VOLUME-9, ISSUE-4, APRIL -2020 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Orthopaedics

TIP APEX DISTANCE AS A PREDICTOR OF FAILURE IN INTERTROCHANTERIC FRACTURES TREATED WITH PFNA

Dr. Vikram Sharma* Associate Professor, Department of Orthopaedics KD Medical College Mathura *Corresponding Author

Dr. Vivek Chandak Senior Resident, Department of Orthopaedics KD Medical College Mathura

ABSTRACT A tip apex distance of 25 mm or less has been shown to be a predictor of prevention of lag screw cut out leading to greater success of fixation, when DHS is used to treat intertrochanteric fractures. This study was aimed to determine whether tip-apex distance (TAD) was also useful as a predictor when proximal femoral nails (PFNA) is used to treat intertrochanteric fractures. A total of 103 patients were included in this study. The TAD values were determined by post operative radiographs.92 patients had adequate follow up till union of the fracture or cut out leading to implant failure.
All 92 patients had intertrochanteric hip fractures. Overall, 19 patients (20.6%) had lag screw cut-out. The average TAD of the patients who did not cut-out was 21 mm, compared to 34 mm for those who did. The percentage of cut-outs correlated directly to both the severity of intertraochanteric fractures and the TAD. Surgeons should try and keep the TAD below 25mm in PFNA as this is likely to prevent complication.

KEYWORDS : PFNA, intertrochanteric fractures, tip apex distance

INTRODUCTION

Unstable intertrochanteric fractures are very common in clinical practice, mostly in elderly osteoporotic patients. Successful treatment of these fractures in the first instance is essential to enable these patients to return to mobility and also avoid the morbidity and financial burden associated with multiple surgeries.

These fractures have been treated with DHS. However DHS is an extramedullary device and studies have shown that intertrochanteric hip fractures with associated posteromedial comminution and extension into the femoral neck should not be treated with a DHS, as it is associated with a high failure rate (1).Intramedullary device are preferred to stabilise such fractures. Comparative studies between the two have shown that the use of intramedullary devices is also associated with a decrease in operative time, intraoperative blood loss, limb shortening, and lengthy hospital stays (2-4).

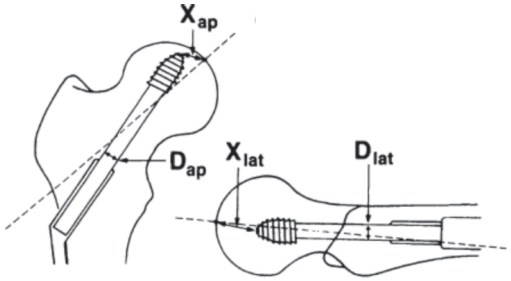
DHS involve the placement of a central screw in the neck of the femur. Studies have shown that the positioning of the screw in the neck is critical to the success of the procedure and it should ideally be placed central in the femoral neck, on both AP and lateral radiographs (5) A compromise may be accepted in slightly posterior and inferior positions, if difficulties are encountered, as these positions have less association with screw cut-outs, compared to superior and anterior placement of the screw, which are associated with a high cut-out rate.(6)

Baumgartner *et al*, initially came up with the concept of Tip Apex Distance in 1995(7).The TAD is the sum of the distance from the tip of the screw to the apex of the femoral head on AP and lateral views. Later in 1997 they confirmed the importance of using the TAD as a clinically useful way of describing the position of the screw (8).

There are many studies which have confirmed the importance of TAD in fractures treated with DHS.PFNA is a unique device that uses helical blade instead of lag screw and there is sparse literature which examined the relationship between the TAD and cut-out specifically for PFNA .Therefore the aim of this present study was to study how the TAD correlated with the outcome of the fixation in intertrochanteric and fractures treated with PFNA.

MATERIALS AND METHODS

A retrospective study of all intertrochanteric hip fractures treated by PFNA at our institution, a 500 bedded hospital with teaching facility, between March 2018 and March 2019 was carried out. Patients having pathological fractures and subtrochanteric fractures were excluded from the syudy. Patients were not excluded on the basis of age and other co morbidities. Data collected included age at surgery, gender, patterns of fracture, operative side, surgeon, implant, accuracy of reduction, TAD. Fracture type, accuracy of reduction and TAD were determined using preoperative and postoperative anterior-posterior (AP) and lateral hip radiographs. Patients were followed up at 2 weeks, 1 month and then monthly till the end point was reached. Muller and Evans classification as modified by Kyle et al. (9) was used to classify intertrochanteric fractures. Types III and IV considered unstable. For all the fractures, the accuracy of reduction was evaluated on immediate postoperative AP and lateral radiographs, on the basis of displacement and angulation, and categorised as good, acceptable, or poor. 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. Radiographs were adjusted for magnification by multiplying the measured distances on both AP and lateral radiographs by the ratio of the true to measured lag screw diameter (Fig. 1).



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

Fig. 1

Illustration of tip-apex distance (TAD) with its corresponding equation for correcting radiographic magnification. X_{ap} and X_{lat} refer to the measured distance as illustrated on the anteroposterior and lateral X-rays, respectively. D_{true} refers to the actual diameter of the lag screw; whereas, D_{ap} and D_{lat} refer to the measured diameter of the lag screw as illustrated on the anteroposterior and lateral X-rays.)

TAD was determined by measuring the distance from the tip of the helical blade to the apex of the femoral head on both AP and lateral radiographs.

The final endpoint of the study was lag screw cut-out or fracture union respectively.

RESULTS

There were a total of 103 patients treated with PFNA during the study period. Of these, only 92 patients met inclusion criteria. There were a total of 38 males and 54 females with an average age of 74±12 years included in this study. 33 patients had Type 1, 31 patients had Type 2, 18 patients had Type 3 and 10 patients had Type 4 intertrochanteric fractures.

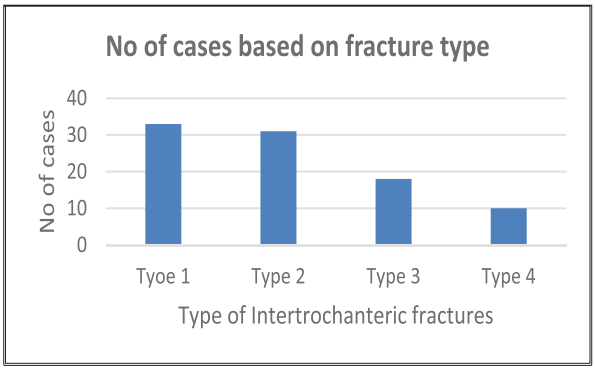


Fig 2 : No. of Cases based on fracture type

Surgery was performed by one of three senior surgeons depending on the availability. Good 50%(n=46) or acceptable 34.7%(n=32) reduction criteria were met for 78 out of 147 patients 15.2% (n=14) patients had poor reduction.

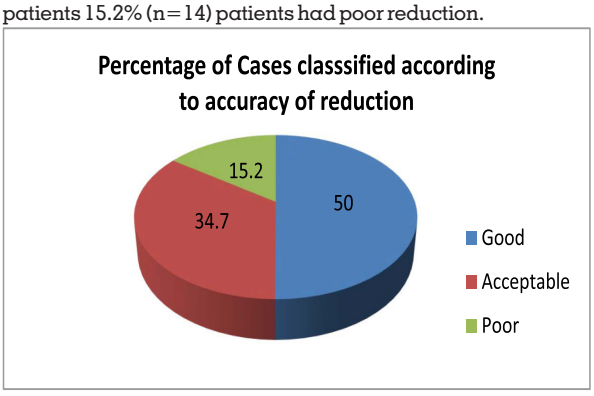


Fig 3 : Percentage of Cases classsified according to accuracy of reduction

All the PFNAs used were of same brand. All of these had a single helical blade. The length of the nail varied according to the femur length, We only used nails more than 240 mm. At a 9 months follow-up, all Type 1 fractures were fully healed while Type 2, Type 3, and Type 4 fractures had non-union rates of 9.6% (*n*=3), 38.8% (*n*=7), and 90% (*n*=9), respectively. All patients who had non union had cut outs. All patients whose fracture had healed (Type 1) did not have cut out. There was a direct co relation between comminution and percentage of cut outs in intertrochanteric fractures as illustrated in Fig. 3.

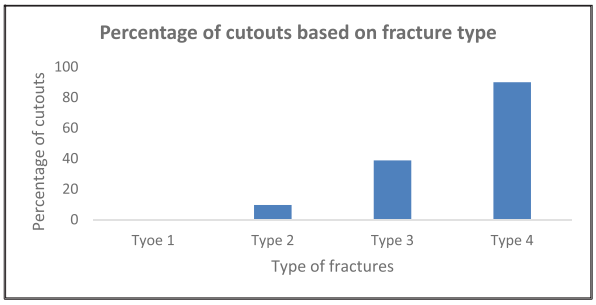


Fig. 4: Percentage of cut-outs for intertrochanteric fracture pattern subtypes. The intertrochanteric fracture patterns were classified according to the system of Muller and Evans as modified by Kyle et al. [9], with types III and IV considered unstable. All patients who had non-union had cutout.

Overall, there was an average TAD of 23 mm±9 mm with an 18.5% cut-out rate (*n*=19 patients).60.8%(n=56) patients had TAD below 25mm ,while 39.1%(n=36) had TAD above 25 mm

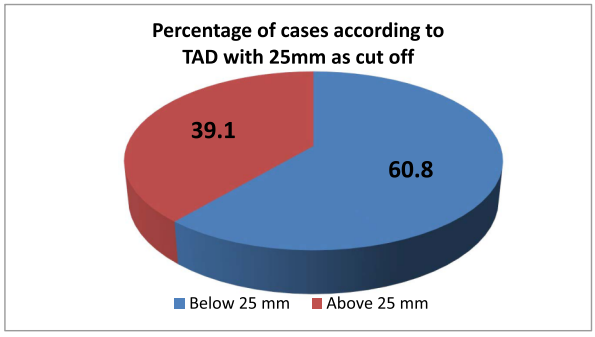


Fig 5: Percentage of cases according to TAD with 25mm as cut off

The mean TAD of the patients who did cut-out compared to those who did not was 34 mm and 21 mm, respectively. Since no patients with a TAD below 25 mm cut-out and 52.7% (n=19) of patients with a TAD above 25 mm cut-out, there was a strong mean difference in the incidence of lag screw cut-out between patients with TAD values above and below 25 mm. Figure 6 illustrates the direct descriptive correlation between TAD and cut-out .Out of the 36 patients,with a TAD of more than 25,14 had a TAD between 25-30 and 22 had a TAD more than 30.The number of cutouts increased as the TAD increased beyond 25mm .It was 38.8%(n=14) when TAD was 25-30mm and increased to 61.1%(n=22)when TAD was more than 30mm.

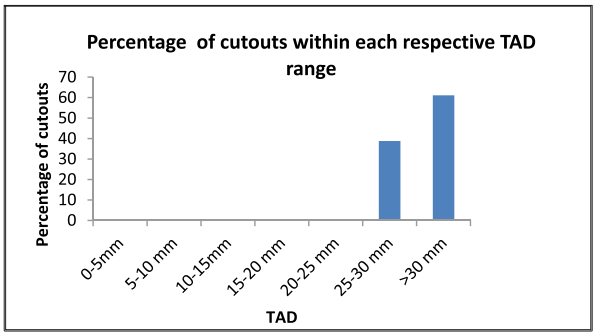


Fig 6: Number of cut-outs within each respective tip-apex distance (TAD) (mm) range

There was no descriptive correlation between cut-out and age, sex, side of fracture, reduction quality, or operating surgeon.

DISCUSSION

Considering the increasing number of elderly patients in our

population in whom these fractures are very common, it is only pertinent that we find ways to avoid complications while surgically treating these patients. While appropriate selection of the implant depending on the fracture geometry and communition is of paramount importance, the importance of correct surgical technique including precise positioning of the screw cannot be over emphasized.

Baumgartner et al., in his initial study documenting the ideal position of the lag screw in the femoral neck, showed a small number of patients who were treated using a cephalomedullary implant(11).Other studies have compared the intramedullary devices versus traditional DHSs (12)

Although patients of this age group have typically very poor follow up for a number of reasons, the advantages of our study include a satisfactory number of patients with adequate follow-up. All of the patients were operated using the same implant and operated by only three consultants eliminating the bias arising due to surgeon's competence and quality of the implant. However, other factors like poor bone quality and comorbidities were not taken into account. The study does provide useful analysis of this very common surgical procedure. The results of our study differed with that of Nikolsky et al,(13),who in their study of relevance of TAD in PFNA concluded that the tip-apex distance in the failures showed a bimodal distribution, not like previously demonstrated with dynamic hip screw and proposed that the helical blade behaves differently to a screw, and placement too close to the subchondral bone may lead to penetration through the head. However our results were in line with the study by Yam et al (14), who in their study concluded that to avoid cut out, one should aim for a tip apex distance of not more than 27 mm.

In conclusion, the very high cut out rate of 52.7 %(n=19), in IT fractures surgically fixed with TAD >25 mm does suggest that PFNA are susceptible to cut-out at TAD values greater than 25 mm. Hence, surgeons should strive for a TAD less than 25 mm when using PFNA especially in the treatment of comminuted intertrochanteric hip fractures to help avoid cut-out

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