



E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2024; 10(3): 203-207
© 2024 IJOS
www.orthopaper.com
Received: 25-06-2024
Accepted: 29-07-2024

Krishna Kant Chaturvedi
Department of Orthopaedics,
K.D. Medical College, Hospital
and Research Centre, Mathura,
Uttar Pradesh, India

Ananya Bhaduria
K.D. Medical College, Hospital
and Research Centre, Mathura,
Uttar Pradesh, India

Tip apex distance as a prognostic indicator of intertrochanteric fractures treated with proximal femoral nail anti-rotational

Krishna Kant Chaturvedi and Ananya Bhaduria

DOI: <https://doi.org/10.22271/ortho.2024.v10.i3c.3601>

Abstract

Introduction: The increase in geriatric population in India has led to a rise in intertrochanteric fractures, especially among elderly females with osteoporotic bones. Effective surgical intervention is essential to restore mobility and function. Among various implants, the Proximal Femoral Nail Anti-Rotational (PFNA2) has shown promising results due to its biomechanical advantages. A crucial factor for the success of these implants is the Tip Apex Distance (TAD), which is the sum of the distances from the tip of the lag screw to the apex of the femoral head on anteroposterior (AP) and lateral radiographs.

Methods and Materials: A retrospective study was conducted of 30 patients presenting with intertrochanteric fractures and treated with PFNA2 at KD Medical College, Hospital, and Research Centre between January 2022 and December 2023. The data included patient demographics, site of fracture, implant used, duration of surgery, Boyd Griffin classification, Modified Harris Hip Score evaluations at 1,3, 6&12 months, blood loss, complications, pre- and post-operative radiographs and TAD Score.

Results: The mean TAD was 16 mm, ranging from 10 mm to 24 mm. Patients with a TAD of less than 25 mm had significantly better clinical outcomes and fewer complications. The study observed that maintaining a TAD between 20-25 mm significantly reduced the likelihood of failures of PFNA.

Discussion: TAD is a critical determinant of the stability and success of fracture fixation with PFNA2. Our findings align with previous studies, emphasizing the importance of maintaining a TAD of less than 25 mm to minimize mechanical failures. This study underscores the need for precise surgical technique and careful postoperative monitoring to ensure optimal outcomes.

Keywords: PFNA2, Tip Apex Distance, intertrochanteric fractures, cut-out, implant failure PFNA2, Tip Apex Distance, IT fractures, cut out

Introduction

With rising geriatric population in India, the incidence of intertrochanteric fractures of the femur is also increasing. Such fractures are commonly seen in elderly females with osteoporotic bones, resulting from low energy trauma like fall or slip ^[1]. These fractures are associated with significant morbidity and mortality, necessitating effective surgical intervention to restore mobility and function early.

DHS has been a standard choice of treatment since long but it is associated with increased intra-op blood loss and delayed mobilizations as compared to intramedullary nails like PFNA2 ^[2].

Among the various intramedullary implants, PFN A2 has shown promising results due to its biomechanics advantages, including stable intramedullary fixation and minimal soft tissue disruption ^[3]. Inserting the PFNA2 blade compacts the cancellous bone providing additional anchoring, which is especially important in osteoporotic bone. One major factor in determining the success of these implants is Tip Apex Distance (TAD) ^[4]. The TAD is defined as the sum of the distances from the tip of the lag screw to the apex of the femoral head, measured on both anteroposterior (AP) and lateral radiographs.

This measurement serves as an indicator of the positioning of the lag screw within the femoral head and is a crucial determinant of the stability of the fracture fixation ^[5].

Corresponding Author:
Krishna Kant Chaturvedi
Department of Orthopaedics,
K.D. Medical College, Hospital
and Research Centre, Mathura,
Uttar Pradesh, India

The importance of TAD was first highlighted by Baumgaertner *et al.* in 1995, who demonstrated a significant correlation between a TAD greater than 25 mm and the risk of lag screw cut-out, leading to fixation failure in patients treated with DHS [6]. However, for PFNA2, TAD <27 mm has been suggested by Michel Yam 2017 *et al.* [5]. Despite the established significance of TAD in DHS, its impact on the prognosis of intertrochanteric fractures treated with anti-rotational PFN has not been extensively studied. Most existing literature focuses on the traditional sliding hip screw or standard PFN, with limited attention to the nuances of the anti-rotational design. This gap in the literature underscores the need for further research to elucidate the role of TAD in the context of anti-rotational PFN.

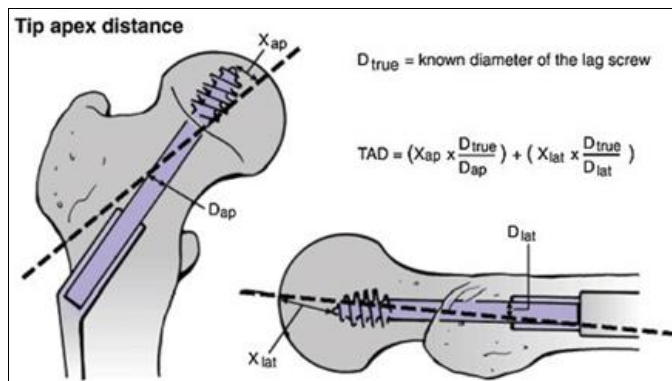


Fig 1: Calculation of Tip-Apex Distance

Materials and Methods

A randomized retrospective study was conducted which includes 30 patients who presented with intertrochanteric fractures at KD Medical College, Hospital and Research Centre during “January 2022-December 2023” and underwent internal fixation with PFNA2 insertion. The patients were operated by one of the two professors, along with the team.

The data was retrieved from inpatient and outpatient records. It included

- Patient demographic data -MRD No., Name, Age, Sex
- Site of fracture
- Implant used
- Duration of Surgery
- Boyd Griffin classification Type of fracture
- Evaluation with Modified Harris Hip Score at 1, 3, 6 and 12 months
- Blood Loss (in ml)
- Complications
- Pre-Op and Post-Op Radiographs
- TAD Score

Inclusion criteria

All types of fractures in Boyd Griffin classification Age >55years

Exclusion Criteria

- Subtrochanteric fractures Pathological fractures
- Followup for less than 4 months

For all fractures, Pre Op X-rays and immediate Post Op X-rays were compared to evaluate the accuracy of reduction of fractures as good, satisfactory and poor on the basis of displacement and angulation. Displacement criteria were met if there was less than 4 mm of displacement on either the AP

or lateral X-ray. Angulation criteria were met if the neck shaft angulation was normal or slightly valgus (130–150°) and there was less than 20 degrees of angulation on the lateral X-ray. A reduction was categorised as good if it met both criteria, acceptable if it met one criterion and poor if it met neither criterion.

PostOp X-rays were used for TAD measurement and TAD was calculated by magnifying the scans equivalent to the actual screw diameter and measuring the distance between the Tip of the screw and the apex of the femur head using a ruler. Failure of implants were evaluated for during follow-up with serial X-rays and noted for lag screw migration and cut-out.

Observations and Results

30 patients with intertrochanteric fractures treated with PFNA2 were analyzed retrospectively. The patient demographic data included ages ranging from 55 to 98 years, with a mean age of 72.5 years. There were 18 females and 12 males.

Table 1: Number of patients in each age group

Age Group (in years)	No of Patients
51-60	12
61-70	9
71-80	6
91-100	3

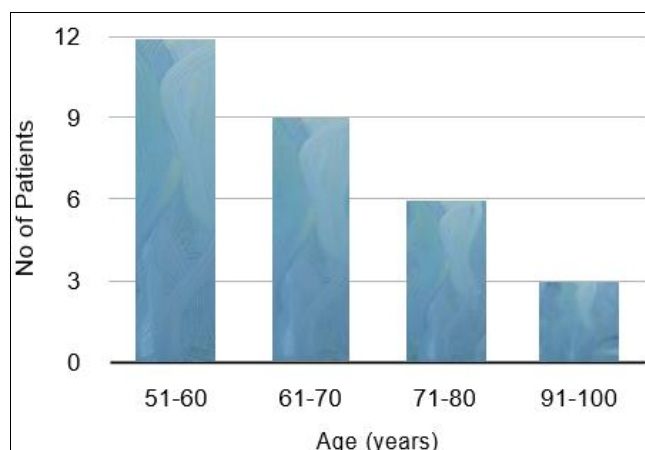


Fig 2: Number of patients in each age group

Blood Loss

The average intra-operative blood loss was 250 ml, with a range of 150 ml to 400 ml.

Type of Inter-trochanteric Fractures

Fractures were classified according to Boyd Griffin Classification.

Table 2: Of Patients based on Type of Fracture

Fracture Reduction Quality	No of Patients
Type 1	7
Type 2	8
Type 3	3
Type 4	12

Fracture Reduction Quality

Based on post-operative radiographs, the quality of fracture reduction was classified as:

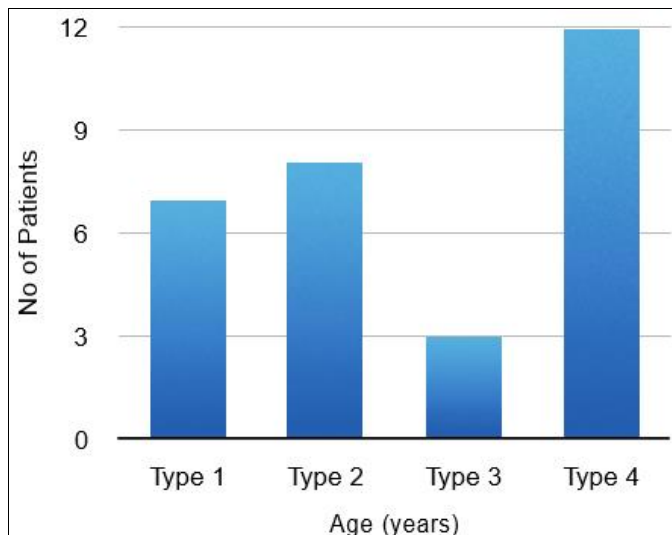


Fig 3: No. of Patients based on Type of Fracture

Table 3: Number of cases categorized according to Fracture reduction quality

Fracture Reduction Quality	No of Patients
Good	18
Satisfactory	9
Poor	3

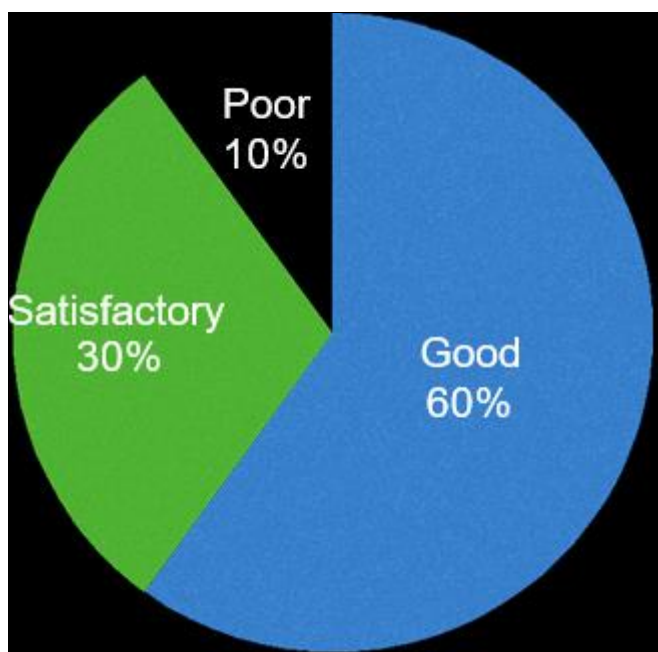


Fig 4: Percentage of cases according to quality of fracture reduction

TAD Measurements

The post-operative Tip Apex Distance (TAD) was measured from radiographs taken immediately after surgery. The mean TAD was found to be 16. mm, with a range of 10 mm to 24 mm.

TAD < 25 mm: 30 patients

Table 4: TAD Range

TAD (in mm)	No of Patients
0-5	0
5-10	3
10-15	7
15-20	8
20-25	12

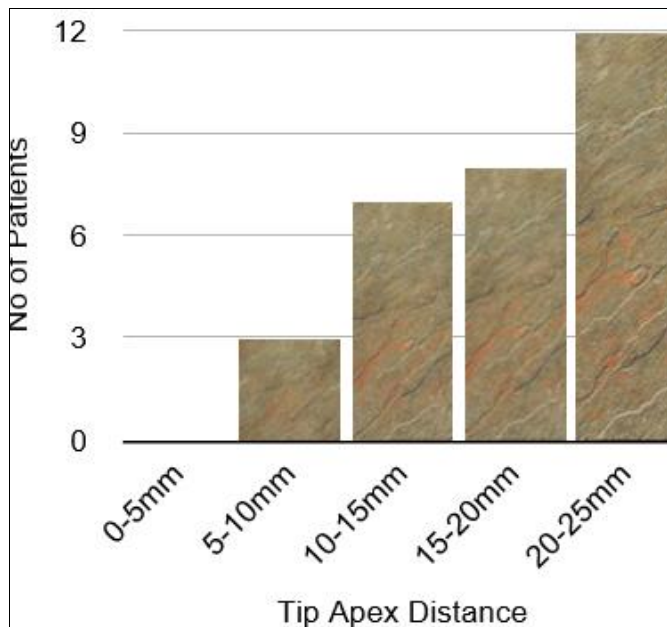


Fig 5: TAD Range

Clinical Outcomes

Clinical outcomes were evaluated using the Modified Harris Hip Score at 1-, 3-, 6-, and 12-months post-surgery. The scores were categorized as excellent, good, fair, and poor.

Table 5: Harris Hip Score at 1, 3, 6 and 12 months

Time Duration	Excellent	Good	Fair	Poor
1 month	2	10	12	6
3 months	5	13	9	3
6 months	9	14	5	2
12 months	12	13	3	2

<70 = poor result; 70-79 = fair, 80-89 = good, and 90-100 = excellent.

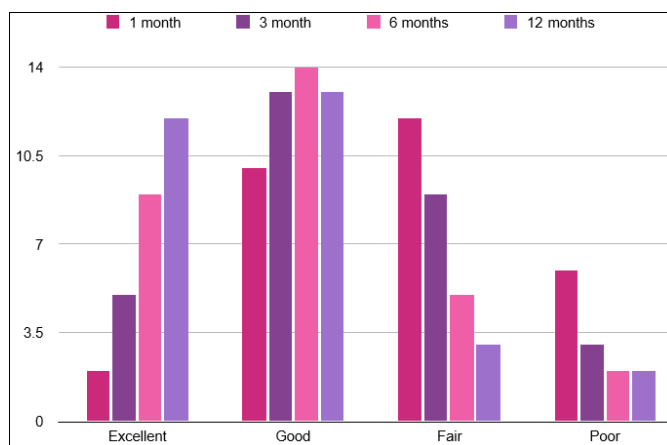


Fig 6: Harris Hip Score at 1, 3, 6 and 12 months

Table 6: Average Harris Hip Score for TAD score

TAD	Avg HHS	Avg HHS	Avg HHS	Avg HHS
10-15mm	72	80	84	88
16-20mm	73	78	84	88
21-25mm	78	83	87	90

For TAD score ranges average Harris Hip Score at 1 month , 3 months, 6 months and 12 months was calculated.

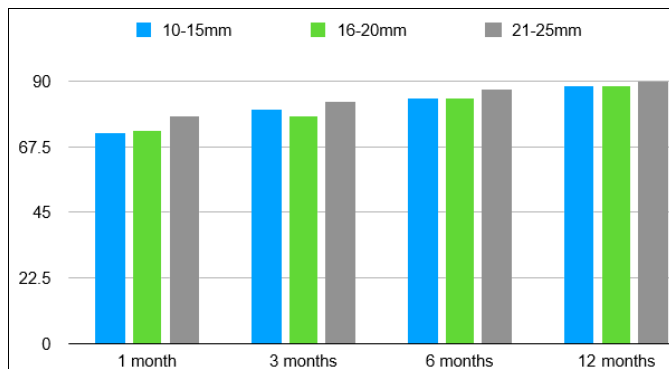


Fig 7: Average HHS for TAD score

Complications

The following complications were noted:

Late weight bearing: 3 patients (10%)

Infection: 2 patients (6.7%) All the above complications were noted in patients who had TAD <20mm

Correlation Between TAD and Clinical Outcomes

Patients with TAD between 21 - 25 mm had higher Harris Hip Scores and fewer complications compared to those with TAD <20 mm.

Discussion

The treatment of intertrochanteric fractures, especially in the elderly, has improved significantly with the use of the Proximal Femoral Nail Anti-Rotational (PFNA). A critical factor influencing the prognosis of these fractures is the Tip Apex Distance (TAD), which is the sum of the distance from the tip of the lag screw or helical blade to the apex of the femoral head, measured on both anteroposterior and lateral radiographs. A shorter TAD is associated with a reduced risk of mechanical failure, such as cut-out, where the screw or blade penetrates the femoral head, leading to treatment failure. While TAD has its limitations, it provides a standardized metric indicating that a TAD of less than 25mm is associated with a better prognosis and a lower risk of mechanical failure.

Yam *et al.* (2017) [5] conducted a retrospective analysis of 340 patients treated with PFNA-II and found that a TAD beyond 27mm significantly increased the risk of cut-out. They suggested that aiming for a TAD of not more than 27mm could minimize mechanical failure. Additionally, maintaining a neck shaft angle above 128° was recommended to further reduce cut-out risks. The results of their study align with our study as the maximum Tip Apex Distance observed in our study was 24mm and no cut-outs were observed under this.

Similarly, Nikoloski *et al.* (2013) [7] reviewed 188 PFNAs and observed that the optimal TAD for PFNA might differ from traditional screws [7]. They found no cut-outs in cases with a TAD between 20-30mm. In our study as well, no cut-outs were observed between the tip apex distance of 10-24mm which supports the Nikoloski's 2013 [7] work.

Kraus *et al.* (2011) [8] also underscored the relationship between TAD and mechanical failure, highlighting that careful placement of the blade within an optimal TAD range is critical to preventing failures such as cut-out. [8] Concomitantly, in our analysis when the TAD score was maintained between the standard range, implant failures were not observed in the study group.

Our research further supports the notion that a TAD of less than 25mm, specifically between 20-25 mm significantly

reduces the likelihood of PFNA failures. In our study, no PFNA failures were observed. In all these cases TAD was maintained below this threshold. This aligns with the findings of the aforementioned studies and reinforces the importance of precise surgical technique and careful postoperative monitoring to ensure optimal outcomes. The consensus across multiple studies, including our own, indicates that maintaining a TAD of less than 25 mm is critical for reducing the risk of mechanical failures in the treatment of intertrochanteric fractures with PFNA. Surgeons should aim for this target during the procedure and ensure meticulous follow-up, particularly in high-risk patients, such as females and those with unstable fractures (AO 31A3). By adhering to these guidelines, the prognosis of intertrochanteric fractures can be significantly improved, leading to better patient outcomes and reduced morbidity.

Conclusion

In our study, complications such as late weight bearing (10%) and infection (6.7%) were only observed in patients with a Tip Apex Distance (TAD) of less than 20 mm. Patients with a TAD between 21-25 mm exhibited higher Harris Hip Scores and fewer complications, indicating a better clinical outcome. Our findings align with previous research showing that a TAD of less than 25 mm is associated with fewer mechanical failures and improved prognosis in the treatment of intertrochanteric fractures using Proximal Femoral Nail Anti-Rotational (PFNA). Maintaining a TAD within this optimal range is crucial for better surgical outcomes.

Acknowledgements

I would like to express my sincere gratitude to all those who have contributed to the completion of this research paper. First and foremost, I would like to thank Dr. Vikram Sharma for their continuous support, guidance, and encouragement throughout the course of this research. Their invaluable advice and insightful feedback have greatly improved the quality of this work. Special thanks to the KD Medical College, Hospital and Research Centre for providing the necessary resources and a conducive environment for conducting this study. I extend my heartfelt thanks to my colleague and fellow researcher, Dr. Ananya Bhaduria, for her encouragement and insightful discussions. Your camaraderie has been a source of motivation and inspiration.

Conflict of Interest

Not available

Financial Support

Not available

References

1. Agrawal AC, Garg AK. Epidemiology of osteoporosis. *J Orthop Inj Orthop.* 2023;57(Suppl 1):45–48. doi:10.1007/s43465-023-01012-3.
2. Lu JF. *Zhongguo gu shang China journal of orthopaedics and traumatology.* 2019;32(9):824–829. DOI:10.3969/j.issn.1003-0034.2019.09.010.
3. Singh NK, *et al.* Is PFNA-II a better implant for stable intertrochanteric fractures in the elderly population? A prospective randomized study. *J Clin Orthop.*
4. Caruso G, Corradi N, Caldaria A, *et al.* New tip-apex distance and calcar-referenced tip-apex distance cut-offs may be the best predictors for cut-out risk after intramedullary fixation of proximal femur fractures. *Sci*

- Rep. 2022;12:357. DOI:10.1038/s41598-021-04252-1.
5. Yam M, *et al.* Rewriting the tip apex distance for the proximal femoral nail anti-rotation. *Injury*. 2017;48(8):1843–1847. Doi:10.1016/j.injury.2017.06.020.
 6. Baumgaertner MR, Lieu R, Puttlitz C, *et al.* Intramedullary versus extramedullary fixation for the treatment of intertrochanteric hip fractures. *Clin Orthop Relat Res*. 1998;348:87–94.
 7. Nikoloski AN, Osbrough AL, Yates PJ. Should the tip-apex distance (TAD) rule be modified for the proximal femoral nail antirotation (PFNA)? A retrospective study. *J Orthop Surg Res*. 2013;8(1):35.
 8. Kraus M, Krischak S, Wiedmann K, Riepl C, Gebhard F, Jockel JA. Clinical evaluation of PFNA and relationship between the tip-apex distance and mechanical failure. *Unfallchirurg*. 2011;114(6):470–478.

How to Cite This Article

Chaturvedi KK, Bhadauria A. Tip apex distance as a prognostic indicator of intertrochanteric fractures treated with proximal femoral nail anti-rotational. *International Journal of Orthopaedics Sciences*. 2024; 10(3): 203-207.

Creative Commons (CC) License

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.