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# INTRAMEDULLARY PROXIMAL FEMORAL NAILING FOR UNSTABLE PERITROCHANTRIC FRACTURE: A PROSPECTIVE STUDY

Orthopaedics

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## ABSTRACT

Trochanteric fracture id one of the commonest fractures in Orthopaedics and also among the most devastating injuries of the elderly. The incidence of this fracture increases with advancing age. Around 50% of the Peri-trochanteric variant of these fractures, are of the unstable type. PFNA2 deploys a helical blade which provides compressibility and an additional rotation control at the fracture site.The aim of this study is to assess the effectiveness of Intra-medullary fixation of unstable peri-trochanteric fractures with inter-locking proximal femoral nail PFNA2, in a prospective study. This study was done in Department of Orthopaedics, Chettinad Hospital and Research institute, Kelambakkam, Chengalpattu district, Tamilnadu and was spread over 4 years from Jan 2017 to December 2020 with minimum follow-up period of 12 months. 66 patients participated in this study. Harris Hip Score was used to assess the functional outcome. The Harris Hip Score, mean at 6 months was 75.35, which improved to 82.02 by 12 months of follow-up. With regard to our complications 4 patients had a superior cut out of helical screw, which required re-operation by bipolar hemiarthroplasty of the cemented variant. 9 patients had a varus deformity of 10-12 degrees. Abductor lurch was noted in 11 patients. Superficial-wound infection occurred in 8 patients and deep wound infection, requiring surgical irrigation occurred in 3 patients. In conclusion, PFNA2 has better stability, better rotatory stress shielding, superior compaction at fracture site, less blood loss, shorter operation time, less radiation exposure and better clinico-radiological outcomes. PFNA2 is a good implant choice to tackle the complex problems encountered in displaced unstable trochanteric fractures.

## KEYWORDS

**INTRODUCTION:**

Fractures around the trochanteric region of femur are among one of the commonest fractures, encountered in Orthopaedics and also among the most devastating injuries of the elderly. The incidence of this fracture increases with advancing age. In younger patients the fractures usually result from a High Energy Trauma like, RTA and fall from height and accounts for only ten percent. In the older patients, suffering from a minor fall, they can sustain similar fracture, in this area occur because of weakened bone, due to osteoporosis or fragility fracture and this accounts for 90% (2). The word peritrochantric includes two, the two ones of Inter-trochanteric, per-trochanteric and those involving both the lesser and the greater trochanter.


**Fig 1: Figure depicting the various zones of the proximal femur.**

Since the femur is the longest and among the strongest bones in the body and one of the principal load bearing bone in the lower extremity, fracture of this bone may result in prolonged morbidity and extensive disability, unless the surgical treatment is appropriately timed and planned, with the right type of implantation. In unstable trochanteric fractures, where there is loss of the postero-medial cortex stability, when load is applied, increased bending forces on the DHS, leads to implant breakage, screw cut-out or separation of plate from the shaft. This leads to the introduction of Intra-medullary devices, which theoretically due to its position provides for a more efficient load transfer and their shorter lever arm, can decrease the tensile strain, thereby decreasing the risk of implant failure.

In 1997, PFN (Proximal femoral nail) was introduced in Czechoslovakia by the Synthes company, which has the Biomechanical Advantage of all IM devices and considered to be as a Second-Generation intra-medullary proximal femoral nail. Several recent studies are going on, for comparison with the DHS and other generations IM devices with a locking interface and the results are encouraging but needs time and further evaluation to be universally accepted. PFNA2 followed the PFNA, with better Biomechanical stability and lower instances of "Implant failure".

Around 50% of the Peri-trochanteric variant of these fractures, are of the unstable type. These cases also have other co-morbidities like renal failure or compromise, Diabetes Mellitus, High BP, and compounding them all is the problem of Geriatric Osteoporosis, especially in the women. The Goal of treatment is to provide for a stable, and near anatomical fixation by surgical methods. Early ambulation is the "Mantra", to be achieved, especially so, in the elderly age group. Union is never a problem in this zone, the problem is with infirm-fixation and fixation failures, which allows for a loss of reduction and subsequent mal-unions, resulting in deformity, compromise on ROM and eventually LLD. Kueffer et. al (1); had emphasised that the Implant- fragment coaptation and stability stood by five corner stones.

These included the Implant design and their placement, achieving a good reduction, the fragment geometry and above all the quality of the bone. Of these corner stones, the surgeon has not many factors that can be under his control. PFN helps in the early post-op mobilization, ambulation and in achieving union, on the other hand PFNA2 deploys a helical blade instead of a conventional twin screw, as is used in conventional PFN. As it is of a helical nature it provides for compressibility and an additional rotation control.

**AIM AND OBJECTIVE:**

To assess the effectiveness of Intra-medullary fixation of unstable peri-trochanteric fractures with inter-locking proximal femoral nail PFNA2, in a prospective study.

**MATERIALS AND METHODS:**

This was a prospective study, done for unstable peri-trochanteric fractures, surgically intervened upon, with a PFNA2 nail. The study was done in Department of Orthopaedics, Chettinad Hospital and Research institute, Kelambakkam, Chengalpattu district, Tamilnadu and was spread over 4 years from Jan 2017 to December 2020, for which recruitment of patients stopped in December 2019, so that there could be a minimum follow-up period of 12 months (Range: 12 to 47 months).

**INCLUSION CRITERIA:**

1. Fractures of the unstable variant of trochanteric type, classifiable as AO/OTA classification 31A1, 31A2 or 31A3.
2. Patients of both the sex and in the age group of 36 to 65.

**EXCLUSION CRITERIA:**

1. Open unstable trochanteric fracture
2. Fracture with other operable fractures of the ipsilateral lower limb.

**PFNA2 Specifications:**

These nails have a Latero-medial angle of five degrees, that allows for its insertion at the tip of the greater or the larger lateral trochanter.

The PFNA2 nail is available in sizes of 170mm(smallest), 200mm(small), 240mm(medium), 260 to 420mm(large).

They have several distal locking options like the static and the dynamic, in the small and medium versions, and the long PFNA2 allows also for secondary dynamization.

Insertion of the blade of PFNA2, helps in compacting the cancellous bone which provides for a better anchorage, which becomes significant in the osteoporotic bone. Such a stability has been proved Biomechanically to combat the rotatory forces and to avoid for a varus type of collapse. These helical blades have fewer cut-out resistance.

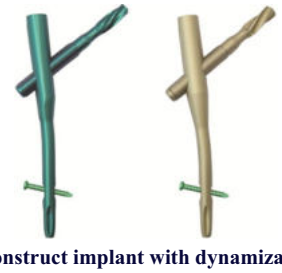


**Fig 2: PFNA2 construct implant with dynamization option of the static or dynamic variants**

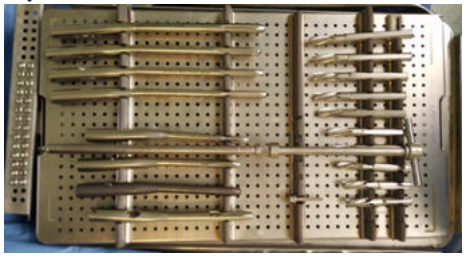


**Fig 3: Implant set of PFNA2**

**Step by step description of the operative methodology:**

a. Determination of entry point.
b. Insertion of the guide wire.
c. Opening of the femoral medullary canal with a flexible drill bit.
d. Reaming of the medullary canal.
e. Checking for fracture reduction under image intensifier.
f. Assemblage of PFNA2 instruments.
g. After measuring PFNA2 blade length and opening the lateral cortex blade insertion.
h. Drill hole for the PFNA2 blade, assemblage of the blade on the impactor and insertion of the PFNA2 blade, followed by its locking. At this stage intra-operative compression is achieved by turning the buttress nut counter-clock wise on the locked blade, which is carried out under image intensifier viewing. The "strain" factor is then released by turning the buttress nut clockwise.

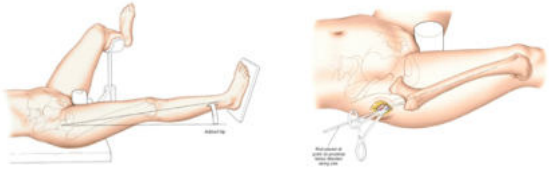
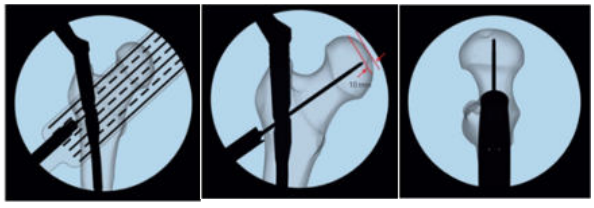
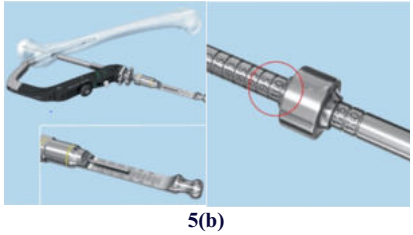


**Fig 4: Positioning and canal negotiation for PFNA2.**

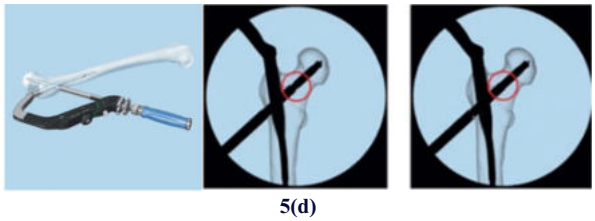


**5(a)**



**5(b)**

**5(C)**



**5(d)**

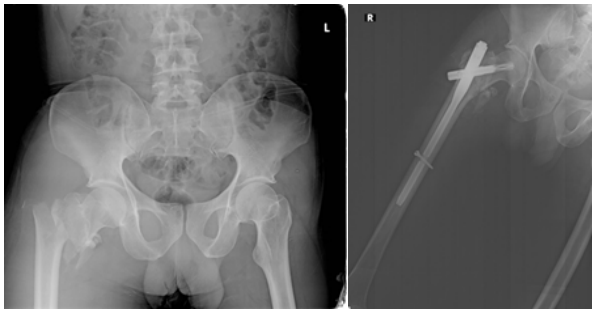
**Fig 5(a-d): Showing, step by step, surgical steps towards fixation by PFNA2 and final locking of the buttress nut.**

**Post-Operative Protocol:**

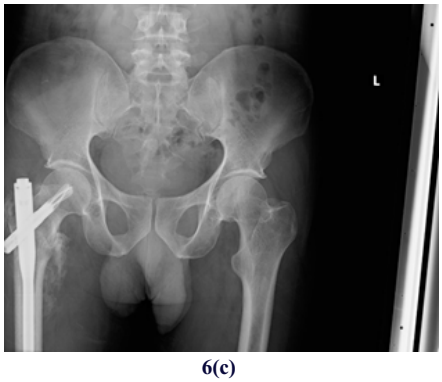
Patients were mobilized with physiotherapy on the POD2 after DT removal, patients were allowed partial weight bearing with walker as tolerated. Sutures were removed on the POD 12. After the third post-operative week, weight bearing was gradually increased. Patients were evaluated clinically and radiologically bi-weekly for the first 3 months and there-after monthly for the next 3 months and then bi-monthly for the next 6 months. Clinical union was recorded, as the absence of tenderness or pain upon full weight bearing. During follow up the Harris Hip Score was evaluated at 3 months and 6 months post-operatively. Various parameters like pain, limp, use of support, distance walked, sitting, stair climbing, absence of deformity, range of motion were evaluated using the Harris Hip Score.

**RESULTS:**

In the 3 years of patient recruitment period, satisfying our inclusion criteria, we had included 66 patients in the study. Out of these 66.67% (n=44) were females and 33.33% (n=22) were male patients. Thus, the male to female ratio was at 1:2. The age groups 56 to 65 years, 46 to 55 years and 36 to 45 years had 45.46% (n=30), 33.33% (n=22), 21.21% (n=14) patients respectively. AO/OTA Type 31A2, 31A3 and 31A1 constitutes 51.51% (n=34), 25.76% (n=17) and 22.73% (n=15) patients respectively.



6(a) 6(b)



6(c)

**Fig.6 (a,b,c) : Depicting displaced fracture, Long PFN fixation and adequate fixation stability and callus at 4 months post-op.**

The mean operating time lag was 2 days (range: 1 to 5 days). The mean operation time period was 65 minutes (range: 60-72 minutes). The mean blood loss was 210 ml (range 180-220 ml). Image intensifier exposure was 90 seconds (75 to 140 seconds). The average hospital stay was 6.2 days (range 5 to 13 days). The time taken for fracture healing clinico-radiologically, was 12.6 weeks (range:11.2 to 15.4 weeks). All patients were ambulated as early as 3 weeks, with walking aids and at the end of 6 weeks all patients were allowed full weight bearing walking. The Harris Hip Score, mean at 6 months was 75.35, which improved to 82.02 by 12 months of follow-up.

With regard to our complications 6.06% (n=4) patients had a superior cut out of helical screw, which required re-operation by bipolar hemiarthroplasty of the cemented variant. 13.64% (n=9) patients had a varus deformity of 10-12 degrees. Abductor lurch was noted in 16.67% (n=11) patients. Superficial-wound infection occurred in 12.12% (n=8) patients and deep wound infection, requiring surgical irrigation occurred in 4.55% (n=3) patients.

**Table 1: Demographics distribution:**

| Age group in years | Male 'n' | Female 'n' | Total 'n' | Total in % |
|---|---|---|---|---|
| 36-45 | 6 | 8 | 14 | 21.21 |
| 46-55 | 6 | 16 | 22 | 33.33 |
| 56-65 | 10 | 20 | 30 | 45.46 |
| Total 'n', (%) | 22 (33.33) | 44(66.67) | 66 | 100 |

**Table 2: Age group and the Fracture pattern distribution:**

| AO/OTA fracture type | Male 'n' | Female 'n' | Total 'n' | Total in % |
|---|---|---|---|---|
| 31A1 | 8 | 7 | 15 | 22.73 |
| 31A2 | 7 | 27 | 34 | 51.51 |
| 31A3 | 7 | 10 | 17 | 25.76 |
| Total 'n' (%) | 22 (33.33) | 44(66.67) | 66 | 100 |

**Table 3: Gait Analysis Distribution at the 12th month follow-up study:**

| Parameter of Limp | No. of patients at 12 months Follow-up 'n' | Percentage |
|---|---|---|
| None | 40 | 60.61 |
| Mild | 13 | 19.70 |
| Moderate | 12 | 18.18 |
| Severe | 01 | 01.51 |
| Total | 66 | 100 |

**Table 4: Ambulatory status as asses at 12 months of follow-up:**

| Parameter of ambulation | No. of patients at 12 months Follow-up 'n' | Percentage |
|---|---|---|
| Without support | 54 | 81.82 |
| With walking stick support | 11 | 16.67 |
| With walker support | 01 | 01.51 |
| Total | 66 | 100 |

**Table 5: Functional Harris Hip Score in the PFNA2 Group study at 6 and 12 months post-operatively.**

| Parameter | 'n' at 6 months post-op | 'n' at 12 months post-op | % at 6 months post-op | % at 12 months post-op |
|---|---|---|---|---|
| Excellent (90-100) | 22 | 42 | 33.33 | 63.64 |
| Good (80-89) | 28 | 16 | 42.42 | 24.24 |
| Fair (70-79) | 14 | 07 | 21.21 | 10.61 |
| Poor (<70) | 02 | 01 | 03.04 | 01.51 |
| Total | 66 | 66 | 100 | 100 |

**Table 6: Vital surgical and Functional parameters analysed.**

| Parameters | PFNA2 Mean (range) |
|---|---|
| Operating time | 65 min (60-72 min) |
| Blood loss | 210 ml (180-220ml) |
| Image Intensifier Exposure | 90 seconds (75-140 seconds) |
| Fracture Union Mean (Range) | 12.6 weeks (11.2 to 15.4 weeks) |
| Harris Hip Score (6- and 12-months post-op) | 75.35 and 82.08 |

**Table 7: Distribution of complications.**

| Complications | 'n' | Percentage |
|---|---|---|
| Superior cut out of Helical screw with re-operation by cemented bipolar hemiarthroplasty | 4 | 06.06 |
| Varus Deformity | 9 | 13.64 |
| Abductor Lurch | 11 | 16.67 |
| Superficial wound infection | 8 | 12.12 |
| Deep wound infection | 3 | 04.55 |

## DISCUSSION:

Unstable trochanteric fractures are always a challenge to the operating orthopaedic surgeons. The Dynamic Hip Screw, while an excellent option in stable trochanteric fractures, do not perform so well in the osteoporotic and unstable fractures of AO/OTA types 31A2 and 31A3. These intra-medullary devices, became gradually more popular, because of their Biomechanical stability and fewer failure rates. The movement arm in the PFN is shorter when compared to DHS. This Biomechanical concept relates to the higher screw cut out rates in DHS, with consequent varus mal-union. The proximal diameter of the PFN is larger leading to an improved stability. It further incorporates the advantages of a closed intra-medullary nailing device. Advantages further in favour of PFN is that there is relatively less blood loss, shorter operating time and a brisk rehabilitation to ambulation time. It permits for an early weight bearing, in comparison to the DHS. The earlier versions of Gamma Nails and other IMHS had their share of complications like femoral shaft fractures, in as high as 17 percent, fixation failure in around 7 percent and complications related to distal locking in as much as 10%, as reported by Schipper I.B et al (10).

PFN was developed in 1997, with the concept of improved stability, better proximal fragment rotational control and fewer complication rates. Bone stress related fractures at the distal end of the nail, were addressed by reduction of the lower or distal nail diameter.

In the present case series scenario, PFNA2 had been used in all cases, which uses a helical blade, unlike PFN 1st generation, which deployed two screws. The helical blade construct provides for a better fracture fragment stability, achieves compression at the fracture site and better controls the rotational stress forces. By achieving a compressibility at the fracture neck juncture, they have a higher cut out strength. It imparts a latero-medial angle of upto 5 degrees, which makes it a superior implant in the elderly osteoporotic bones.

**We would like to highlight the advantages of the helical blade PFNA2 over the conventional PFN. These includes:**

1. As reaming is done away with, there is less bone loss.
2. Femoral head to helical blade contact, provides for an enhanced contact area of surface.
3. Provides for a better control over rotational stress and guarantees stability.
4. Duration of surgery is relatively shorter.
5. Loss of blood is significantly lower, as also a lower radiation dose at image intensification.
6. There is a significantly fewer rates of screw cut out and thereby reducing instances of varus mal-union and consequent limb shortening.

'7. Z' effect is absent and so is the post-op hip pain.

8. Proximal nail diameter of PFNA2 is smaller by 2 mm.

In the unstable fractures there is a loss of the postero-medial buttress. The larger this loss of fragment, as in AO/OTA type 31A2 and 31A3, stabilization of the fragments becomes a vital issue to address.

Our average operating time of 65 minutes is comparable to that of Li J et al (3); at 66.25 minutes and J Zhou et al (9) at 68 minutes. Our mean blood loss of 210ml was comparable to that of Yu.W.Zhang et al (8); at 180ml and that of J Zhou et al (9). However, Levent Karapinar et al (4); and Li J et al (3) have reported lesser blood loss at 127 to 132 ml.

Our Union time range of 11.2 to 15.4 weeks, compares well with Li J et al (3); Y Xu et. Al (5); J Zhou et al (9) and that of Levent Karapinar et al (4).

Our 12 months post-op HHS at 82.08 was closest to the study of Yu W Zhang (8) at 80.75 and Li J et al (3) at 81.90.

Our HHS also compares well with the study of Gormeli et al (6); at 79.7% and is less than that of Venugopal Palakurthi et al (7); at 92.96%.

## CONCLUSION:

In short, in comparison to the conventional PFN, the PFNA2 has better stability, better rotatory stress shielding, superior compaction at fracture site, less blood loss, shorter operation time, less radiation exposure and better clinico-radiological outcomes. If complications do arise the option of cemented bipolar HRA always exists. PFNA2 for unstable peri-trochantric fractures is advantageous, as it is one of a closed reduction type, the fracture haematoma is preserved, there is lesser tissue iatrogenic damage, it paves way for early weight bearing and above all return to work by 4 to 6 months. PFNA2 is a good implant choice to tackle the complex problems encountered in displaced unstable trochanteric fractures.

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