

Importance of Tip Apex Distance in Management of Intertrochanteric Hip Fractures by The Use of DHS

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ABSTRACT

Background: Hip fractures in older adults most commonly involve the femoral neck and intertrochanteric regions. Early surgical fixation followed by mobilization is essential to limit complications such as thromboembolism and pneumonia. The dynamic hip screw (DHS) remains a standard technique for stabilizing intertrochanteric fractures. Among the factors influencing fixation success, the tip–apex distance (TAD) has been identified as a key radiographic measurement that correlates with implant stability and the risk of cut-out.

Objective: To evaluate the efficacy of TAD in prediction of both clinical and radiological outcomes in patients undergoing DHS fixation for intertrochanteric fractures.

Patients and Methods: A retrospective analysis was performed on 100 consecutive cases managed at Helmya Hospital, Cairo, between July 2021 and July 2022. All patients received DHS fixation for intertrochanteric fractures. Preoperative evaluation included clinical and radiological assessment. Postoperative TAD was measured on standard anteroposterior and lateral radiographs. Pain and function were assessed using the visual analogue scale (VAS), and radiographic follow-up continued for 12 months, focusing on screw cut-out.

Results: The study included 76 females and 24 males, with a mean age of 65 years. There was a statistical significance correlation between larger TAD values and screw cut-out rates ($P < 0.01$). Postoperative VAS scores improved significantly ($P < 0.001$). Two cases (10%) developed screw cut out.

Conclusion: TAD is a reliable indicator of fixation success in DHS treated intertrochanteric fractures. Achieving a TAD within the optimal range intraoperative significantly lowers the risk of screw cut out and improves outcomes.

Keywords: Tip–apex distance; Intertrochanteric fractures; Dynamic hip screw; Fixation failure; Hip surgery.

INTRODUCTION

Fractures involving the intertrochanteric area and femoral neck make up the majority of hip fractures in the elderly. Early operative fixation and postoperative mobilization are crucial in minimizing complications related to immobilization, such as pneumonia, thromboembolic events, and increased mortality⁽¹⁾.

The dynamic hip screw is one of the most commonly used fixation devices for stable intertrochanteric fractures. The lag screw slides within the barrel, allowing controlled collapse at the fracture site during weight-bearing, provided medial cortical support remains intact⁽²⁾. Despite modern advances, mechanical failure of DHS fixation occurs in 6–13% of cases, most often due to varus collapse or lag screw cut-out⁽³⁾. To standardize assessment of screw placement, **Baumgaertner et al.** introduced the tip–apex distance (TAD) concept⁽⁴⁾. TAD is determined by adding the distance from the screw tip to the femoral head apex on both anteroposterior and lateral radiographs. Their study showed that $TAD < 25$ mm was associated with no screw cut-out, whereas $TAD > 30$ mm carried a failure risk of approximately 27%. **Pervez et al.** later suggested targeting $TAD < 20$ mm to further lower complication rates⁽⁵⁾. Incorrect screw positioning, especially superior or anterior placement has been identified as a major predictor of failure⁽⁶⁾.

Screw cut-out remains the leading mechanical complication following DHS fixation and often necessitates revision surgery—a high-risk procedure for elderly patients with multiple comorbidities. Consequently, careful intraoperative placement to achieve an optimal TAD is critical for reducing failure rates in both stable and unstable intertrochanteric fractures.⁽⁷⁾

This study aims to examine the predictive role of TAD in evaluating the risk of screw cut-out among patients treated with DHS fixation for intertrochanteric fractures.

PATIENTS AND METHODS

Study Design and Setting

This retrospective observational study was carried out at Al Helmya Military Hospital in Cairo, Egypt. Data were collected between July 2021 and July 2022, with the final follow-up completed in May 2022.

Patient Population

A total of 103 consecutive patients with intertrochanteric fractures who underwent surgical stabilization using DHS were included. Preoperative evaluation involved standardized clinical assessment and plain radiographs. Postoperative follow up by plain

radiography (immediate post-operative, monthly till union and at 6, 9 and months and at 12 months. VAS was obtained at each visit.

Inclusion Criteria

- Patients of any age with intertrochanteric fractures managed by DHS fixation.
- Availability of complete pre- and postoperative radiographic records.
- A minimum follow-up period of 9 months.

Exclusion Criteria

- Revision surgery involving the same anatomical region.
- Pathological fractures due to malignancy.
- Active infection, either local or systemic.
- Patient refusal to undergo the procedure or follow-up.
- Missing clinical or imaging data.
- Documented hypersensitivity to implant materials.
- Contraindications to anesthesia.

Surgical Technique

All surgeries followed the standard DHS fixation protocol. Under fluoroscopic control, anatomical reduction was achieved. A lag screw was inserted with careful attention to positioning for optimal alignment. Postoperative anteroposterior and lateral radiographs were used to calculate the TAD following **Baumgaertner's** method⁽⁴⁾, by adding the distances from the tip of the screw to the apex of the femoral head on both radiographic views.

Outcome Measures

Radiographic assessment concentrated on postoperative TAD and the occurrence of screw cut-out during the follow-up period. Clinical evaluation was performed using VAS to measure pain levels preoperatively and postoperatively.

Ethical considerations:

Ethical approval was obtained from the institutional review board of Military Medical Academy, and informed consent was secured from all participants prior to their inclusion in the study. The study followed The Declaration of Helsinki through its execution.

Statistical Analysis

Data were analyzed using standard statistical software IBM SPSS Statistics for Windows, Version 26.0; IBM Corp., Armonk, NY, USA. Quantitative variables were summarized as mean $\pm$ standard deviation, whereas categorical data were expressed as frequencies and percentages. The correlation between TAD and the incidence of screw cut-out was examined using Pearson's

correlation coefficient for continuous variables and the Chi-square test for categorical associations. Differences in mean values between groups were analyzed using the independent samples t-test. A P-value < 0.05 was considered statistically significant.

RESULTS

This retrospective study included 100 patients (76 female and 24 male) which was diagnosed with intertrochanteric femoral fractures, managed using DHS fixation. The average follow-up period was 9 months, with a range from 6 to 12 months and the mean age was 69 ± 8.1 years (Range: 50–80 years). (Fig.1,2)

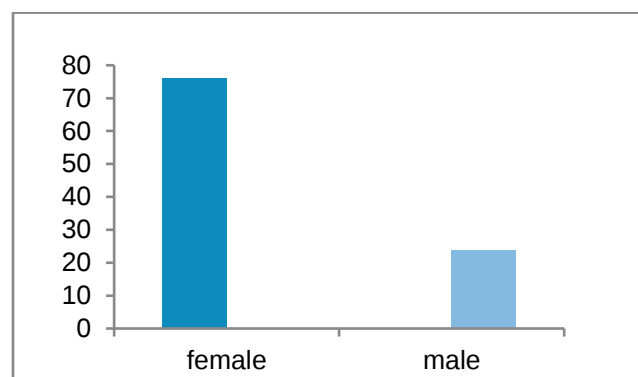


Figure 1: Gender distribution.

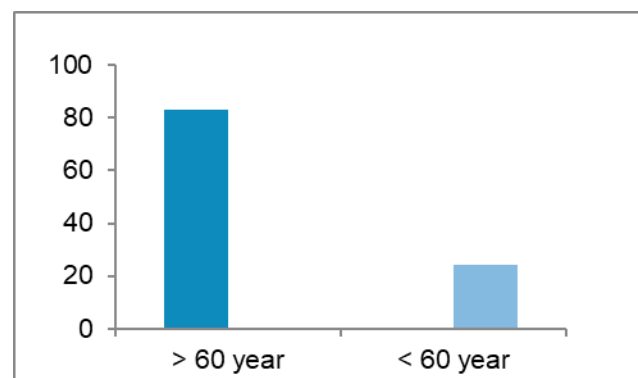


Figure 2: Age distribution.

Demographic and Operative Data (Figures 1-3 and table 4)

The mean duration of surgery was 131.4 ± 23.2 minutes (Range: 100–180 minutes). The hospital stays 3.2 ± 0.7 days, typically between 3 and 4 days. Estimated blood loss during surgery 370.4 ± 24.3 mL (range: 200–600 ml). Five patients (5%) required a postoperative blood transfusion.

Clinical Evaluation

Pain was assessed using the VAS at baseline (preoperatively) and during follow-up visits at 1, 3, 6, and 12 months (Figure 3). The mean preoperative VAS score was 8.1 ± 0.9 , which decreased to 4.3 ± 0.8 at 1 month,

3.1 ± 0.7 at 3 months, 2.4 ± 0.6 at 6 months, and 1.8 ± 0.5 at 12 months. A statistically significant reduction in mean VAS was documented at 1 month postoperatively compared with preoperative scores ($P < 0.01$). Continued assessment at 3, 6, and 12 months showed a highly significant progressive improvement in pain levels over time ($P < 0.001$).

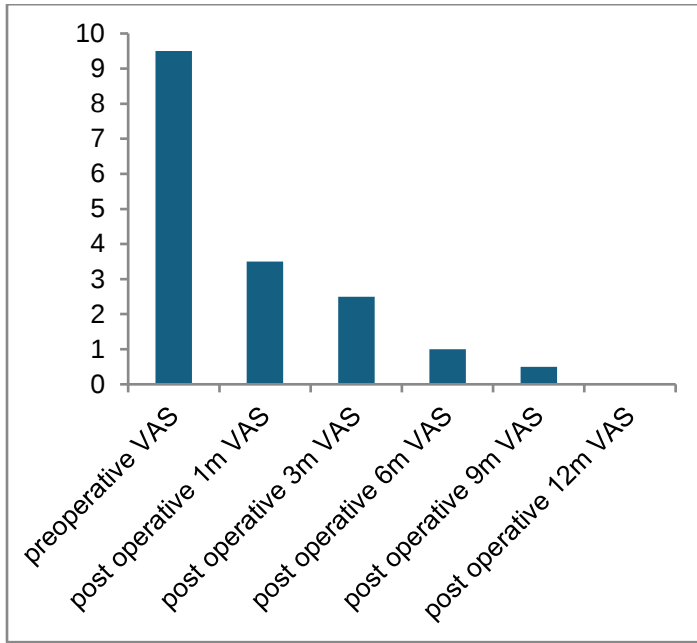


Figure 3: Pain assessment scores statistics.

Radiological Evaluation (Table 1)

TAD was measured on immediate postoperative anteroposterior and lateral radiographs. Statistical analysis demonstrated a strong relationship between increased TAD values and the occurrence of screw cut-out ($F = 17.825$, P value < 0.001). The F value represents the test statistic obtained from a one-way analysis of variance (ANOVA) comparing the mean TAD values between the screw cut-out group and the no cut-out group. The mean TAD in the screw cut-out group was 33.5 ± 2.1 mm, compared with 22.4 ± 3.6 mm in the group without cut-out. Patients with larger TAD measurements were therefore at a significantly greater risk of mechanical failure.

Table 1. Correlation between TAD and screw cut-out

Parameter	F value	P-value	Significance
TAD vs. Cut-out	17.825	<0.001	Highly significant

TAD = Tip–apex distance; F = One-way ANOVA test statistic.

The mean postoperative TAD was 24.1 ± 3.8 mm, which is approximately equal to the established standard value of < 25 mm. Table also demonstrates that the standard deviation of TAD measurements (3.8 mm) reflects the variability in postoperative screw positioning, which may help in predicting the risk of screw cut-out.

Complications

Postoperative complications occurred in 20 patients (20%). One patient developed a late superficial infection with *Staphylococcus aureus*. Malunion was noted in 12 patients (12%) at final follow-up. Screw cut-out occurred in 15 patients (15%), all of whom had high TAD values. No instances of implant breakage or pseudarthrosis were reported during the observation period (Table 2).

Table 2: Postoperative complication rate

Complaint	N. cases	percent	Fate
Infection	5	5%	Resolved on antibiotic by 2 weeks
Malunion	10	10%	Need revision osteotomy
Cut-out	15	15%	Need revision
Metal breakage	0	0%	-
Pseudarthrosis	0	0%	-

CASE PRESENTATION (Figure 4)

A 62-year-old male farmer sustained a right hip injury after being struck by a motorbike. On arrival, he was hemodynamically stable, and plain radiographs demonstrated a minimally displaced intertrochanteric fracture of the right femur.

Surgical fixation was performed 72 hours post-injury using a DHS system. The tip–apex distance was measured at 13 mm. The perioperative course was uneventful, and the patient was allowed partial weight-bearing shortly after surgery.

At the 6-week follow-up, radiographs showed evidence of callus formation and appropriate sliding of the lag screw, indicating fracture healing. The patient was subsequently permitted full weight-bearing, and the DHS implant was removed after union was confirmed.

At the one-year follow-up, radiographs confirmed complete fracture consolidation, and the patient demonstrated excellent functional recovery. He had returned to full-time work and was able to participate in low-impact recreational sports without limitation.

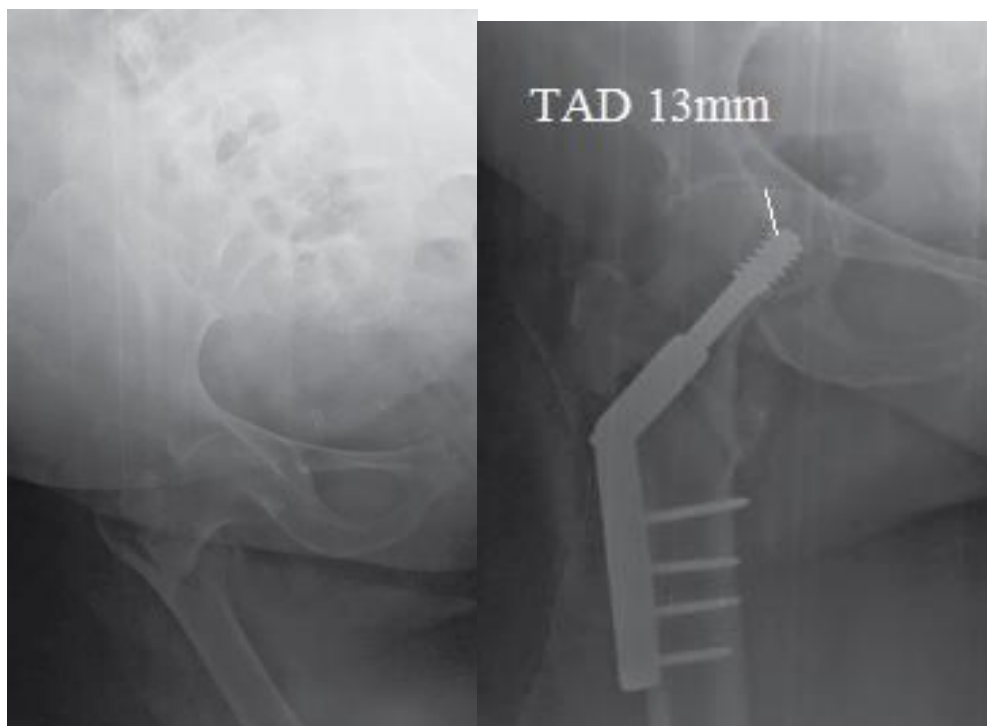


Figure 4: (A) Plain x ray Showing fracture right hip intertrochanteric (B) postoperative X-ray demonstrating DHS fixation of the fracture.

DISCUSSION

Hip fractures constitute a significant global health issue, especially among the elderly, leading to high morbidity, mortality, and financial impact on healthcare systems. Between 1990 and 2019, the global incidence of hip fractures rose significantly from 1.26 million in 1990 to 14 million by 2019, and 14.1 million by 2021. This figure is projected to increase further to 21 million by 2050, as populations age and life expectancy rises ⁽⁸⁾.

Intertrochanteric fractures represent a considerable portion of these injuries, particularly in individuals with osteoporotic bone, where timely surgical intervention is essential to restore mobility, limit complications, and lower mortality rates ^(9,10).

Among available fixation methods, the DHS remains widely used. Its mechanical principle allows for controlled compression at the fracture site during weight-bearing, promoting stability. Despite its effectiveness, mechanical failure—most commonly screw cut-out through the femoral head—continues to be a notable complication ⁽¹¹⁾.

The tip–apex distance, introduced by **Baumgaertner et al.** (1995), has become an essential metric in evaluating fixation accuracy. Their work showed that TAD < 25 mm is linked to a substantially lower risk of screw migration ⁽⁴⁾. Multiple subsequent studies have reinforced the significance of TAD as a

technical factor directly affecting both mechanical stability and clinical outcomes ^(12,13).

The findings of this study are in line with existing evidence. A significant correlation was observed between higher TAD values and the occurrence of screw cut-out ($F = 17.825$, $P < 0.001$). Notably, all cases of cut-out occurred with TAD > 25 mm, emphasizing its predictive role. The 15% cut-out rate observed is similar to published data, where superior or anterior lag screw positioning—which increases TAD—has been associated with higher failure rates ⁽¹⁴⁾.

From a clinical standpoint, patients experienced a notable reduction in pain postoperatively, reflecting stable fixation and allowing for early rehabilitation—an important factor in functional recovery. Infection and mal-union rates were low, consistent with reported outcomes in comparable DHS-treated populations ⁽¹⁵⁾. These results highlight the critical importance of meticulous surgical technique, particularly in accurate screw placement within the femoral head to maintain optimal TAD.

This study confirms that TAD as a simple, reproducible, and clinically valuable predictor of fixation success. Surgeons should aim for a TAD below 25 mm, achieved by placing the lag screw in a central–inferior position on both anteroposterior (AP) and lateral radiographs, to minimize the risk of screw cut-out and improve outcomes.

CONCLUSION

Dynamic hip screw fixation continues to be a reliable and widely used method for treating intertrochanteric femoral fractures. The tip–apex distance remains a straightforward and effective parameter for predicting mechanical failure. In this series, TAD values > 25 mm were significantly associated with screw cut-out. Meticulous intraoperative screw placement to maintain TAD < 25 mm is essential for achieving stable fixation and favorable clinical outcomes.

RECOMMENDATIONS

- **Surgical Technique:** Aim for central–inferior lag screw positioning on both AP and lateral views to ensure TAD < 25 mm.
- **Training:** Include standardized educational modules for orthopedic trainees and surgeons focusing on TAD measurement and optimal lag screw placement.
- **Intraoperative Imaging:** Employ high-quality fluoroscopic guidance to confirm precise screw placement before definitive fixation.
- **Follow-Up:** Adopt structured postoperative radiographic protocols to detect early mechanical complications and intervene promptly.
- **Further Research:** Large, prospective multicenter studies are needed to refine TAD thresholds and evaluate advanced imaging methods for improving intraoperative accuracy.

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