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IMPORTANCE OF TIP APEX DISTANCE IN SUCCESS OF PFN USED TO TREAT INTERTROCHANTERIC FRACTURES OF FEMUR

Orthopedics

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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 was 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 (PFN) are used to treat intertrochanteric fractures. A total of 147 patients were included in this study. The TAD values were determined by post operative radiographs.124 patients had adequate follow up of four months till union of the fracture or cut out leading to implant failure.

All 124 patients had intertrochanteric hip fractures. Overall, 23 patients (18.5%) had lag screw cut-out. The average TAD of the patients who did not cut-out was 20 mm, compared to 36 mm for those who did. The percentage of cut-outs correlated directly to both the severity of intertrochanteric fractures and the TAD. Surgeons should try and keep the TAD below 25mm in PFN as this is likely to prevent complication.

KEYWORDS

PFN, intertrochanteric fractures, tip apex distance

Introduction

Fractures of neck of femur are one of the commonest fractures seen in clinical practice mostly in elderly osteoporotic patients. Their incidence is rising as aging population is increasing. 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.

DHS and PFN are the two devices most commonly used to stabilise these fractures. PFN is an intramedullary device while DHS is extramedullary. Comparative studies between the two have shown that the use of intramedullary devices is associated with a decrease in operative time, intraoperative blood loss, limb shortening, and lengthy hospital stays [1-3].

Both these devices involve the placement of a central screw in the neck of the femur .The positioning of the screw in the neck is critical to the success of the procedure and it is important that the technique of screw placement is precise and should ideally be central in the femoral neck, on both AP and lateral radiographs. Studies have previously recommended the essential role of adequate reduction of the fracture, as well as central placement of the lag screw on both AP and Lateral views of the radiograph. (4) 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(5)

Other causes of failure are osteoporosis, and poor patient selection, as DHS is not ideal for unstable and reverse oblique fractures. Previous studies have shown that intertrochanteric hip fractures with associated posteromedial comminution and extension into the femoral neck should not be treated with a DHS, which is associated with a high failure rate (6).The technical ability of the operating surgeon may also determine the outcome, 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).

Although previous studies have stated that there is no statistical difference in cut-out between lag screw fixed with either IM nails or side plates, no study has examined the relationship between the TAD and cut-out specifically for intramedullary devices .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 PFN.

Materials and methods

A retrospective study of all intertrochanteric hip fractures treated by PFN at our institution, a 350 bedded corporate hospital with teaching facility, between January 2014 and December 2017was carried out.

Following categories of patients were excluded from the study:

- Pathological Fractures
- Subtrochanteric Fractures
- Having less than four months of follow up

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, and four-month postoperative functional status. Fracture type, accuracy of reduction and TAD were determined using preoperative and postoperative anterior-posterior (AP) and lateral hip radiographs.

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).

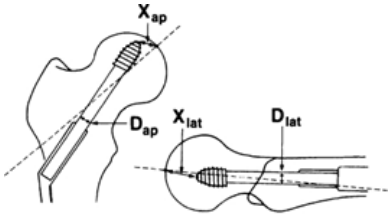

Fig.1

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 lag

screw 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 147 patients treated with PFN during the study period. Of these, only 124 patients met inclusion criteria. There were a total of 46 males and 78 females with an average age of 76 ± 12 years included in this study. 43 patients had Type 1, 28 patients had Type2, 38 patients had Type3 and 15 patients had Type4 intertrochanteric fractures.

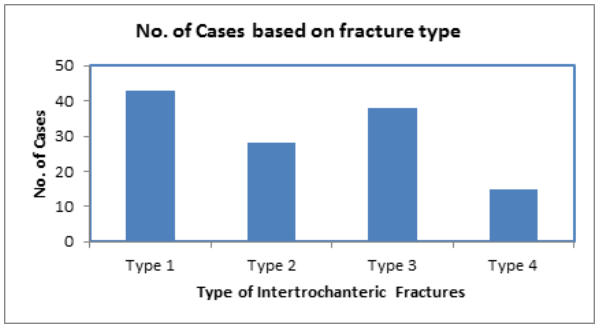

Fig 2

No. of Cases based on fracture type

Surgery was performed by one of two senior surgeons depending on the availability. Good 29.03%(n=36) or acceptable 51.6%(n=64) reduction criteria were met for 100 out of 147 patients (68.2%).31.9% (n=47) had poor reduction.

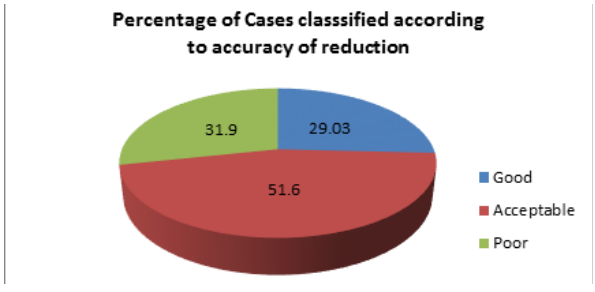

Fig 3

Percentage of Cases classsified according to accuracy of reduction
All the PFNs used were of SMPL brand. All of these had a single lag screw of diameter of 12 mm, and an angle of 130 degree. They were further classified as short or long depending upon the length of the nail. 58 patients had short nails(180 mm) and 66 patients had long nails(240 mm).

At a mean of 16 months follow-up, all Type 1 fractures were fully healed while Type 2, Type 3, and Type 4 fractures had non-union rates of 10.7% (*n* = 3), 34.2% (*n* = 13), and 46.6% (*n* = 7), 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.

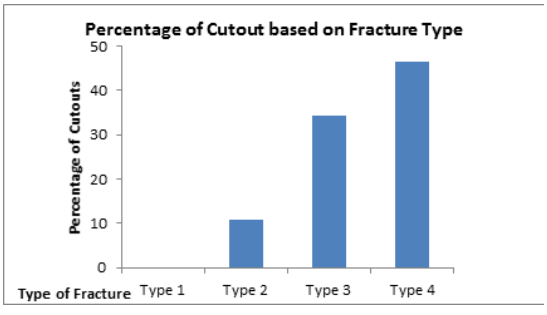

Fig. 4

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 21 mm ± 9 mm with an 18.5% cut-out rate (n = 23 patients).61.2%(n=76) patients had TAD below 25mm ,while 38.7%(n=48) had TAD above 25 mm

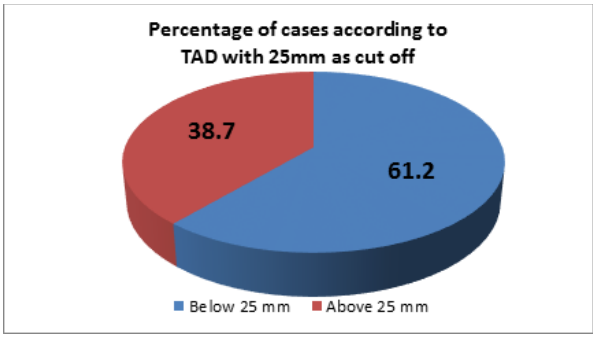

Fig 5

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 36 mm and 20 mm, respectively. Since no patients with a TAD below 25 mm cut-out and 47.9% (n=23) 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 .The number of cutouts increased as the TAD increased beyond 25mm .It was 33.3%(n=5) when TAD was 25-30mm and increased to 78.2 %(n=18) when TAD was more than 30mm.

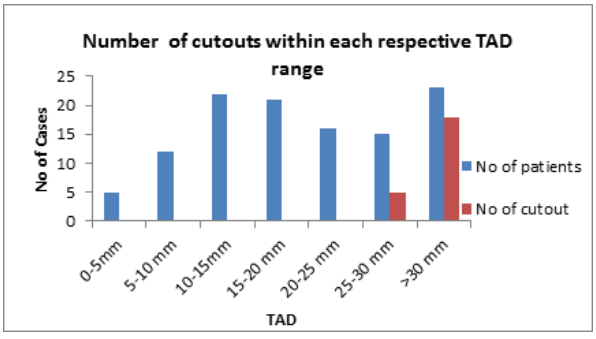

Fig 6

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, length of the nail used 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). However, we could not find any studies that specifically evaluated the lag screw cut-out rate using PFN.

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 two surgeons eliminating the bias arising due to surgeon's competence and quality of the implant.

The disadvantage of this study is . Other factor like poor bone quality and other comorbidities were not taken into account .The study however does provide useful analysis of this very common surgical procedure.

In conclusion, the very high cut out rate of 47.9 %(n=23), in IT fractures surgically fixed with TAD >25 mm stresses the importance of accurate surgical technique in the prevention of complications which occur after surgical treatment of these fractures wherein revision surgery may be required. The percentage of cut-outs increased as the TAD increased. As noted, other factors like poor bone quality in the surrounding bone and degree of comminution in intertrochanteric fractures may contribute to cut-out.

As shown in other studies focusing on sliding hip screws, intramedullary devices 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 IM devices, especially in the treatment of comminuted intertrochanteric hip fractures to help avoid lag screw cut-out

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