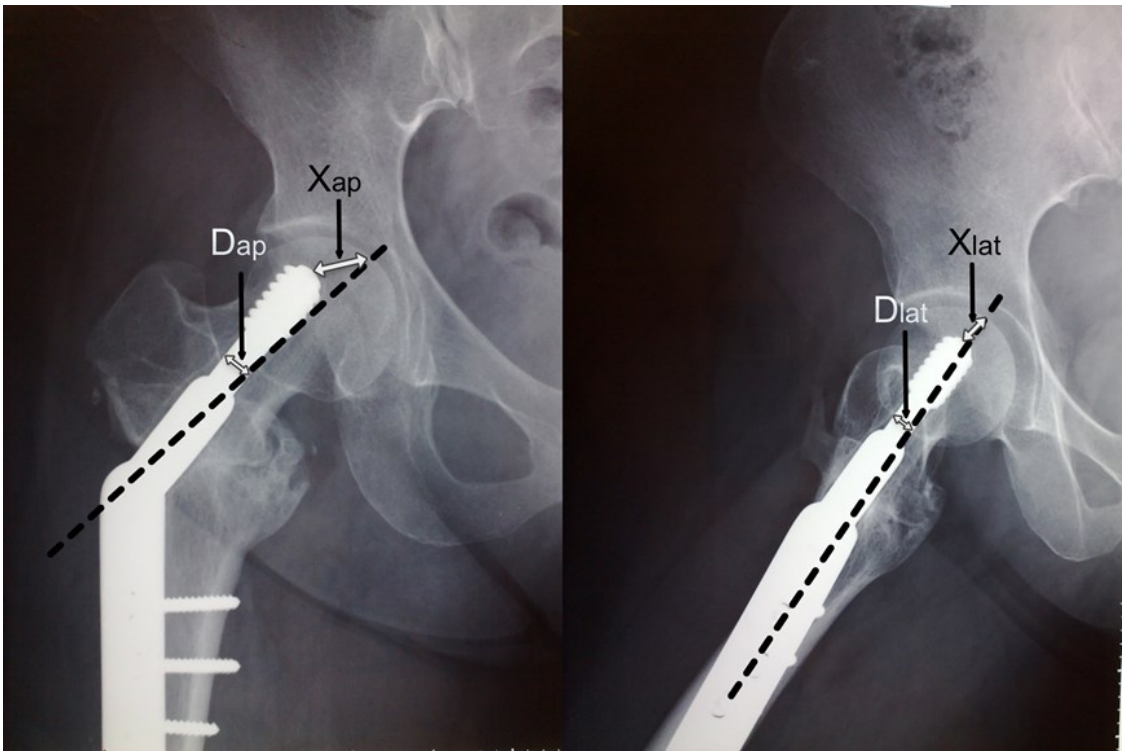
MATERIALS AND METHODS

Medical records of 33 adults and elderly patients admitted for intertrochanteric fracture and treated with DHS from January 2005 to December 2010 were reviewed. Subjects above 18 years of age were included and those with multiple long bone fractures, segmental fracture of the femur, pathological fractures and previous hip surgery were excluded.

The radiographic measurement of TAD according to the technique described by Baumgaertner *et al.*[4] was used. The TAD measurement takes into consideration both the location and depth of screw penetration. The TAD was defined as the sum of the distances from the apex of the femoral head to the tip of the lag screw on anteroposterior and lateral radiographs. Measurement was corrected for the magnification by using the known diameter of the shaft of lag screw as reference (Figure 1). The post-operative TAD was compared with the TAD at one year post-surgery to indicate screw migration.



$$TAD = (X_{ap} \times \frac{D_{true}}{D_{ap}}) + (X_{lat} \times \frac{D_{true}}{D_{lat}})$$

Figure 1: Method of measuring and calculating the TAD

The TAD of 25mm was used as reference threshold value to predict the risk of screw cut-out. Statistical analysis was performed using PASW/SPSS version 18 for windows. For all test, statistical significance was considered at *p*-value of < 0.05.

RESULTS

There were 20 male patients (61%) and 13 female patients (39%) with mean age of 59 years (range: 18-89 years). Malay patients accounted for 67% followed by Chinese (24%), Indian (6%) and foreigners (2%). The right-sided fractures were encountered in 52% of cases. The most common mechanism of injury in elderly patients indicated fragility fracture due to low-energy fall (61%). Motor vehicle accident (33%) and industrial accident (6%) accounted for the mechanisms of injury in young adults.

Stable fractures as defined according to the AO classification system, accounted for 58% of 33 fractures. Fracture personality factors: side of fracture and fracture stabilty, were not found to influence the TAD (Table 1). We acknowledge that this is most likely due to the relatively low number of failures in our study.

Table 1: Overview of the patients (N=33) with and without screw cut-out

	TAD		*p*-value
	≤ 25mm	>25mm	
Age	68.3 (13.78)	50.3 (21.31)	0.007
Race			
Malay	8 (36%)	14 (6.4%)	
Chinese	7 (88%)	1 (22%)	0.054□
Indian	1 (50%)	1 (50%)	
Others	0 (0%)	1 (100%)	
Gender			
Male	7 (35%)	13 (65%)	0.058*
Female	9 (69%)	4 (31%)	
Side			
Right	7 (41%)	10 (59%)	0.387
Left	9 (56%)	7 (44%)	
Fracture Stability			
Stable	10 (53%)	9 (47%)	0.579
Unstable	6 (43%)	8 (57%)	
Screw cut-out			
No	16 (52%)	15 (48%)	0.48*
Yes	0 (0%)	2 (100%)	

* Fisher exact test, exact sig. (1-sided), □Computed for 2X2 table (Malay vs The rest)

The recommended TAD distance of ≤ 25mm was not achieved in 52% of patients. The mean immediate post-operative TAD 25.9±8.68mm was not significantly altered after one post-operative year (mean TAD 25.5±8.68mm). Elderly patients with mean age of 50 years have higher likelihood to achieve TAD of < than 25 mm (*p*-value of 0.007). Two patients from with TAD of > 25mm developed screw cut-out/superior migration giving rise the overall complication rate of 6% but it was not statistically significant when compared with those with TAD of < 25mm. This outcome is most likely due to the relatively low number of failures in our series. Patients with TAD of <25 mm were free of complication. Other implant-related failures: acetabular penetration, implant breakage or disengagement, non-union and malunion were not observed.

DISCUSSION

Intertrochanteric fractures continue to be a 'disease' of elderly population with a raising trend of incidence attributable to an increasing aging population.[5,6] Its predominant mechanism of injury, low-energy fall, indicates fragility fractures among elderly in our study population. Other studies have shown that most fractures were domestic injury affecting elderly individuals with either health-compromised premorbid or poor ambulatory status, and more than 75% of fractures resulted from a fall while standing or walking.[7-9]

Prediction of the outcome of DHS fixation by radiographic measurements has been extensively studied. Measurement of TAD as described by Baumgaertner *et al*.[4] has been used to guide an optimal placement of lag screw. It is importance to recognize that the TAD measurement is evaluated in two dimensions accounting for both the location and depth of lag screw penetration. A concentrically placed lag screw will have a lower TAD than an eccentrically placed screw.

In our study, only 48% of fixation managed to achieve TAD of < 25mm and this was particularly a common occurrence in elderly patients. The reason for this occurrence probably related to the awareness that deeper placement of lag screw tip to engage subchondral bone has a strong purchase on the osteopenic bone in the elderly. We also found that our 6% complication rate was attributed to eccentric screw placement with TAD of more than 25 mm. Study by Pervez *et al*.[10] indicated that that low rate of screw cut-out was correlated with TAD of less than 20 mm and fracture reduction in valgus position. Similar results were duplicated by

Chua *et al.*[11] by emphasising a relationship between TAD threshold value of >20mm and risk of screw cut -out in Asian patients. The screw cut-out rate was found to be more than 20% if the TAD exceeded 25 mm as compared with TAD of < 20 mm.

Fracture stability was not found to influence the final outcome of this study. The relationship between left-sided fracture and the development of unstable reduction due to re-displacement of fracture fragments has been highlighted by Mohan *et al.*[12] It was speculated that left-sided fracture tended to have displacement of the proximal fragmant due to torque created by clockwise rotation of lag screw during its insertion.

In contrary, the torque effect of clockwise rotation of lag screw compresses the right-sided fracture site and hence increases stability of the fracture. Surgeons confronted with left-sided unstable intertrochanteric fractures should be aware of the possibilty of creating excessive torque effect during insertion of lag screw for the unstable fractures with eventual fixation of a non-anatomically reduced fracture. This can be addressed by provisionally fix the main fragments with a large-diameter Kirschner wire to enhance stable reduction and to negate rotation during insertion of lag screw. Rehabilitation of a non-anatomically reduced unstable intertrochanteric fracture will endure significant torsional force. Torsional force acting on the head-neck segment of the proximal femur normally occurs during gait and this provides an explanation for the evolving superior migration and subsequent screw cut-out following fixation of an unstable fracture with a non-concentrically placed lag screw and a long TAD.

CONCLUSIONS

A satisfactory outcome of intertrochanteric fracture fixation can be expected with the use of DHS provided the lag screw is optimally placed. This interdependently requires anatomical reduction to impart inherent stable reduction and placement of lag screw tip enganging the subchondral bone in central-central positions on both AP and lateral radiographs.

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