

## Original Article Orthopaedics

# SIGNIFICANCE OF TIP APEX DISTANCE (TAD) IN PROXIMAL FEMORAL NAIL ANTIROTATION (PFNA) II SYSTEM USED IN TRAUMA CASES OF PROXIMAL FEMORAL FRACTURES

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Article submitted on: 22 September 2019

Article Accepted on: 26 September 2019

### Abstract

**Introduction:** Proximal femoral fractures of trochanteric region are common orthopaedic trauma in routine practice and the ideal implant for treatment is still not found. After the sliding hip screw and various intramedullary nails having been used for so long, newer implants like PFNA II (Asian version of PFNA) with helical blade are now available. But ideal position of helical blade in femoral head has been in debate till date. For sliding hip screw, concept of maintaining Tip Apex Distance (TAD) less than 25mm is well accepted. So, the purpose of this study is to determine the optimal TAD for PFNA II in trochanteric femoral fractures.

**Materials and methods:** 100 cases of proximal femoral fractures of trochanteric region which were treated with PFNA II between August 2015 to July 2019 at Geetanjali Medical College and hospital, Udaipur, Rajasthan, India were included in this study. TAD value and position of helical blade tip in femoral head was correlated with failure of fixation. 60 cases were studied retrospectively and 40 cases prospectively.

**Results:** The mean TAD found in this study was 17.97 mm. The overall fixation failure in this study was 3 out of 100 cases (3%). TAD of more than 25 mm was seen in 7 cases out of which 1 case failed (14.28%). However, only 2 out of 93 cases (2.15%) failed in cases with TAD less than 25 mm. Position of helical blade tip in failed cases was superior-centre in 2 cases,

while centre-posterior in 1 case. However, all 60 cases with centre-centre position healed successfully. Failed cases showed implant breakage in 2 cases and fracture collapse in 1 case.

**Conclusion:** This study recommends that maintaining TAD less than 25 mm prevents fixation failure in treating trochanteric femoral fractures with PFNA II. Central position of helical blade tip shows most successful result. Also, helical blade of PFNA II provides better hold in osteoporotic bones.

**Keywords:** trochanteric fractures, TAD (Tip Apex Distance), PFNA II, helical blade

## Introduction:

Proximal femoral fractures are common orthopaedic trauma seen in day to day practice at any trauma centre. The goal of surgical treatment is to achieve stable fracture fixation that will aid in early weight bearing. Sliding hip screw has been in use since 1970s and is generally supposed to give compact reduction with stable fixation. However mechanical failure is quite high and is found around 16 to 23%<sup>1,2</sup>. For sliding hip screw and plate construct it has been very well established that Tip Apex Distance of less than 25 mm is crucial to minimize risk of cut out<sup>3</sup>.

Cephalomedullary nails are now favoured for treatment of proximal femur fractures but still fixation failure happens sometime which is believed to be affected by various factors including position of hip screw in head, accuracy of reduction, bone quality. The various nailing systems used are gamma nails, PFN and recently PFNA (PFNA II is modified version for Asian population).

The ideal implant should have sufficient purchase in femoral head/neck fragment to limit failure of fracture healing due to varus deviation, rotation, uncontrolled fracture collapse. PFNA II (Proximal Femoral Nail Anti rotation Asia) System is an intramedullary device with helical blade rather than screw for better purchase in femoral head<sup>4</sup>. PFNA blade appears to provide additional anchoring in osteoporotic bone<sup>5</sup>. Various Randomised controlled trials included in a meta-analysis showed there were less blood loss and fewer complications<sup>6</sup>.

Now, it is still a matter of debate that what should be the optimal value of TAD and the position of tip of helical blade when using PFNA II

in proximal femoral fractures. The present study aims to find the optimal range of TAD and position of helical blade in proximal femoral fracture of trochanteric region fixed with PFNA II.

## Materials and Methods:

The study was performed in tertiary care teaching hospital in southern rajasthan between August 2015 to July 2019. The design of this study was hybrid, longitudinal type with both retrospective and prospective cases of proximal femoral fractures of trochanteric region suffered due to trauma and underwent surgical fixation using PFNA II implant. The study was performed after approval from institutional research ethics committee.

All the patients were taken up for surgery after thorough evaluation and obtaining preanaesthetic clearance. The surgeries were done on fracture table in spinal or general anaesthesia under strict aseptic precaution. Preoperative antibiotic (1.5 gm cefuroxime, intravenous) was administered in all cases after sensitivity testing. Intraoperative fluoroscopy was used to assess fracture reduction.

In cases of stable fracture (AO 31A1), partial weight bearing was started on first postoperative day, while in all unstable type fractures (AO 31A2 and 31A3) only non-weight bearing ambulation with walker was allowed on first postoperative day. Full weight bearing was started after sufficient callus visible on radiographs done at subsequent follow-ups.

Immediate Postoperative anteroposterior and lateral radiographs were obtained to calculate Tip Apex Distance (TAD)<sup>3</sup>. All radiographs were printed with magnification scale. Correction factor for magnification

was obtained by dividing helical blade true diameter by blade diameter measured in radiograph using printed scale. So, corrected distance from tip to apex in AP and lateral view separately was obtained by multiplying correction factor to distance measured on radiograph. Corrected distance from tip to apex both in AP and lateral view obtained in millimetre was added to get final TAD (Fig.1).



**Fig.1 Calculation of TAD (in mm) on radiograph**

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

$X_{ap}$  = Distance of tip from femoral head apex on AP xray measured with printed magnification scale

$D_{true}$  = true diameter of helical blade (here 10.4 mm)

$D_{ap}$  = diameter of helical blade measured in AP film with printed magnification scale

$X_{lat}$  = Distance of tip from femoral head apex on lateral xray measured with printed magnification scale

$D_{lat}$  = diameter of helical blade measured in lateral film with printed magnification scale

Position of helical blade tip in femoral head was located on AP and lateral radiographs and classified into 9 zones as described by Cleveland.<sup>3</sup>. Femoral head was divided into superior, centre and inferior thirds in AP view, while into anterior, centre, and posterior thirds in lateral view. So, total nine zones created for possible location of blade tip.

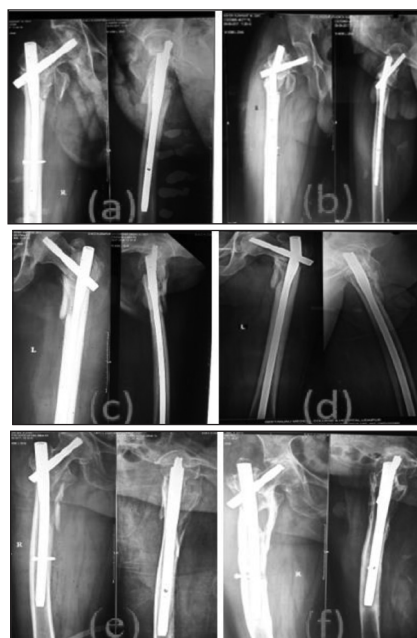
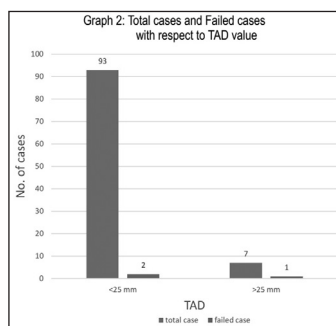
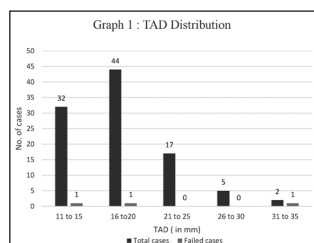
Follow-up was carried out at 2

weeks, 6 weeks, 12 weeks, 6 months. Sequential radiographs were obtained after first follow-up and were assessed for fixation failure due to fracture collapse, implant cut out, implant breakage, nonunion, infection.

## Results:

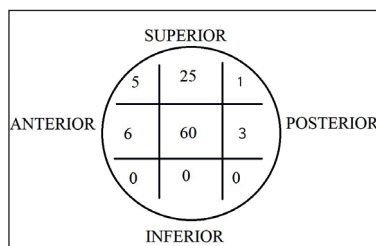
Total 100 cases were studied in this study, out of which males were 51 and females were 49. The mean age of patient was 67.72 years. The side of operated limb was right in 58 cases and left in 42 cases.

The mean TAD value in this study was 17.97 mm (range 11 to 33 mm). Out of 100 cases 93 cases had TAD less than 25 mm, while 7 cases had TAD more than 25 mm (Graph 1). The total number of cases which failed were 3 out of 100 (3%). 2 out of 93 cases (2.15%) with TAD less than 25 mm failed and 1 out of 7 cases (14.28%) with TAD more than 25 mm failed (Graph 2). The failed cases showed fracture collapse with partial blade back out (TAD 14 mm), breakage of nail at blade-nail junction (TAD 16 mm and 33 mm) (Fig. 2). None of the cases were seen with helical blade cephalad cut out and medial or axial head perforation.



**Fig. 2 a and b shows fixation failure due to broken implant with TAD 33mm and position of tip in centre-posterior zone. Fig. c and d shows fixation failure with broken implant with TAD 16 mm and tip in superior-centre zone. Fig. e and f shows fixation failure due to fracture collapse and loosening of helical blade with TAD 14 mm and tip in superior-centre zone.**

The position of helical blade tip in femoral head according to Cleveland zone (fig. 3) was found as follows:



**Fig.3 Position of helical blade tip in 9 zones of femoral head**

Position of tip in centre-centre zone was seen in 60 cases with minimum TAD 11 mm and maximum TAD 30 mm (Average TAD 17.36 mm) and none of these cases showed failure. The cases which failed showed blade tip position of superior-centre (2 out of 25 cases with TAD 14 mm and 16 mm) and centre-posterior (1 out of 3

cases with TAD 33 mm). In rest of the cases the tip of blade was centre-anterior (6 cases), superior-anterior (5 cases), superior posterior (1 case) with no failure.

## Discussion:

Since the first utilisation of sliding hip screws for the treatment of proximal femoral fracture and later on various cephalomedullary nails, fixation failure has always remained a matter of concern. It can happen due to various reasons like breakage of implant, fracture collapse, implant cut-out, nonunion, infection.

Various deciding factors that have been attributed to fixation failure of fractures around proximal femur are quality of fracture reduction, position of implant placement in femoral head<sup>7</sup>. However, bone quality, age of patient and various related factors may play role in fracture healing.

Various methods have been recommended for deciding the optimal positioning of hip screw in head of femur. Generally, centre-centre or centre-inferior position (central position in lateral view and inferior position in neck and head in AP view) of hip screw is chosen (decided by Cleveland method)<sup>8</sup>.

TAD has been a highly favoured criteria for choosing hip screw position<sup>9</sup>. But the optimal value of TAD in PFNA II is still debatable. Mereddy P et al., in 2007 studied PFNA in 62 cases and found centre position in hip screw in 52 cases and mean TAD 12 mm (range 4 – 34 mm) out which blade cut out rate was 3.6%<sup>5</sup>.

Kraus M et al. studied in 2011 that out of 195 patients in ten cases (5.1%) the blade migrated, four cases (2.1%) showed blade cut out and in one case the nail broke (0.5%). The mean TAD was 26.7 mm, in cases of cut out 41.3

mm and in blade migrations 38.6 mm. No failure could be documented when the TAD was less than 30 mm<sup>10</sup>.

Andrej N Nikoloski et al. studied in 2013 that out of 178 cases there were 18 surgical implant-related failures (19%). The single most common mode of failure was cut-out in six cases (6.2%). Three cut-outs (two medial perforation and one varus collapse) occurred with tip-apex distance (TAD) less than 20 mm. There was no cut-out in cases where the TAD was from 20–30 mm and three cut out in more than 30 mm TAD. The tip-apex distance in the failures showed a bimodal distribution, not like previously demonstrated with dynamic hip screw<sup>11</sup>.

### Conclusion:

In this study, fixation failure was seen in 3 out of 100 cases (3%). Out of these 3 cases which failed, position of helical blade tip was superior-centre in 2 cases and centre-posterior in 1 case, while all the cases which had centre-centre position healed successfully. The mean TAD in our study was 17.97 mm. TAD of more than 25 mm was seen in 7 cases out of which 1 case failed (14.28%). The helical blade design of PFNA II provide better hold in osteoporotic bones. The limitation of the present study was small sample size, so there is scope of further evaluation with larger sample size to determine the optimal TAD for PFNA II. The present study recommends to maintain TAD of less than 25 mm and to keep the helical blade in centre-centre position in trochanteric fracture treated with PFNA II.

### Acknowledgement:

The authors acknowledge the researchers whose articles have been cited and mentioned in references of this manuscript for their highly

appreciable work. The authors are also grateful to the scholars whose research work has been reviewed and discussed in this study.

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