Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 1, 2021, Pages. 2314 - 2333
Received 15 December 2020; Accepted 05 January 2021.

ANALYSIS OF OUTCOME OF PROXIMAL FEMORAL NAILING IN UNSTABLE TROCHANTERIC FRACTURES

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ABSTRACT

The development of implant designs to address these unstable fractures of the proximal femur, have got refined. This has significantly improved the surgical outcomes in managing these problematic fractures. The proximal femoral nail, which was the implant used in this study, has established its distinct superiority in the instances of surgically managing displaced and unstable trochanteric fractures. Its unique advantages are that it is amenable to closed reduction whic h preserves the fracture hematoma. There is less surgical insult. It enables early rehabilitation and early return to pre-injury activity status. Among them, displaced and unstable trochanteric fractures are in significant numbers. The development of implant designs to address these unstable fractures of the proximal femur, have got refined. This has significantly improved the surgical outcomes in managing these problematic fractures.

Keywords:demographics, trochanteric, postero-medial comminution, decubitus ulcers, fractures, Osteoporosis

Introduction

The demographics of world population are changing. More of the elderly people are living in the developing countries. Presently about three-fifths of the hip fracture occur in Asia which, it is predicted that will become almost one-half by the year 2050. Inter-trochanteric fractures are one of the most common fractures of the hip occurring both in the young adults, as a result of high energy trauma and in the elderly, as a result of low energy trauma due to osteoporosis[1]. Problems of these fractures are: (a) they are associated with substantial morbidity and mortality, (b) mal-union is common, (c) implant failure like cut-out of head and penetration into hip is a complication, (d) it is a great financial burden to the family and, (e) it is most commonly associated with medical co-morbidities like diabetes and hypertension. These fractures are 3 to 4 times more common in the elderly women who are osteoporotic, in whomtrivial trauma is by far the most common mode of injury [2,3]. These patients become confined to home and become dependent for their activities of daily living on others. One-half of these fractures that occur in the aged around the hip joint are of the trochanteric type and one-half of these are of the unstable variant. In treating trochanteric fractures, it is important to distinguish between the unstable and stable variants of these fractures. With cortical instability on one side of the fracture owing to cortical overlap or destruction, the fracture would tend to collapse in the direction of instability. Thus, by definition a truly stable inter- trochanteric fracture, is a one that when reduced has a cortical contact without gap posteriorly and medially. This contact is vital in spreventing fracture displacement into varus or retro-version. During imaging upon an unstable fracture pattern, it may be missed due to an inadequately imaged lateral radiograph and which shall interfere with the clinical assessment of the size of the postero-medial comminution and identifying the presence of a coronal split in the greater trochanter, which makes it technically a four - part fracture. Thus, it is important to understand that unstable fractures cannot be treated on the same lines as stable ones, because when there is inadequate fracture opposition, the fixation will collapse and eventually lead to a shortening of around 13 to 18 mm, which in turn will affect the ambulation because the shortening with collapse shall affect the abductor lever

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arm, eventually leading to abductor weakness. To summarize, unstable fractures are those fractures with a lateral wall or postero-medial comminution, fracture with reverse oblique pattern and fractures extending into the femoral neck or sub- trochanteric region.

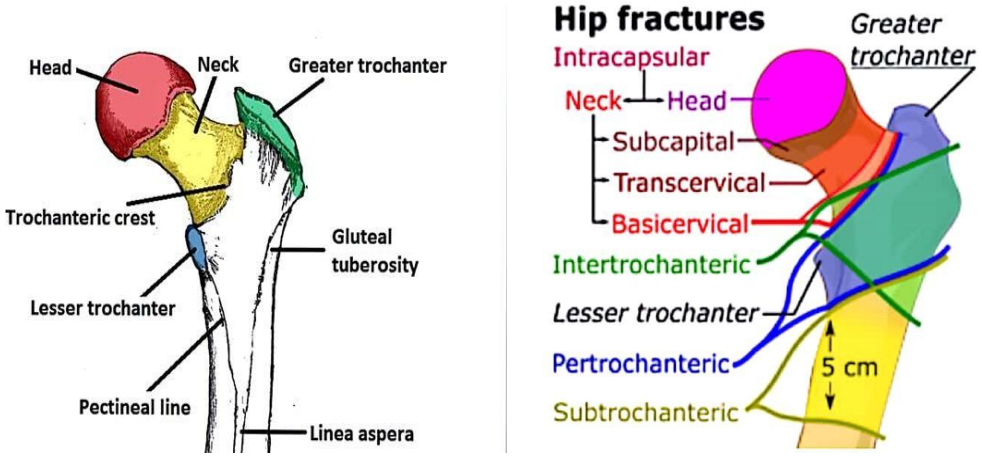

Fig. 1: Zonification of proximal femoral fractures.

Non-operative conservative management which was done earlier had resulted in an increased morbidity, as well as complications like mal-union with varus and external rotation deformity resulting in a short limb gait, non-union and a high rate of mortality due to complication of long recumbency and immobilisation which resulted in complications like decubitus ulcers, deep vein thrombosis, urinary tract infections, contracture of the joint, orthostatic pneumonia and renal calculi [2]. The goal of the treatment in inter-trochanteric fractures is the restoration of the patient to his or her pre-injury functional and ambulatory status at the earliest. Various fixation devices have been evolved to treat these fractures by internal fixation, thereby increasing patient comfort, facilitate nursing care, decrease hospital stay and hence to prevent complications of prolonged recumbency. It is a universal dictum to treat inter - trochanteric fractures with stable internal fixation as early as possible.

With regards to the operative treatment, for more than a decade in the past, the sliding hip screw was in use. The type of implant used has a direct bearing on the stability of fixation and its complication. Dynamic hip screw is an eccentric load sharing device and a time-tested surgical procedure to manage these fractures but is associated with open reduction, loss of fracture hematoma, periosteal stripping and extensive soft tissue dissection[4]. Factors beyond the control of surgeon for successful treatment are: (i) fracture geometry and stability, (ii) bone quality, (iii) comminution. Factors under the control of surgeon are: (i) good reduction, (ii) proper choice of implant, (iii) proper surgical technique, and (iv) availability of modern operation rooms, entireset of implants, instrumentation and image intensifier.

The factors most significant for instability and fixation failure are: (i) loss of postero-medial support, (ii) severe comminution, (iii) subtrochanteric extension of the fracture, (iv) reverse oblique fracture, (v) shattered lateral wall, (vi) extension into femoral neck area and (vii) poor bone quality. Osteoporosis is particularly important in the fixation of proximal femoral fractures. This can be measured by Singh's index and bone densitometry (DEXA).

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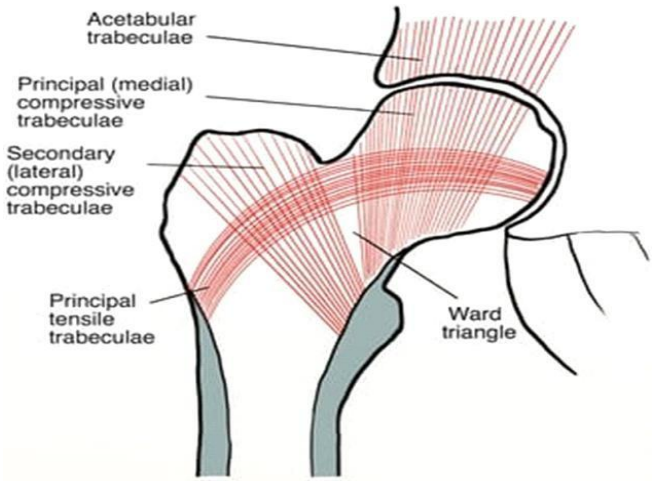

Fig. 2: Pattern of normal proximal femoral trabeculisation.

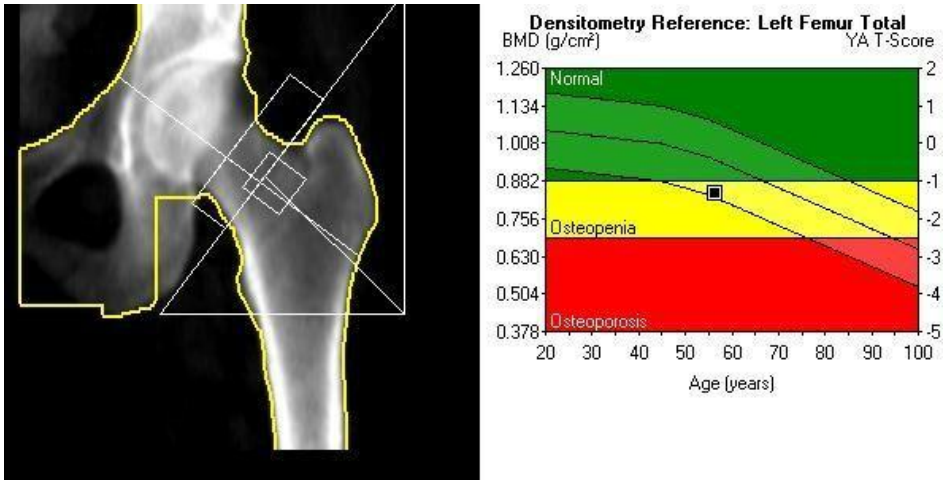

Fig. 3: DEXA scan analysis.

Trochanteric Fracture:

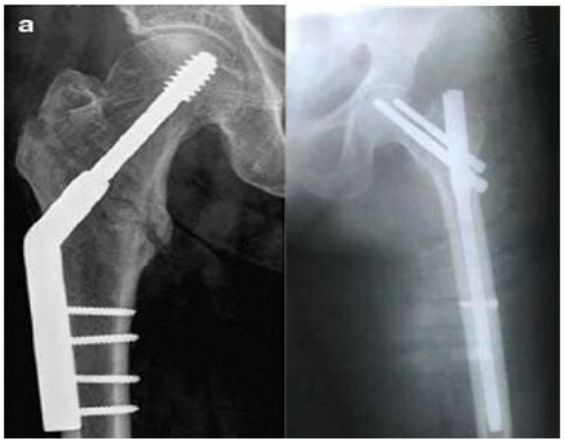

Fig. 4: DHS fixation. Fig. 5: PFN fixation.

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Closed intramedullary proximal femoral nail (PFN) overcomes the shortcomings associated with DHS. Its biomechanical properties like being an axial load bearing device, with a short lever arm, greater implant length, smaller and flexible distal ends and an additional de- rotational screw in femoral neck offers significant advantages over the DHS8. It also has the benefits of being a shorter procedure, lesser blood loss, an undisturbed fracture haematoma and early patient mobilization. In published literature, both DHS and PFN have their own set of advantages and disadvantages. Reports suggest a better functional outcome with DHS for stable fractures. However, in unstable intertrochanteric fractures, PFN had been shown to have better functional outcomes 9.

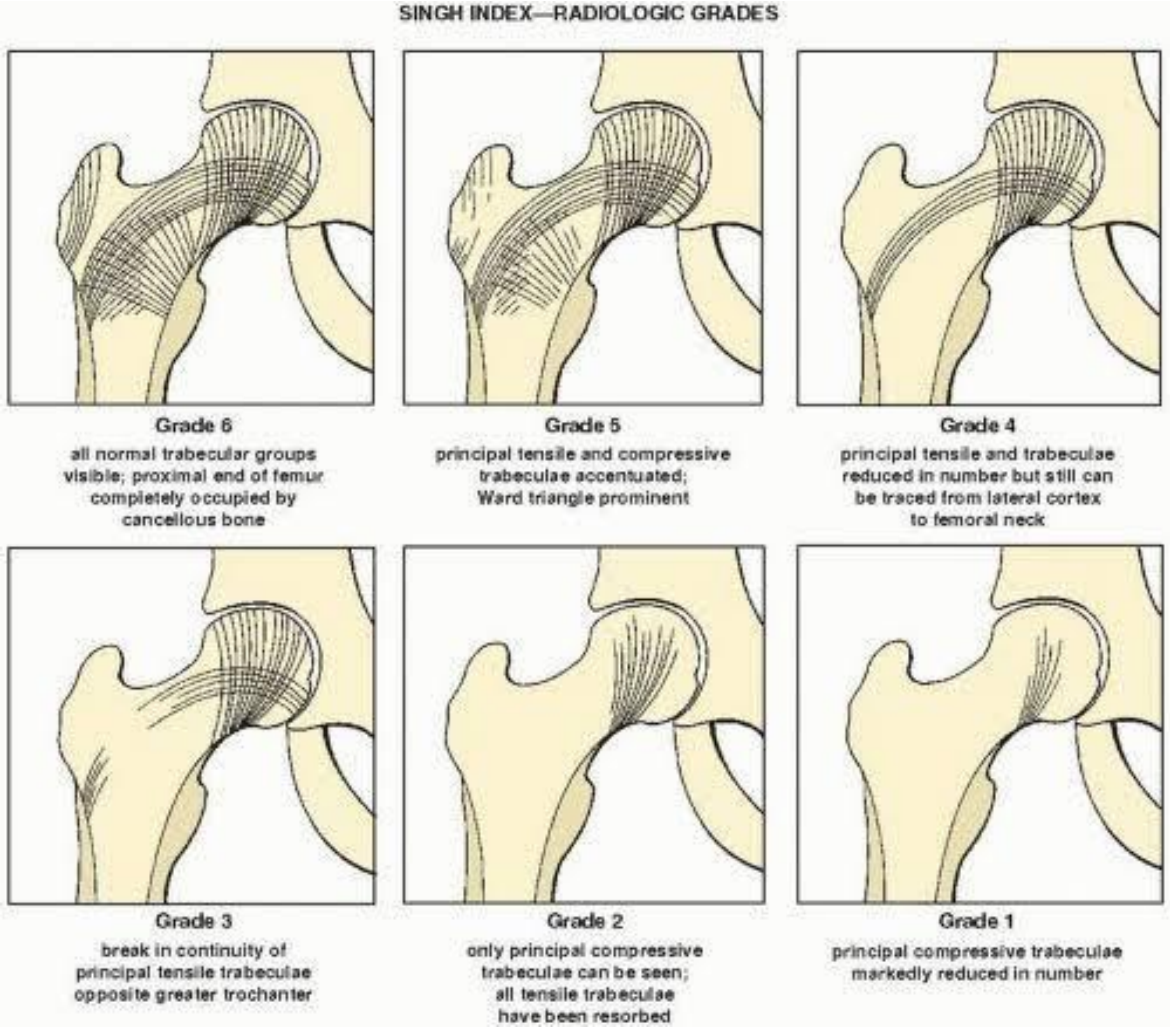

Fig. 6: Gradation using Singh's index. Normal being grade

The proximal femoral nail (PFN) introduced by the AO/ASIF group in 1998 has become prevalent in treating trochanteric fractures in the recent years [10,11]. Theoretical biomechanical advantages of intramedullary nails over screw and plate fixation are attributed to a reduced distance between the hip joint and the implant. Success of proximal femoral nail for the treatment of such fractures is based on these biomechanical principles. It helps in the prevention of mal-union and aids early mobilization[12].

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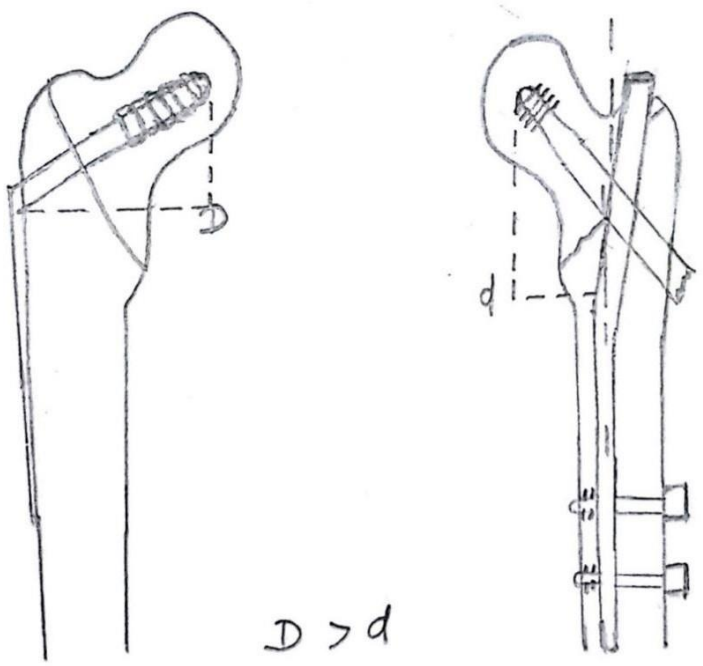

Fig. 7: Showing decreased lever arm of intramedullary nail vis a vis the DHS. Implant of choice in lateral wall or posteromedial wall comprised trochanteric fractures.

The objective of any surgical intervention of a trochanteric femoral fracture should be to achieve a stable osteosynthesis providing for early full weight-bearing. It is important to understand that, the proximal femoral nailing enshrines the "AO principles" in letter and spirit. With reposition and fracture stabilization, a particular importance must be attached to the collo-diaphyseal and the ante-torsion angle, so that they do not interfere with the functional interaction of the hip and knee joint. Un -complex trochanteric fractures ordinarily stabilize sufficiently after reposition so that even an extramedullary implant can ensure full weight-bearing stability[13]. With evermore distal fracture course and intertrochanteric comminutionzone,rotational instability and pivot transfer of thefracturearea.

Fig. 8

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to lateral and caudal areas accompanied by an increase of the dislocating forces. These kinds of fractures (A2 and A3 according to the AO/ASIF classification) are the ones that best profit from an intramedullary and rotationally stable osteosynthesis.

MATERIALS AND METHODS

NO. OF PATIENTS 'n'

The present study has been a prospective study, involving patients who had sustained unstable inter-trochanteric fractures. The study began in March 2017 and went on till February 2018 (a total recruitment period of 12 months). The study concluded in September 2018, so that there was a minimum follow-up of 7 months (mean 12.6; range 7 to 19 months).

INCLUSION CRITERIA:

- Only unstable trochanteric fractures were included (AO- OTA 2.2, 2.3, 3.1, 3.2 and 3.3).
- Only fractures seen within 15 days of injury were included.
- Both male and female patients, in the age group of 46 to 65 years were included in the study.

EXCLUSION CRITERIA:

- Patients with displaced trochanteric fracture not conforming to the above parameters were excluded.
- Open and pathological fractures were excluded.
- Inability to walk independently, prior to fracture due to pre-existing stroke or CVA were excluded.

FOLLOW UP PERIOD:
Minimum period of 7 months (mean 12.6; range 7 to 19 months).

The cases were studied on the basis of mechanism of injury, classification and treatment with Proximal femoral nail along with their surgical and functional outcomes with their residual complications, if any.

RESULTS

Table 1: AGE DISTRIBUTION:

AGE GROUP (In Years)	No. of Patients 'n'	% age
46 – 50	12	28.57
51 – 55	11	26.19

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56 – 60	11	26.19
61 – 65	8	19.04
TOTAL	42	100

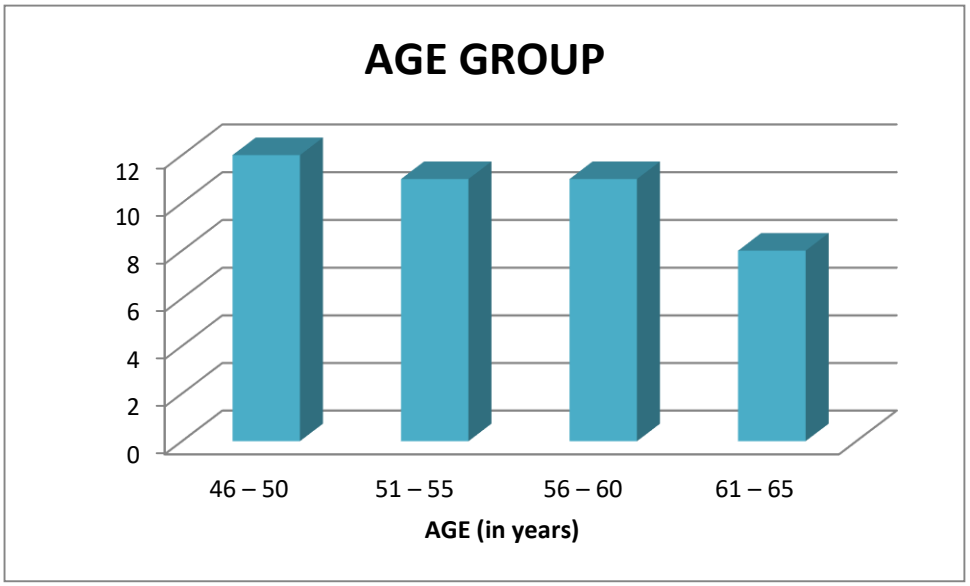

Table 2: SEX DISTRIBUTION:

SEX	No. of Patients 'n'	% age
Male	16	38.10
Female	26	61.90
TOTAL	42	100

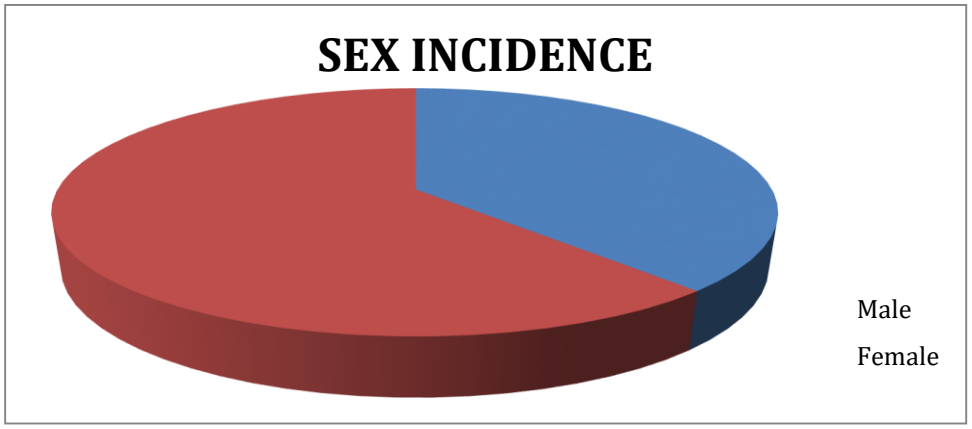

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Table 3: MODE OF INJURY:

MODE OF INJURY	No. of Patients 'n'	%age
Accidental fall from standing height	37	88.10
Road traffic accident	5	11.90
TOTAL	42	100

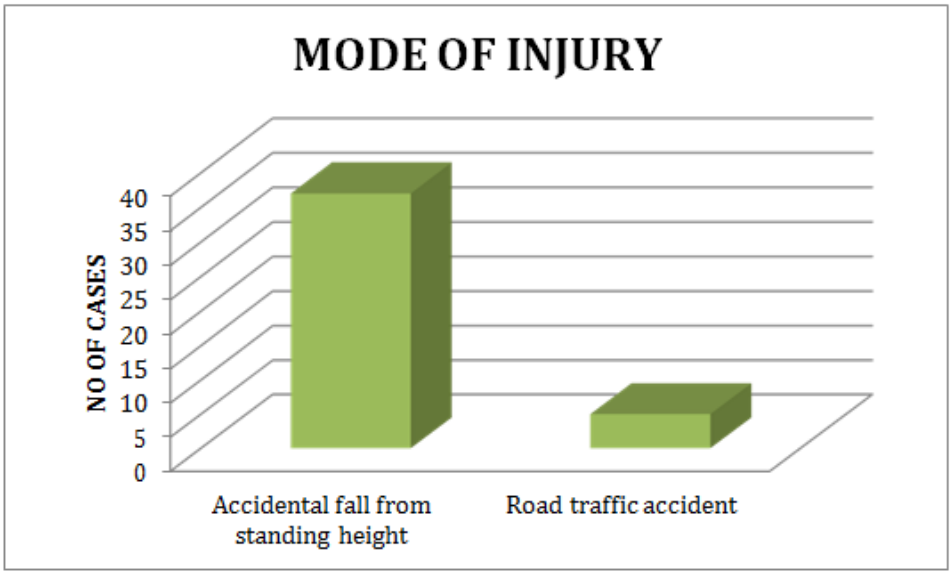

Table 4: TIME ELAPSED BETWEEN INJURY AND SURGERY:

TIME INTERVAL (In days)	No. of patients 'n'	% age
0 – 2	6	14.28
3 – 5	7	16.66
6 – 8	5	11.90
9 – 12	12	28.58
13 – 15	12	28.58
TOTAL	42	100

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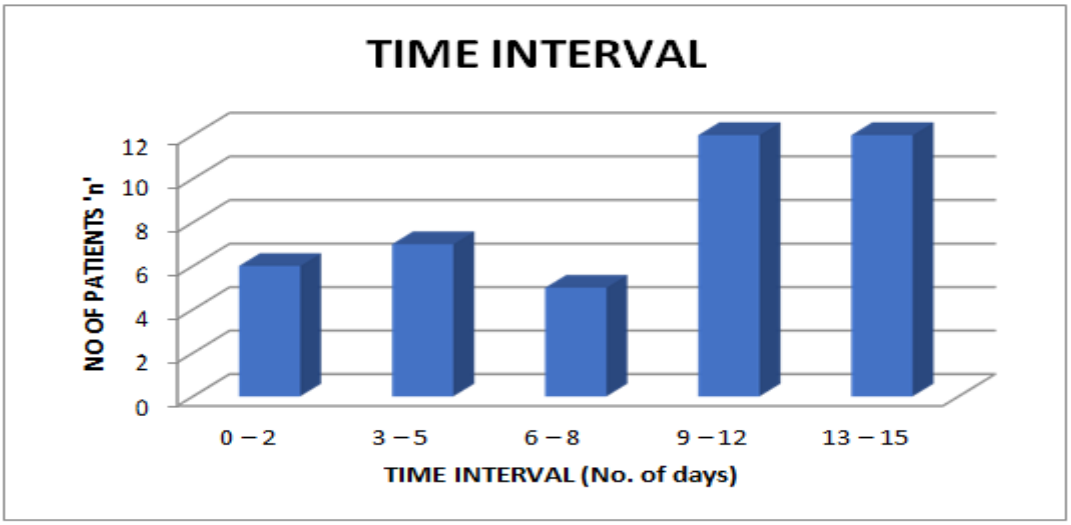
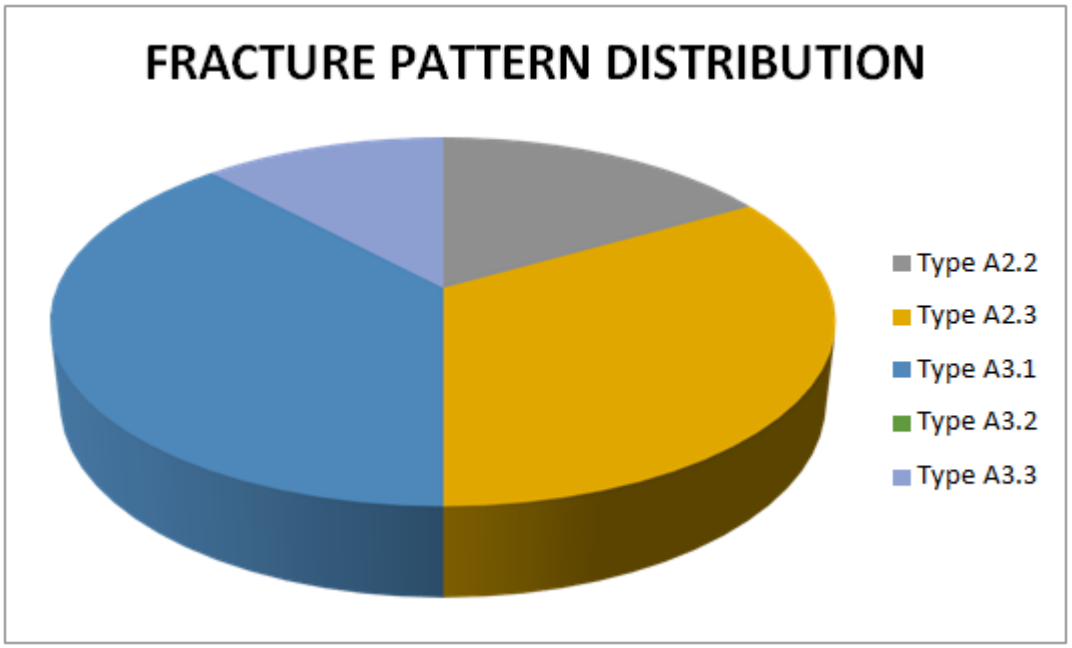


Table 5: FRACTURE PATTERN DISTRBUTION:

AO CLASSIFICATION	No. of Patients 'n'	% age
Type A2.2	7	16.66
Type A2.3	14	33.33
Type A3.1	16	38.01
Type A3.2	-	-
Type A3.3	5	12.00
TOTAL	42	100



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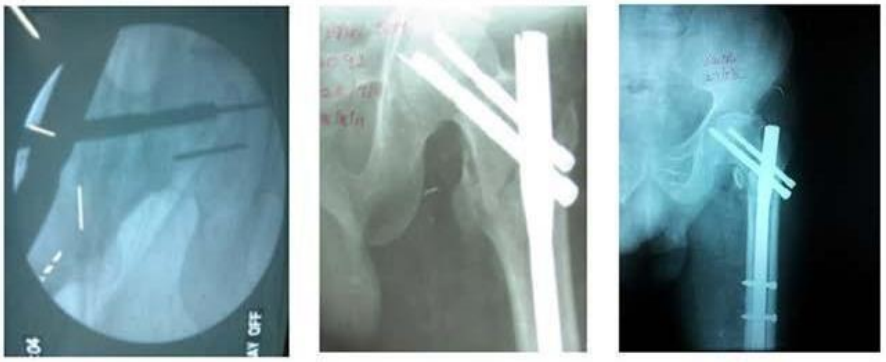
1. INTRA- OPERATIVE DRILL BIT BREAKAGE . 2. REVERSE ‘ Z’ EFFECT.



3.INFECTION WITH ‘Z’ EFFECT

4.Implant failure with malunion

CASE ILLUSTRATION

Case illustration 1:

Pre- op X- ray. Immediate post- op X- ray.

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Post- op X- ray at 4 weeks. Post- op X- ray Clinical photograph showing at 4 months, straight leg raising at 6 months post- op.

Clinical photograph showing some disability to sit cross - legged at 6 months post- op.

Case illustration 2:

Pre- op X- ray AP. Pre- op X- ray lateral. Immediate post- op X- ray.

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Post- op X- ray at 6 weeks. Post- op X- ray at 9 months- AP view. Post- op X- ray at 9 months Lateral view.


Clinical photograph showing straight leg raising. **Clinical photograph showing cross- leg s itting.**

Case illustration 3:



Pre- op X- ray. Immediate post - op X- ray. X- ray AP at 4 weeks post- op.

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X- ray post- op at 10 weeks. X- ray post- op at 10 months.


Superficial infection. Some disability to sit cross-legged at 6 months post- op.

Case illustration 4:



Pre- op AP. Immediate post- op AP. Immediate post-op- lateral.

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X- ray at 4 months- AP. X- ray at 8 months- AP. X- ray at 8 months- lateral.

Case illustration 5:

Pre- op - AP. Pre- op – lateral. Immediate post- op– AP. Post- op– lateral.

X- ray at 6 weeks- AP. X- ray at 14 weeks - AP. X- ray at 14 weeks – lateral.

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At 6 months- squat s itting. **At 6 months – hip f lexion.**

DISCUSSION

The successful treatment of inter-trochanteric fractures depends on many factors [15]; the age of the patient, the patient‟s general health, the time elapsed from trauma to treatment, concurrent medical treatment and the stability of fixation[10]. The appropriate method and the ideal implant used for these fractures are still debated with proponents of the various approaches and each claiming their advantages over others. Many internal fixation devices have been recommended for the treatment of these fractures, including extra-medullary and intra-medullary implants. The dynamic hip screw has remained the implant of choice for over four decades because of its favorable results and a relatively low rate of non-union and failure. It provides for controlled compression at the fracture site. The use of DHS had been supported by their bio-mechanical properties which had been presumed to improve the healing of fractures[11]. However, the DHS requires a relatively larger exposure, more tissue handling and near anatomical reduction, all of which increases the morbidity, the probability of an infection and a significant blood loss. The possibility of varus collapse and the inability of the implant to survive until fracture union were its main draw-backs.

The side-plate and screws weaken the bone mechanically. The common causes of this fixation failure were unstable trochanteric fractures, osteoporosis, a lack ofanatomical reduction, failure of the fixation device and incorrect placement of the lag screw in the femoral head12 , 13 . Control of axial telescoping and rotational stability are essential in unstable proximal femoral fractures. An intra-medullary implant inserted in a minimally invasive manner is always better tolerated in the elderly patients [14]. The cephalo-medullary nails with a trochanteric entry point have recently gained in popularity [15]. They have been shown to be bio-mechanically much stronger than extra-medullary implants[16]. The Gamma nail were associated with specific complications, among which was a constant anterior thigh pain and the fear of fracture of the femoral shaft [17,18]. The PFN system, developed by AO/ASIF, has some major bio-mechanical innovations to overcome the previously mentioned limitations of the Gamma nail [18]: Addition of the 6.5 mm anti-rotation hip screw has helped to reduce the incidence of implant cut-out and the rotation of the cervico- cephalic fragment. In this respect, it should be borne in mind that the lag screw must be adjusted to the calcar, taking into account the need to place the de - rotational hip screw. The smaller diameter and the fluting of the tip of the nail, is especially designed in - order to reduce stress forces below the implant and thereby reducing the incidence of low-energy fracture at the tip [19]. The PFN nail has been shown to prevent the fractures of the

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femoralshaft by having a smaller distal shaft diameter which reduces stress concentration at the tip [19]. Intramedullary implants for internal fixation of the proximal femur withstands a higher static and a several-fold higher cyclical loading than does a DHS type of implant. As a result, the fracture heals even without the primary restoration of the medial support. The implant temporarily compensates for the function of the medial column [20]. In A1 and A2 fractures axial loading leads tofractureimpaction, whereas in A3 fractures such impaction does not occur, and medial displacement of the distal fragment of the fracture is bound to occur due to the instability factor. Due to its position close to the weight - bearing axis the stresses that are generated on the intra- medullary implants are negligible. The PFN implant also acts as a buttress in preventing the medialization of the shaft[101]. Bio-mechanically, compared to a laterally fixed side plate, the Intra-medullary nail decreases the bending force on the hip joint by 25 to 30% [22]. This has the advantage in the elderly age group in-order to make them weight bear earlier. The entry portal of the PFN through the trochanter limits the surgical insult to the tendinous hip abductor musculature only, unlike those nails which require entry through the pyriformis fossa. Compared to Gamma nail, the additional anti- rotation screw placed in the femoral neck avoids rotation of the cervico-cephalic fragments during weight bearing [24,25,26]. The stabilizing and the compression screws of the PFN adequately compress thefracture, leaving between them a bone block for further revision should the need arise [24]. In our study of 42 patients with unstable intertrochanteric fracture, the average age incidence was 56.72 years. This is in contrast to higher age group as reported in the western literatures. Our study results are comparable with those of R. C. Gupta et al; [22], Mohanty SP et al;[24] and of that reported by G.S. Kulkarni et al;. Majority of cases occurred in older individuals as the average life expectancy of an Indian is 10 years less than western standards and malnutrition and osteoporosis go hand in hand.

Authors	**Average age**
K Karl Lunsjo et al; [107]	81.0
B Boyd and Griffin [40]	69.7
R R. C. Gupta[105]	51.2
R Richard Kyle[108]	72
Mohanty S. P.[106]	61.7
G.S. Kulkarni[89]	62
Our study	56.72

We used short PFN 135 ^{o} in 24 cases and the long or short PFN 130^{o} in 18 cases. We used longer nail for unstable reverse oblique variant and for fractures with sub- trochanteric extension in-order to minimize peri-prosthetic fracture arising from stress raiser effect, from the tip of the

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nail[26]. A mismatch between the nail curvature and femoral bow might result in the impingement of the tip of the nail

CONCLUSION

The proximal femoral nail, which was the implant used in this study, has established its distinct superiority in the instances of surgically managing displaced and unstable trochanteric fractures. Its unique advantages are that it is amenable to closed reduction whic h preserves the fracture hematoma. There is less surgical insult. It enables early rehabilitation and early return to pre-injury activity status. We hereby conclude that, osteosynthesis using a PFN, used in unstable trochanteric fractures, results in a low rate of clinical complications, gives excellent stabilization, fewer mechanical complications and satisfactory functional results. It is thus an ideal implant for surgically managing unstable inter - trochanteric fractures.

Funding: No funding sources

Ethical approval: The study was approved by the Institutional Ethics Committee

CONFLICT OF INTEREST

The authors declare no conflict of interest

ACKNOWLEDGMENTS

The encouragement and support from Bharath University, Chennai is gratefully acknowledged. For provided the laboratory facilities to carry out the research work.

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Received 15 December 2020; Accepted 05 January 2021.

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