COMPARATIVE STUDY BETWEEN DYNAMIC HIP SCREW AND PROXIMAL FEMORAL NAIL IN THE MANAGEMENT OF TROCHANTERIC AND SUBTROCHANTERIC FEMORAL FRACTURES.

By,

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INTRODUCTION

Peritrochanteric fractures are devastating injuries that most commonly affect the elderly and also in young, have a tremendous impact on both the health care system and society in general. Peritrochanteric fractures mainly comprise of fractures of trochanter and subtrochanteric region. Despite marked improvements in implant design, surgical technique and patient care, peritrochanteric fractures continues to consume a substantial proportion of our health care resources, remains a challenge to date.

Trochanteric fractures are common in the elderly people. The frequency of these fractures has increased primarily due to the increasing life span and more sedentary life style brought on by urbanization. Trochanteric fractures occur in the younger population due to high velocity trauma, whereas in the elderly population it is most often due to trivial trauma.

The incidence of trochanteric fractures is more in the female population compared to the male due to osteoporosis. In a Swedish study of more than 20,000 patients, the incidence of hip fractures in women doubled every 5.6 years after the age of 30 years.

The trochanteric fractures can be managed by conservative methods and there is usually union of the fracture. If suitable precautions are not taken the fracture undergoes malunion, leading to varus and external rotation deformity at the fracture site and shortening and limitation of hip
movements. It is also associated with complications of prolonged immobilization like bedsores, deep vein thrombosis and respiratory infections.

Since this fracture is more common in the elderly patients, the aim of treatment should be prevention of malunion, and early mobilization. Taking all the factors into consideration surgery by internal fixation of the fracture is ideal choice.

There are various forms of internal fixation devices used for Trochanteric Fractures. The most commonly used device is the Dynamic Hip Screw with Side Plate assemblies. This is a collapsible fixation device, which permits the proximal fragment to collapse or settle on the fixation device, seeking its own position of stability.

The latest implant for management of trochanteric fractures is proximal femoral nail, which is also a collapsible device with added rotational stability. This implant is a centromedullary device and biomechanically more sound. It also has other advantages like small incision and minimal blood loss.

Pertrochanteric and subtrochanteric fractures of femur posses clinical, structural, anatomical and biomechanical characteristics that distinguish them from intracapsular fractures. Subtrochanteric fractures comprises about 10 to 34% of hip fractures.

Subtrochanteric fractures are complicated by malunion and delayed or nonunion. The factors responsible for these complications in subtrochanteric fractures are high stress concentration, predominance of cortical bone and difficulties in getting biomechanically sound reduction because of
comminution and intense concentration of deforming forces.

The present choice of treatment of subtrochanteric fractures is open reduction and internal fixation. Many internal fixation devices have been recommended for use in subtrochanteric fractures, because of high incidence of complications reported after surgical treatment with each implant. A lack for satisfactory implant in surgical treatment of subtrochanteric fractures has led to series of evolution in design of a perfect implant. Subtrochanteric femoral fractures are associated with high rates of non-union and implant failure, regardless of the method of fixation. Only recently has a better understanding of biology, reduction techniques and biomechanically improved implants allowed for subtrochanteric fractures to be addressed with consistent success.

In spite of the advances in anesthesia, nursing care and the surgical techniques, hip fractures remain a significant cause of morbidity and mortality in the elderly population.

In view of these considerations, the present study of Surgical Management of Peritrochanteric Fractures is taken up.

Intertrochanteric (IT) fractures are commonly seen in elderly population. It is usually associated with other co-morbid conditions like diabetes, hypertension, renal failure which makes Anesthesia fitness for treatment of this fractures difficult task. Increased dependency in activities of daily living, and a history of other osteoporosis related (“fragility”) fractures are also found to be associated with intertrochanteric fractures.

Early and adequate fixation is very important in these patients so as to mobilize them at earliest and prevent complications of recumbancy.
Osteoporosis in this age group makes fixation of these fractures a difficult task, and increases chances of complications like screw cut-out when D.H.S. is used to fix I.T. fractures.

Surgical anatomy of proximal femur with special reference to trabecular pattern is important aspect while dealing with I.T. fractures. 90% of I.T. fractures in elderly patients result from simple fall.

Classifications of Evan’s, Boyd’s, Tronzo’s and A.O’s are used commonly to classify I.T. fractures.

Goal of treatment is to achieve accurate anatomical or non-anatomical but stable reduction, rigid fixation, and early mobilization of patient and prevent deformity at hip.

Stable fractures can be very well treated with dynamic hip screw alone with good results proven by various studies. It is the unstable fractures which are difficult to manage with dynamic hip screw alone. Rates of complications like screw cut out, shortening of limb, varus deformity of proximal femur, and even non-union are higher in unstable fractures as compared with stable fractures.

Hence the need for any other better fixation device or any modifications in design of dynamic hip screw or any add-on fixation device with D.H.S is felt.
AIMS AND OBJECTIVES

AIMS:

• To achieve fracture union by using two different kind of internal fixation modality devices in similar type of fractures.

• Comparative study of PFN and DHS in the management of fractures of trochanteric & sub trochanteric fractures.

OBJECTIVES:

• Evaluation of effectiveness and strength of PFN and DHS in the management of trochanteric and subtrochanteric fractures.

• To observe the effectiveness of both the implants regarding early mobilization of the patients.

• The advantages & disadvantages of the two internal fixation being used to treat similar kinds of fractures.
Although fractures of hip were known since time of Hippocrates, Sir Astley Cooper (1822)\(^{124}\) was the first to have given the accurate description of fracture occurring at upper end of femur and who has distinguished extra capsular from intra capsular fractures many decades before the discovery of x-rays.

Percival Pott at the end of 18\(^{th}\) century was the first to stress the need of exerting traction in fractures of upper end of femur.

Steinmann in 1907 devised the metallic traction which proved to be more effective way of applying traction.

Invention of tri-flanged nail for internal fixation of fractures of femur by Smith Peterson (1925) was the major breakthrough in field of internal fixation device.

Thornton (1937)\(^{126}\) added an adjustable side plate to the S.P nail and thus made it possible to use it for fractures of trochanter.

Boyd and Griffin (1949)\(^{127}\), Fielding and Magliato (1966), Zickel (1976), suggested surgical management for pertrochanteric and subtrochanteric fracture.

Mervyn Evans (1951)\(^{125}\) classified fractures into stable and unstable group thus putting emphasis on stability of the fracture which is very important for deciding line of management and improving the ultimate outcome.

Raymond and Tronzo\(^{128}\) described new classification of fracture, classifying it into 5 different types keeping in mind the anatomy of fracture.
and, stability, weather reduction is possible or not. His classification is the most accepted one today.

**Jewett (1952)**\(^{129}\) published his paper recommending that all hip fractures be treated with 135 degree nail plate device. He also developed the fixed angled nail plate which was initially biflanged and later on changed to triflanged which is still used for fractures. Owing to the fact that they do not allow controlled collapse and impaction at the fracture site, without penetration of the femoral head, a stable reduction (anatomical or non-anatomical) period to nail insertion is essential to prevent this complication.

**Taylor G.M. (1955)** was the first to talk of various deformities resulting from fractures. He stated that varus deformity is symptomatic when the neck shaft angle is less than 120 degrees.

**Clawson DK**\(^{130}\) of USA in 1959 with help of Richards manufacturing company invented the sliding compression screw devise which is the second major breakthrough in the field of internal fixation devices for fractures.

**Saramiento (1963)**\(^{131}\) introduced the technique of valgus osteotomy to obtain stability in unstable fractures.

**Dimon and Hugston (1964)**\(^{132}\) have suggested an easier way of achieving stability, the medial displacement technique.

**Weismann et.al (1964)** were fixing the lesser trochanter in order to achieve anatomical reduction while **Wardie (1967)** has stated that reduction and fixation of displaced lesser trochanter fragment to femoral shaft in order to provide a stable buttress for reduction to proximal fragment is difficult time consuming and often unsuccessful.

**Fielding and Magliato (1966)**\(^{47}\) proposed a simple classification in which
they have defined subtrochanteric fracture.

Singh (1970)\textsuperscript{133} introduced the method of examining the degree of osteoporosis by x-ray evaluation of trabecular pattern of proximal femur. This is important as fixation of proximal fragment and fracture stability depends on bone quality.

Ender (1970)\textsuperscript{134} introduced multiple flexible Condylodephalic nails.

Harrington (1975)\textsuperscript{135} recommended use of methyl methacrylate cement to reinforce the internal fixation in osteoporotic bone. It does improve the fixation, but is associated with increased incidence of infection and delayed implant loosening.

Seinsheimer (1978) presented a new classification for subtrochanteric fractures.

Green et.al (1986)\textsuperscript{136} and Stern et.al (1987)\textsuperscript{137} have presented a series of comminuted fractures treated with Leinbach prosthesis and concluded that it is recommended for the elderly patients with comminuted fractures.

Use of intra-medullary hip devices for treatment of fractures was started in 1980’s. Since then there has been several modifications in design of intra-medullary implants.

In 1959, AO blade plates were developed by ASIF. They advised the device to be effective, must function as tension band, with presence of prompt reconstitution of an intact medial cortical buttress.

In a study of 130 patients with pertrochanteric and subtrochanteric fractures in which 40 patients were treated with AO blade plate. 7 patients were rated as failures and 4 patients developed non-union. Failure is due to poor reduction of fracture fragments and to the initiation of weight bearing
too early in the postoperative course.

In another study using ASIF blade plate fixation for severely comminuted pertrochanteric and subtrochanteric fractures. The review revealed that ASIF blade plate provides adequate stabilization and fixation with high rate of union.

Another study biomechanically compared various methods of stabilization of pertrochanteric and subtrochanteric fractures of femur. **Russel Taylor** introduced reconstructed intramedullary nail for pertrochanteric and subtrochanteric fractures.

Another author compared the results of open reduction and blade plate fixation of subtrochanteric fractures to indirect reduction and fixation.

In 1990 another study mentioned about operative stabilization of pertrochanteric and subtrochanteric fractures of femur. This study demonstrates acceptability of implants in management of pertrochanteric and subtrochanteric fractures, provided strict adherence to reconstruction of medial cortex is accomplished.

**R.J Medoff**\(^{38}\) in 1990 designed a device that allows axial compression through the portion and through the metaphyseal subtrochanteric portion through a sliding device that is incorporated onto the plate attachment to the shaft of femur. The compression slide acts as a intermediate segment, capturing the lag screw proximally and engaging the barreled side plate distally in a sliding track. The barreled side plate is attached to the femoral shaft with the bone screws directed into two planes. This is called “The axial compression screw plate device”.

In 1991, a report about treatment of inter trochanteric fractures by external
A fixator was published by Anil Dhal, Mathew Varghese and V.B Bhasin, Maulana Azad Medical College, New Delhi. The advantages were greatest economy preserving the fracture hematoma, minimal surgical trauma, negligible blood loss, early ambulation, short hospital stay and removal as an outpatient procedure. This method is still under evaluation.

In 1991, A. Bodoky, U. Neff, M. Heberer & F. Harder from the department of Surgery, Basel university of Switzerland advocated the use of two doses of cephalosporin antibiotics preoperatively in patients managed with internal fixation of hip fracture. According to their study antibiotic prophylaxis significantly reduced the incidence of wound infection.

Halder and Williams in 1992 introduced Gamma Nail and Parker described complications of Gamma nail.


In 1992 an author presented comparative study of Gamma nail and DHS.

In 1993 another author studied about the association of age, race and sex with location of the proximal femoral fractures in the elderly.

In 1994, Gargan M F, Gundle R, Simpson A. H claimed that there is no benefit of osteotomy and therefore recommended anatomical reduction and fixation by the sliding hip screw in most cases.

In 1994 an author presented a case report and review of the literature.
on post-operative femoral fracture after Gamma nailing.

In 1994, Blatter et al studied about treatment of the pertrochanteric and subtrochanteric fractures of the femur with DCS.

In 1994 an author studied about pertrochanteric and subtrochanteric fractures of the femur treated with Zickel nail. Zickel nail is not been recommended by them any more for treatment of pertrochanteric and subtrochanteric fractures.

In 1994 Cole studied about intramedullary nail and lag screw fixation of proximal femur fractures. The vector nail has been introduced as an alternative form of fixation for complex proximal femur fractures.

Another author studied about osteosynthesis of proximal femoral fractures with modular interlocking system of AO femoral intramedullary nail.

In 1995, Butt M.S, Krikler S J, Nafie, Ali M.S studied the comparisons of Gamma Nail and DHS and found that clinical and radiological union results with both implants were the same but the rate of complication with Gamma Nail was higher. Hence they do not recommend Gamma Nail for the treatment of per trochanteric fractures.

In 1995, M R Baumgaertner, S L Curtin, D M Lindskog and J M Keggi had developed a simple method to describe the position of the lag screw. In this the tip apex distance(TAD) is the sum of the distance from the tip of lag screw to the apex of the femoral head on anterior posterior and lateral view after controlling the magnification. In their study, to determine the value of this measurement in prediction of the so called cut out of the lag screw the average tip apex distance is 24 mm for successfully treated
fractures

In 1995, an author reviewed 161 pertrochanteric and subtrochanteric fractures and the risk factors influencing outcome, age, fracture pattern and fracture level.

In 1996, an author reviewed a series of 128 patients with pertrochanteric fractures of femur and gave results of 81% very good to good and 7% fair with gamma nailing.

In 1996, Bartlt R, Hofer F\(^{144}\) said that the in hip fractures after DHS, the anti rotation screw is placed with help of parallel drill guide. It was possible to position the anti rotation screw in the parallel manner in all the patients so that the dynamic effect of DHS was impaired and a faulty penetration of the screw into the hip of a badly positioned anti rotation screw could be avoided.

In 1996, the AO/ASIF developed the proximal femoral nail (PFN) as an intramedullary device for the treatment of unstable per-, intra- and subtrochanteric femoral fractures in order to overcome the deficiencies of the extramedullary fixation of these fractures. This nail as the following advantages compared to extramedullary implant-such as decreasing the moment arm, can be inserted by closed technique, which retains the fracture hematoma an important consideration in fracture healing, decreases blood loss, infection, minimizes the soft tissue dissection and wound complications.

In a clinical multicenter study, authors reported technical failures of the PFN after poor reduction, malrotation or wrong choice of screws. Gotze et al. compared the loadability of osteosynthesis of unstable per-and
subtrochanteric fractures and found that the PFN could bear the highest loads of all devices.

An author compared trochanteric fractures treated with the Gamma nail or the Proximal Femoral nail and concluded that there were no significant differences in the use of either nail in terms of the recovery of previous functional capacity, nor in terms of the time required for fracture healing. With regard to the more significant technical complications recorded, shaft fractures and the cutting-out phenomenon were more common with the use of the Gamma nail, while secondary varus occurred at a greater rate when using the PFN.

Another author in 1997 reviewed a series of 65 patients and concluded that the gamma nail enables the surgeon to treat more types of hip fractures with a less invasive technique and achieve equal or better results.

In 1999 an author treated 10 cases of ipsilateral hip and femoral fractures and concluded that use of a long gamma nail to fix this dual fractures is recommended whenever possible.

In 1999, Hoffmann R., Schmidmaier G, Schulz R. , Schutz M had done a prospective randomized study of the fixation of trochanteric femur fracture with classic nail (Intramedullary hip screw fixation system) and DHS. They found no significant difference between the two study groups.

In 1999, Prof. Berton Moed from Wayne State Hospital in Detroit, Michigan, USA, described his experience comparing Medoff sliding plate to the Hip screw (DHS). The Medoff sliding plate was designed to improve the treatment of inter trochanteric fractures by achieving the compression along
the femoral neck and longitudinal axis of the femoral shaft. In his experience Medoff sliding plate was associated with significant higher amount of blood loss and operative time. But the failure of this device in unstable fracture was only 3% as compared to DHS, where the failure rate was 14%.

In 2000, Habernek H, Schmid L, Frauenchun E\textsuperscript{146} had a retrospective review of sport related femoral fractures treated either by Gamma nail or the DHS. They found that Gamma Nail was clearly the best with regard to stability but required more operative time than DHS. Also intra operative complications occurred with Gamma nail as compared to DHS.

In 2000, Habernek H, Wallner T, Aschauer E and Schmid L\textsuperscript{147} had done a comparative study of Enders nail, DHS and Gamma nail for the treatment of peritrochanteric fractures. They found out that the technique for DHS is safer and simpler than other methods. However DHS has been superseded by Gamma nail due to its absolute stability. The number of mal alignment did not differ significantly between DHS and Gamma Nail but was higher with Ender’s nailing.

In 2000 a group of investigators compared the use of Enders nails, hip screws and gamma nails in the treatment of peritrochanteric fractures and concluded that the gamma nail had superseded the rest because of its absolute stability but was technically more demanding with a higher number of intraoperative complications.

In 2001 a study concluded that PFN is an excellent implant for treatment of unstable fractures of proximal femur. The terms of successful outcome include a good understanding of fracture biomechanics, correct indication and exactly performed osteosynthesis.
In **2002** a study concluded that PFN is a method of choice in trochanteric fracture, namely in high subtrochanteric fractures.

In **2002** another study concluded that the PFN is a good choice for trochanter subtrochanteric fractures and also the use of the PFN for unstable trochanteric fractures is very encouraging.

In **2002** another study to evaluate the PFN for the treatment of 76 unstable trochanteric femoral fractures concluded PFN is a useful device in the treatment of the unstable trochanteric femoral fracture. It is a relatively easy procedure and a biomechanically stable construct allowing early weight bearing.

In a prospective randomized controlled trial of subtrochanteric femur fractures treated with a Proximal Femoral Nail compared to a 95 degree Blade plate and concluded that internal fixation of subtrochanteric femur fractures with a 95 degree angled blade plate is associated with increased implant failure and revision compared to closed intramedullary nailing using a Proximal Femoral Nail.

In **2003** another study recommended PFN as choice of implant for peritrochanteric fractures.

In **2003** a prospective study of proximal femoral fractures treated with PFN on 55 patients and concluded PFN as a intramedullary device for treatment of unstable per, intra and subtrochanteric femoral fractures.

In **2003** a study on 24 subtrochanteric femoral fractures treated with long PFN concluded Long PFN is a reliable implant in the treatment of complex subtrochanteric fractures. Posteromedial wall reconstruction of the proximal femur is mandatory when treating sub-trochanteric fractures with
Long PFN to avoid mechanical failure and non-union.

In 2004 a study concluded both PFN and gamma nail had comparable results except that PFN had less intraoperative blood loss and concluded that pit falls and complications were similar and mainly surgeon or fracture related, rather than implant related.

In 2004 another study concluded that PFN is a suitable implant for unstable fractures, but the high re-operation rate precludes its routine use for every peritrochanteric fracture.

In 2006 another study of 83 patients of proximal femoral fractures treated with PFN, has confirmed the advantages of PFN if compared with other present osteosynthetic methods.

In 2007 a study on 87 consecutive patients treated with a proximal femoral nail (PFN) for trochanteric femoral fractures concluded PFN is useful for the treatment of trochanteric femoral fractures.

In 2007 a study of 30 skeletally mature patients treated with PFN for peritrochanteric fractures concluded that proximal femoral nail is the implant of choice for subtrochanteric fractures and its use in unstable trochanteric fractures is very encouraging.

In 2007, a prospective study on 100 consecutive patients concluded Osteosynthesis with the PFN offers the advantages of high rotational stability of the head-neck fragment, an unreamed implantation technique and the possibility of static or dynamic distal locking and PFN is useful for treating stable and unstable trochanteric fractures.

In 2009, a retrospective review of 26 cases concluded PFN is a suitable implant for unstable femoral fractures needing open reduction.
internal fixation. It has low per operative and post operative morbidity.

In 2009, another study on 35 patients concluded that the correct position of the osteosynthesis material and use of an intramedullary nail providing a stronger fixation of the proximal part may reduce mechanical complications following the treatment of unstable hip fractures.
CLASSIFICATIONS

“A classification is useful only if it considers the severity of the bone lesion and serves as a basis for treatment and for evaluation of the results”.

BOYD AND GRIFFIN (1949) Classification

Based upon the principles of planning, treatment and estimating the prognosis

**Type 1:**
- Fracture is extending along the line from the greater to lesser trochanter.
- Stable
- Reduction is simple and easy to maintain.
- Good result.

**Type 2:**
- It is stable comminuted fracture
- Main fracture is along line but with simple fracture in cortex.
- Reduction is more difficult.

**Type 3:**
- Unstable
- Basically subtrochanteric with at least one fracture passing across the proximal end of the shaft just distal to or at the lesser trochanter associated with comminution.
- Reduction more difficult

**Type 4:**
Classifications

- Unstable

- Fracture of trochanter region and the proximal shaft with fracture in at least in 2 planes.

- It is very difficult to stable reduction.

Evans (1929) Classification\textsuperscript{125} –

This classification made an important contribution to understanding of fractures.

This classification system is based on stability of fracture pattern and potential to convert an unstable fracture pattern to stable one.

Evans observed that “Key” to stable reduction is restoration of Posteromedial cortex continuity.
Classification system

Inter trochanteric fractures

Stable

Unstable

Stability can be restored to anatomical or near anatomical reduction.

Anatomical reduction would not create stability.

Evans type I

Fracture line extends upward and outwards from lesser trochanter.

Evans type II

Reverse obliquity fracture pattern is seen, major fracture line extends outwards and downwards from lesser trochanter.

These type II fractures have tendency towards medial displacement of femoral shaft due to pull of adductor muscles.
Evans classification of fractures

- **A1** - Fractures are uncomminuted simple two part fracture
- **A2** - Fracture extends over two or more levels of Medial cortex.
- **A3** - Fracture extends through lateral cortex of femur.

All these groups further subdivided in to 1, 2, and 3 according to extent of fracture line extension and fracture comminution.

- A1.1, A2.a is commonly described as “Stable” fracture pattern while A2.2 through A3.3 usually is “unstable”.

**AO classification of trochanteric fractures:**

- **A1** - Fractures are uncomminuted simple two part fracture
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Orthopedic Trauma Association (OTA) Alphanumeric Fracture Classification

31 – A Femur, proximal trochanteric

A1 pertrochanteric simple

- A1.1 Along line
- A1.2 Through greater trochanter
- A1.3 Below lesser trochanter

A2 pertrochanteric multifragmentary

- A2.1 with one intermediate fragment
- A2.2 with several intermediate fragments
- A2.3 extending more than 1 cm below lesser trochanter

A3 Intertrochanteric

- A 3.1 Simple oblique
- A 3.2 Simple transverse
- A 3.3 Multifragmentary

AO classification of trochanteric Fractures
Tronzo’s Classification\textsuperscript{128}:

**Type I**: Incomplete fracture only involving greater trochanter.

**Type II**: Uncomminuted fracture with or without slight displacement intact posterior wall and relatively small lesser trochanter fragment.

**Type III**: Comminuted posterior wall with telescoping of neck spike into shaft fragment. Lesser trochanter fragment being large.

**Type IV**: Comminuted posterior wall with telescoping of neck spike into shaft fragment but greater trochanter totally broken.

**Type V**: Comminuted posterior wall without telescoping of the two major fragments. Neck spike displaced outside shaft. Most posterior wall lost medially,

**Type VI**: Reverse oblique fracture with medial displacement of shaft greater trochanter attached or not to neck fragment.
Anatomical classification:

1) **Intertrochanteric**: fracture along line.

2) **Peri- Trochanteric fracture**: fracture extends proximally into the greater trochanter. Both of the trochanter may be involved and comminution is present. It is most common type.

3) **Inter-subtrochanter type**: fracture has both as well as subtrochanteric element. It is always comminuted and a difficult fracture to treat. It results from very high velocity injury and usually occurs in younger age group.

4) **Subtrochanteric**: fracture below the lesser trochanter.

Classification of Subtrochanteric Femur fractures

*Maurice E Muller* - Numerous classification systems have been suggested for sub-trochanteric fractures, which have a prognostic importance and are of benefit in planning treatment.

*Seinsheimer’s classification*(1978):

It is based upon number of fragments and the location and configuration of fracture line.

**Type I** – Undisplaced fracture or one with less than 2mm displacement.

**Type II** -- Two part fracture

  II a Transverse fracture

  II b Spiral configuration with the lesser trochanter attached to proximal fragment.
II c  Spiral configuration with lesser trochanter attached to distal fragment.

**Type III** -- Three part fracture

II a  Three part spiral configuration with the lesser trochanter a part of third fragment

II b  Three part spiral configuration with third part a Butterfly fragment.

**Type IV**  Comminuted fracture with four or more fragments.

**Type V**  Sub-Trochanteric Inter trochanteric configuration.

**Fielding’s Classification (1966)**:

They defined subtrochanteric area as an area three inches in length extending from the proximal border of lesser trochanter to an area two
Classifications

inches distal to the lesser trochanter.

They then classified subtrochanteric fractures on the basis of three anatomic locations.

**Type I**: fracture occurring at the level of lesser trochanter.

**Type II**: Fractures occurring in an area one to two inches (2.5-5.0 cm) below the upper border of the lesser trochanter.

**Type III**: Fractures occurring in an area two to three inches (5.0-7.5 cm) below the upper border of the lesser trochanter. Transverse fractures fit in this classification well but oblique comminuted fractures may involve more than one of the levels described and should be classified according to the level of the major portion of the fracture or the area where the stress of the fracture concentrated.

As a rule fractures at the upper level have a better prognosis for union than at the lower level. Fielding and Magliato recognized an increased incidence of complications following treatment, as the fracture became more distal. Unfortunately this classification does not address the problem of comminution, which is critical in assessing fracture stability.

Fielding classification
Russell Taylor Classification of subtrochanteric fracture of femur

It is based on involvement of Pyriformis fossa by the fracture line.

**Type I**

Fracture does not extend into Pyriformis fossa.

**Type 1A**

Comminution and fracture line extends from below lesser trochanter to femoral isthmus.

**Type IB**

Fracture line and comminution involve area of lesser trochanter to isthmus.

**Type II**

Fracture extends proximally into greater trochanter and involves Pyriformis fossa.

**Type II A**

No Significant Comminution or fracture of lesser trochanter is seen.

**Type II B**

Significant comminution of Medial femoral cortex and loss of continuity of lesser trochanter.
A.O. CLASSIFICATION (1970)

Type A: Simple, transverse, oblique, or spiral

Type B: Fractures that have lateral butterfly.

Type C: Fractures that have medial butterfly.

Type D: Comminuted fractures.

Type E: Shattered fractures.

A.O. Classification not only identifies the fracture pattern but also the
most important feature, namely the type of comminution.

Type B and Type C fractures can still be reconstructed to yield a stable structural unit, whereas in Type D and Type E fractures which have their hallmark comminution to such a degree that stable unit cannot be achieved. This group includes fractures with an irreconstructable medial buttress or such segmental comminution that it represents a segmental loss.

Ender’s system:

Type I: Everson fracture i.e. posteromedial rotational wedge.
**Type II**: Impaction fracture i.e. fractures line extending subtrochantrically or being reversed.
ANATOMY OF PROXIMAL FEMUR

The femur is the longest and strongest bone of the body and like all long bones consists of a shaft and two ends. It articulates at its upper end with the hip bone and at its lower end with both the patella and the tibia. The upper end of the femur comprises a head, a neck, a greater and a lesser trochanter.

The head of the femur is rather more than half a ‘sphere’ and is directed upwards, medially and slightly anteriorly. The neck is about 5 cm long, connects the shaft, it is a stout bar of bone, roughly pyramidal in shape and flattened anteriorly. The long axis of the neck makes an angle of about 120-130 degrees with the long axis of the shaft and is termed the neck shaft angle. This arrangement allows greater mobility at the hip joint and enables the lower limb to swing clear of the pelvis. Anteriorly, at the junction of the shaft and the neck is a rough bony ridge, the line. It begins in a tubercle at the upper and medial part of the anterior surface of the greater trochanter and is directed inferomedially where it joins the spiral line, which becomes continuous with the medial lip of the linea aspera. Posteriorly a prominent ridge of bone, the crest joins the posterior aspect of the greater trochanter. On the upper part of the crest is a round protuberance called the quadrate tubercle.

The greater trochanter is large quadrangular laterally positioned. The upper posterior margin overhangs the trochanteric fossa. The greater trochanter provides insertion for most of the muscles of gluteal region. The upper border of the greater trochanter gives insertion to the piriformis and the medial surface to the common tendon of obturator internus and two gemelli. The gluteus minimus is inserted into the rough impression on its
anterior surface. The gluteus medius is inserted into the oblique and flattened strip on its lateral surface. The area behind the insertion is covered by the deep fibres of gluteus maximus with the trochanteric bursa interposed. The trochanteric fossa receives the insertion of the obturator externus.

The lesser trochanter is a conical eminence, which projects medially and backwards from the shaft at its junction with lower and posterior part of the neck. It gives attachment to the psoas major on its summit and iliacus at its base. The shaft of the femur is narrower in its middle, it expands a little as it is traced upwards, but it widens appreciably near the lower end of the bone. In its middle one third the shaft possesses three surfaces (anterior, lateral and medial) and three borders [posterior, lateral and medial]. In its upper one third, the shaft presents a fourth surface which is directed backwards and is called the posterior surface. This is bounded medially by the spiral line which is continuous above with the lower end of the line and below with the medial lip of linea aspera. On the lateral side the surface is bounded by gluteal tuberosity which extends upwards to the root of the greater trochanter and is continuous below with the lateral lip of linea aspera. In its lower third also the shaft possesses a fourth surface, the popliteal surface of the femur. The lateral and anterior surface of the shaft provides attachment in their upper $\frac{3}{4}$ for the vastus intermedius. The medial surface is devoid of muscular attachments and is covered by the vastus medialis. The medial edge of the tuberosity provides insertion for the pubic fibres of the adductor magnus. The lateral lip of linea aspera gives origin to the vastus lateralis and medial lip to the vastus medialis. In addition, the linea aspera gives attachment to the adductor longus, the
intermuscular septa and the short head of biceps femoris. The posterior surface of the upper third receives the insertions of the pectineus and the adductor brevis.

**BLOOD SUPPLY:**

The description of adult vessels is based on the work of Trueta and Harrington (1953). Since the vascular pattern established during the phase of growth is not replaced at maturity, but persists throughout in life, the basic arrangement is one of an epiphyseal and metaphyseal circulation, even when the growth plate has disappeared outline the anastamotic arrangement around the upper femur. Corck described the blood supply to the proximal end of the femur, which he divided into three major groups.

**a.** An extracapsular arterial ring located at the base of the femoral neck.

**b.** Ascending cervical branch of the arterial ring on the surface of the femoral neck.

**c.** Arteries of the ligamentum teres.

The extracapsular arterial ring is formed posteriorly by large branch of medial femoral circumflex artery and anteriorly by branch from lateral femoral circumflex artery. The ascending cervical branches of retinacular vessels, ascend on the surface of the femoral neck in an anterior, posterior, medial and lateral groups. The lateral vessels are most important. Their proximity to the surface of the femoral neck makes them vulnerable to injury in femoral neck fractures.

As the articular margin of the femoral head is approached by these ascending cervical vessels, a second less distinct ring of vessels is formed,
commonly referred to by Chung as the sub synovial intra-articular arterial ring. It is from this ring of vessels that vessels penetrate the head and are referred to as epiphyseal arteries, the most important being the lateral epiphyseal arterial group supplying the lateral weight bearing portion of the femoral head. These epiphyseal vessels are joined by inferior metaphyseal vessels and vessels of the ligamentum teres. Blood supply to the femur, like that of all tubular bones, is by the way of metaphyseal, periosteal and endosteal supply. The periosteal supply is related to the multiple muscle origins from the shaft to the femur the nutrient arteries perforate the femoral shaft along the linea aspera. The arteries are derived from perforating branches of profunda femoris artery.

**STRUCTURE:**

The shaft of the femur is roughly tubular compact bone, with a large medullary cavity. The wall of the cylinder is thick in the middle third of the shaft but above and below, the wall becomes thinner while medullary cavity is gradually filled with trabecular bone, the upper and lower ends of the shaft and the articular extremities consists of trabecular bone, invested by a thin compact layer.
The pertrochanteric and subtrochanteric area can be a site of stress concentration owing to the short radius of curvature at this site. When bone has insufficient opportunity to turnover and remodeling as in metabolic bone disease this may be a site of pathologic fracture.

In 1957, Harley and Griffin clarified the definition of the calcar femorale, as a dense vertical plate of bone within the femur, which originates in the posteromedial portion of the shaft, under the lesser trochanter, and radiates laterally through the cancellous tissues towards the greater trochanter.
OSTEOLEGY AND VASCULAR ANATOMY OF PROXIMAL FEMUR

HIP JOINT AND MUSCLES AROUND HIP
Anatomy of Proximal Femur

MUSCULAR FORCES:

The upper end of the femur is surrounded by a mass of powerful muscles. Inclusion of muscle forces necessary during single leg support adds to the complexity of the problem and can increase the stress to much higher values. On the other hand, some muscles such as the tensor fascia lata, may act to partially neutralize bending forces under certain conditions. In a normal hip, the strong gluteal muscles abduct and the powerful psoas flexes and rotates. These forces are balanced by the adductor and hamstrings. With a subtrochanteric fracture, the forces are unbalanced and the unopposed muscular action produces the characteristic abduction, rotation and flexion deformity described by Froimson. The same muscle forces act upon the fixation device after operation. These forces have been shown to generate high forces on the femoral head even when the patient is in bed, which in turn cause stresses in the subtrochanteric area as shown by Koch. Rydell has demonstrated that muscular pull for merely flexing or extending the hip in bed caused as much pressure on the femoral head as did slow walking with or without crutches.
MUSCLES AROUND HIP

Anterior view

Lateral view

Posterior view
MEDIAL BUTTRESS AND CROSS-SECTIONAL AREA:

The medial wall or the so-called medial buttress explodes, because of the great compressive forces. When the medial buttress is absent and the cross sectional area bearing load is minimum, all the stress is concentrated on the plate at the fracture site. This results in fatigue fracture of the implant and non-union. Therefore, the anatomy and functional continuity of the bone at the fracture site should be established by fixing fracture pieces by lag screws, cerclage wires, etc and the medial wall should be reconstructed by massive bone grafting. Thus, the cross sectional area to bear the load is increased and less force acts on the plate. Hence, integrity of the medial wall of the proximal femur is very important.

TRABECULAR PATTERN AND INDEX OF OSTEOPENIA

The normal trabecular pattern of femoral head and neck as seen on AP x-ray shows primary and secondary compression and tension trabeculae. The primary compression trabeculae are strongest trabeculae and the most persistent pattern. They extend from the medial cortex at the base of femoral neck to sub-chondral cortex of the sureromedical head. Primary tension trabeculae start from the lateral cortex just distal to greater trochanter and run along the superior neck adjacent to its cortex then cross the compression trabeculae to reach the inferomedial sub chondral cortex of head. The primary tension trabeculae prevent the collapse of primary compression trabeculae into varus. Secondary tension trabeculae begin at the cortex of lateral femoral shaft inferior to primary tension trabeculae and extend towards the middle of neck. Secondary compression trabeculae begin along the medial femoral cortex at the level of the lesser trochanter and extend
towards greater trochanter. The space bounded by primary and secondary trabeculae is called as Wards triangle.

**SINGH AND MAINI INDEX**

Singh and Maini have introduced a graded scale of 6 groups to judge the quantum of bone on radiology.

In healthy young individuals all trabeculae are present. Such bones would be graded 6 on Singh’s scale.

The entire head and neck of such femur have strong cancellous bone that gives strong hold to any fixation device. The grade 5 is identified by absence of trabecular pattern in ward’s triangle. Grade 4 shows loss of secondary trabeculae. In grade 3 bone primary tension trabeculae are missing while their path crosses the area of greater trochanter. Primary tension trabeculae are completely lost in grade 2. In grade 1 even primary compression trabeculae are thinned.

For clinical purpose bones graded 6, 5, 4 are variants of normal bone; whereas bones graded 3, 2, and 1 have reduced strength and may be considered osteopenic. Rates of complications following fixation have strong relationship with degree of osteopenia. Because a fractured bone cannot be assessed for osteopenia the intact opposite hip must be included on initial radiograph, preferably with 15 degree of internal rotation.
BIOMECHANICS OF HIP JOINT

The hip joint is ball and socket joint. In weight bearing the pressure forces are transmitted to the head and neck of the femur at an angle of 165 degrees to 170 degrees regardless of position of pelvis. The plane of the force coincides with strongly developed trabeculae that lie in the medial portion of the femoral neck and extend upwards through the supero-medial aspect of the femoral head. These trabeculae are in line with similar pressure trabeculae that start at acetabulum and run upwards and medial to sacro-iliac joint. The reacting forces normally run perpendicular to cartilaginous epiphyseal plate.

When a patient stands on both legs the static force passing through each of the hip is half of or less than one-third of total body weight. When the patient stands on one leg the pressure exerted on the femoral head is the sum of the force of abductor lever arm and the weight of the body. Each force is related to the relative length of the levers and the two forces are counter balancing. If the abductor lever arm is longer (i.e. the laterally placed insertion of the abductors) the ratio between the levers is less and less abduction force is needed to maintain balance and thus less pressure on femoral head$^{151,152,153}$.

Normal activities subject proximal femoral region with Bending, Torsional, Axial forces. Because of peculiar shape of this region is loaded eccentrically. These loads are resisted by large dimension, greater peripheral substance & large cortical surface of Greater trochanter.
Forces acting on hip joint –

- Body weight
- Joint reaction force
- Bending stress
- Shear stress
- Torque transmitted by shaft

Major stresses generated at proximal femoral region are due to

- Abductor muscle force
- Hip joint reaction force

Gluteus medius muscle contributes to axial compression loads along the femoral neck, while body weight & strength of muscle together generates force which act on hip joint.
In comparison to above mentioned forces the force of equal magnitude but in opposite direction act on hip joint termed as hip joint reaction force. Major compressive stresses in femur are greatest in medial cortex one to three inches below the lesser trochanter, this area is termed as “Adam’s Arch” this is highly stressed region in the body. Tensile stress occurs at lateral cortex.

**Biomechanical Contribution of muscles –**

Deforming muscle forces acting on proximal femoral region give rise to peculiar deformity of fracture fragments. Iliacus & Psos major cause flexion, abduction & external rotation of proximal fragment, while powerful adductors cause adduction of distal fragment. Eventual shortening occurs as a result of contracture of all long muscles, which also causes overriding of fracture fragments.
After understanding biomechanical considerations of anatomy now we will discuss Biomechanical considerations of proximal femoral fractures –

Intertrochanteric & subtrochanteric region involve cortical & compact cancellous bone. Because of complex stress configuration & its non homogeneous osseous structure these fractures occur along the path of least resistance. Force generated during discordant activities is considerably higher than those generated during normal ambulation. Failure to absorb these forces often results in fractures.

Fractures presumably occur due to combination of compression, bending, torsion & shear loads. Amongst all loads major contribution forces is compression & bending force. Long bone is strong in compression than tension. Repetitive loads which are lower than tensile strength of bone cause fatigue fracture. Each load cause microscopic damage to osseous structure, eventually these defects coalesce together & produce fracture. Amount of energy absorbed determines whether is simple or comminuted.

Loads generated at trochanteric fracture site act in two directions – Parallel & perpendicular to fracture line. These two different directional forces conjointly act on fracture producing shear & compression stresses across fracture site.

Shear force act parallel to fracture line & tends to displace the femoral head downwards relative to femoral shaft. Compression force act in perpendicular direction & tends to compress the femoral head against femoral neck. Compression force brings fracture fragments together causing mechanical interlocking of fracture fragments. Bending effect of joint load is greater in Intertrochanteric fractures as the Lever arm i.e. distance between
line of action of hip joint load & fracture line is longer in these fractures. This result in bending of proximal fragment in varus direction.

In undisplaced two part fractures the tension generated by gluteus medius muscle is maintained, which contributes to stability of fracture when it is reduced. When both trochanters are separated compressing effect of gluteus medius is lost. It also destroys the internal support of trabaculae.

Shear force acting on fracture is not major force but axial rotation force acting on femoral shaft during internal or external rotation of limb is important force which can disrupt fixation.

**In the Subtrochanteric region** –

Major deforming forces acting on this region are due to muscles inserted over this region. Position of proximal fragment is influenced by abductors, flexors & external rotators of hip while position of distal fragment is determined by adductors
IMPLICATION OF FRACTURE ANATOMY

Degree of comminution of fracture directly affects the stability of the fracture. Less the comminution more is the resistance offered to the deforming forces by enhancing compression and shear resistance response. Femoral neck length and neck shaft angle also determines the magnitude of bending, shear loads. Higher the values of the neck shaft, larger the loads acting on the fracture site leading to less secure fixation.

Therefore, the Degree of comminution of fracture $1/\alpha$ resistance offered to deforming forces.

Main fragments of an unstable fracture are:

- Proximal neck fragment
- Greater trochanteric fragment
- Lesser trochanteric fragment
- Proximal femoral shaft fragment
The resulting deficiency of unstable fracture includes posterior & posteromedial wall defect. Fragile lateral wall continues from proximal femoral shaft. Fractures of this wall convert Intertrochanteric fracture in to Subtrochanteric fracture.

Lateral wall is important in giving lateral buttress for proximal fragment compression, which facilitates rotational, varus stability after fracture impaction & fracture spike interdigitation. If lateral wall is broken then there is no lateral buttress for proximal neck fracture fragment leading to collapse.

In fixation of fracture bone must support load, as greater this support, less is the load on implant. In comminuted fractures stress on implant is more as implant bears more load than bone support. In fractures implant bears more load as bending effect of the hip joint forces is more in them.

According to fracture fragments there is placement of fixation device such that, proximal fragment is within femoral head, mid segment is for region while distal fixation is at lateral trochanteric wall or intramedullary area.
The ability to maintain reduction in these three parts is key to unimpaired bone healing.

**PATHOMECHANICS OF FRACTURE & FRACTURE GEOMETRY**

Clinical attention has been given to number, size, shape, location & displacement of fracture fragments. Comminution when involves the postero medial cortex of bone acts as a major contributing factor for complication of fixation.

Multiple fragments with postero medial cortex comminution are likely to displace in varus & retroversion therefore considered as unstable fractures.

Fractures in whom there is no postero medial cortex comminution & anatomical reduction is possible are considered as stable fractures.

**Fragments of fractures**

**Proximal fragment** – When fracture site is proximal to short external rotators then this fragment is rotated internally. In this situation fracture is reduced by internal rotation of distal fragment.

If the fracture lies below the level of short external rotators then the proximal fragment goes into external rotation, so fracture is reduced with distal fragment in external rotation.

**Role of angulation at the fracture site** – Fracture fragments have a tendency of varus angulation in the coronal plane, but they may have angulation in sagittal plane too. This angulation in the sagittal plane is due to unopposed action of muscles. Hamstrings, Gluteus Maximus has tendency to produce angulation. This angulation produces marked widening of fracture line.
Unstable fractures are seen in some of the following situations –

Reverse oblique fractures: In this there is marked tendency of displacement of shaft due to pull by adductor muscle. Comminution at of greater trochanter also predisposes to medial displacement. In this condition where there is no contact between proximal and distal fragments as a result of comminution or wide displacement of fracture medially and posteriorly. When lesser trochanter is fractured a displaced defect in postero medial wall. This medial defect gives rise to varus collapse & posterior wall defect leads to displacement in retroversion.

FRACTURE GEOMETRY

In this section some of the common type of fractures of greater & lesser trochanters described.

Following are some of the common type of Greater trochanter fracture:

- Fracture line runs downwards & medially just below the attachment of gluteus medius muscle. This type of fracture may gape widely.
- Fracture line at the base of greater trochanter, which has tendency to displace in posterior direction.
- Rarely avulsion fracture of tip of greater trochanter is seen.

Fracture of lesser trochanter – It is widely assumed that these fractures are due to avulsion caused by Psoas Major & Iliacus muscle inserted over the lesser trochanter.
Following are some of the types of fractures:

**Compression type:** When bone is bent beyond its limit of elasticity a transverse tear develops on the convex side & triangular fragment separates on the concave side. This fracture is due to forces generated in neck shaft angle while it is being bent. Such fractures are very large & usually include part of calcar femorale.

**Impaction type:** They are seen due to striking the lesser trochanter against the under surface of neck of femur during extreme varus angulation. Minor degrees of impaction merely fracture the superior cortex of lesser trochanter while heavy impaction shears off whole trochanter usually superficial to calcar femorale.

**Causes of hip fractures**

Intertrochanteric fractures are commonly seen in elderly people. Fracture is often caused by trivial trauma (Domestic fall). Elderly people are prone to these fractures mostly because of some of the following **risk factors** like advancing age osteoporosis, visual impairment, malnutrition, neurological impairment, reduced physical activity, reduced muscle power, reduced protective reflexes, malignancy to name a few.

**According to study by Cummins & Nevitt there are some of the factors responsible for proximal femoral fractures which are as follows:**

- Fall must be oriented in such a way the person lands on or near the hip.
- Inadequate protective reflexes.
- Inadequate local shock absorbers (poor muscle & fat mass around the hip joint)
• Insufficient bone strength due to osteoporosis, osteomalacia.
• Muscle contractions in this region during fall may lead to increase fracture rate as compared to muscles in relaxed state.
• Repetitive stress, repetitive loading results in reduced bone failure strength causing fatigue fracture.
• Pathological fractures.

In young patients, intertrochanteric & subtrochanteric fractures often results due to high energy trauma like road traffic accident, fall from height etc but pathological fractures, fractures following penetrating injuries or gunshot injuries are seen in young patients.

ROLE OF CALCAR FEMORALE :

According to HARTY & GRIFFIN, the calcar femorale is a dense vertical plate of bone extending from posteromedial portion of the femoral shaft under the lesser trochanter and radiating laterally to greater trochanter, serving to reinforce the femoral neck posteroinferiorly. The calcar is thickest medially and gradually thins as it passes laterally. Therefore the quality of bone for purchase within the head and neck varies from one quadrant to another. Although the optimum position of a nail within the head and neck is somewhat controversial, all agree that it should be central or slightly inferior & posterior. The bone of poorest quality is the anterosuperior aspect of head and neck.

According to Wu CC, Shih CH, Lee My the most adequate location of lag screw of dynamic hip screw should be inferior in frontal plane and central in coronal plane.
The important function of calcar is transmission of the weight of the body, which comes from superior articular surface of the head. In addition it maintains the neck shaft angle.

**ROLE OF PSOAS MAJOR:**

Various authors have done experimental studies on Psoas Major and found contradicting results.

FRAZER (1920) pointed out that, if it has any rotating action, on the hip joint, it can only be internal rotator, for it is attached to the femur lateral to the axis of rotation, which runs from the hip joint to the knee joint and its direction of pull is both upwards and forwards. When the hip is extended, the forward component is small and derived from the posterior location of the lesser trochanter. As the hip flexes the forward pull of the Psoas relatively increases and tends to pull the shaft forward along an arc centered over hip joint. This is precisely the movement of internal rotation, for the femur with its offset head deeply sunk in the acetabulum, cannot like the radius, rotate in its long axis but can only swing forward or backward around an axis which lies entirely medial to the shaft.

STEINDLER (1955), described the Psoas Major muscle as external rotator of the hip and hence said that the proximal fragment rotates externally due to unopposed action of the Psoas. But radiograph shows that rotational position of the upper fragment is not determined by whether the lesser trochanter remains attached to the upper or the lower fragment.

HORN J.S & WANG Y.C (1964) did not believe that Psoas is an external rotator. Its tendon lies immediately in front of the hip joint and its dynamic function must be flexion of the hip. During weight bearing, it works in retrograde direction and prevents the trunk from rolling backwards,
over the femoral head, whenever the centre of gravity momentarily passes posterior to coronal plane between the hip joints.

**ROLE OF OSTEOPOROSIS:**

The presence of osteoporosis is important because fixation of proximal fragment depends entirely on the quality of cancellous bone present. Although the medial cortical abutment will restore the fracture stability, good quality bone in head and neck is essential for fixation of proximal fragment.

In 1938 WARD\textsuperscript{159}, first describes the trabecular system of the femoral head. According to him, thicker trabeculae come from the calcar and pass superorly into the weight bearing dome of the femoral head, while the thinner trabeculae extend from the inferior region to the foveal area across the head and the superior portion of the femoral neck and into the trochanter, and hence to the lateral cortex.

**LAROS & MOORE:** Using the Singh’s index system they found that the patients with Singh’s index grade 3 or below had increases complication of fixation. They said that by placing the implant in posteromedial location in the femoral head, the incidence of nail cutting out decreased.
**TYPES OF REDUCTION**

1. **ANATOMICAL STABLE REDUCTION:**
   
   Open anatomical reduction and internal fixation of unstable fractures has been mentioned by Laskin\textsuperscript{161} and associates and Riska. Reduction and fixation of a displaced lesser Trochanteric fragment to the femoral shaft in an effort to provide a stable buttress for reduction to proximal fragment has also been suggested. Wardle mentions that this method is difficult, time consuming and often not successful. These techniques are of limited value especially in cases in which there is comminution of the lesser Trochanteric fragment or, in which extensive surgical exposure is required to attain an anatomical reduction. However in young patients, in whom anatomical restoration of hip joint is important may be candidates for this procedure.

2. **NON ANATOMICAL STABLE REDUCTION:**

   (A) **WAYNE COUNTY OR VALGUS REDUCTION\textsuperscript{162}**
   
   In this reduction the shaft of the femur is displaced lateral to the medial cortex of femoral neck, thereby creating a buttressing force to resist varus displacement. This technique is helpful in unstable fractures with only slight medial and posterior cortical instability. If more cortical instability is present one must resort to an osteotomy.

   (B) **DIAMON & HUGSTON METHOD\textsuperscript{132}**
   
   Diamon and Hugston reported that four part fractures with a posterior or medial gap after reduction (an unstable reduction) collapsed into varus. This collapse results in the nail penetrating the acetabulum, bending, breaking or cutting through the head.
In their hands, the addition of medial displacement osteotomy reduced this complication to 8%.

**DIAMON HUGSTON METHOD**

(C) **SARAMINTO METHOD**

He introduced a valgus osteotomy for unstable fractures in an effort to gain medial cortical stability. This technique changes the fracture plane vertical to near horizontal and creates contact between the medial and the posterior cortex of the proximal and distal fragment.
SARAMINTO METHOD
MANAGEMENT OF TROCHANTERIC FRACTURES

Watson-Jones states that “fractures through the intertrochanteric line of the upper end of the femur, and peritrochanteric fractures, unite readily no matter what treatment is used because the broad fractured surfaces are richly supplied with blood and there is seldom wide displacement. But at the same time, unless suitable precautions are taken, the fracture may unite in a position of coxa vara with shortening of the limb and limitation of hip movements. Moreover, this fracture occurs in the elderly patients the risks from prolonged immobility and recumbency arise. Thus treatment should be so planned as to encourage union without deformity, and at the same time allow early mobilization.”

Hence the trochanteric fractures can be managed in two ways

1. Conservative or Non-operative method. 2. Operative method.

CONSERVATIVE MANAGEMENT:

“Two strong men will suffice by making extensions and counter extension” as stated by Hippocrates (350 BC).

The indication for non-operative treatment of intertrochanteric fractures is unclear.

The indications for conservative management are:

a. The terminal patient.
b. A patient with an old fracture.
c. A non-ambulatory patient who is comfortable with the fracture.
d. If the fracture could not be stabilized adequately by open
reduction.
Conservative Treatment Regimes include:

- Simple support with pillows.
- Splinting to the opposite limb.
- Buck’s traction.
- Skeletal traction through the lower femur or upper tibia.
- Well-leg traction.
- Russell’s balanced traction.
- Plaster spica immobilization.

Buck’s Traction:

This is the skin traction applied to the lower extremity. The traction force is applied over a large area of skin. This spreads the load, and is more comfortable and efficient. In treatment of fractures, the traction must be applied only to the limb distal to the fracture site.

Buck, in 1861 introduced the application of adhesive plaster to the skin of the leg for the purpose of achieving isotonic traction in the treatment of fracture of femur into surgical practice shortly before the Civil war of America. According to John D.M. Stewart, the maximum traction weight that can be applied with skin traction is 15lb (6.7kg). When the skin traction is applied in senile patients with thin, atrophic, inelastic skin, the result is often most distressing. The control of lateral rotation of the limb in skin traction is also difficult. Hence in the treatment of intertrochanteric fractures, which frequently occur in the aged patients, a skeletal traction is preferred.

Skeletal Traction:
In 1907, Fritz Steinmann, of Bern described a method of applying skeletal traction through the femur by means of two pins driven into the femoral condyles. Shortly, after the initial description of the two pin technique, in 1916 he introduced the Steinmann pins, which are rigid stainless steel pins of varying lengths, 3-5 mm in diameter and perfected the ‘through and through pin technique.

In 1909, Martin Kirschner, of Greifswald introduced small diameter wires for application of skeletal traction. These wires are insufficiently rigid until pulled taut in a special stirrup introduced by him in 1927. Rotation of the stirrup is imparted to the wire.

In 1929, Bohler of Austria introduced a special stirrup that is attached to the Steinmann pin. The Bohler stirrup allows the direction of the traction to be varied without turning the pin in the bone.

In 1972, Denham introduced a pin identical to the Steinmann pin, except for a short raised threaded length situated towards the end held in the introducer. This threaded portion engages the bony cortex and reduces the risk of the pin sliding. This type of pin is particularly suitable for use in cancellous bone or in osteoporotic bone in the elderly.

For management of an intertrochanteric fracture by skeletal traction, a metal pin or wire is driven through the lower end of femur or the upper end of tibia. By this means the traction force is applied directly to the skeleton. It may be employed as a means of reducing or maintaining the reduction of a fracture, by overcoming the muscle spasm. A serious complication of skeletal traction is osteomyelitis.

After applying the skeletal traction the limb is applied the limb may
be rested on a Bohler-Braun frame. It acts as a cradle for the limb. The patient’s body and the proximal fragment move relative to the distal fragment, which is immobile. This may predispose to the occurrence of a deformity at the fracture site.

**Well-Leg Traction:**

Roger Anderson in 1932 described a traction method wherein; skeletal traction was applied to the injured leg, while the ‘well’ leg was employed for counter-traction. It is valuable in correcting an abduction or adduction deformity at the hip. The principle of this method is that, if there is an abduction deformity at the hip, the affected limb appears to be longer. When traction is applied to the ‘well’ limb and the affected limb is simultaneously pushed up (counter-traction), the abduction deformity is reduced.

Reversing the arrangement will reduce an adduction deformity. This technique allows the patient to be moved from bed to chair and eliminates the cumbersome apparatus required by skeletal traction. But, using the normal limb for counter-traction can lead to skin problems and ulceration in the elderly.

**Russell’s Balanced Traction**

Hamilton Russell of Melbourne introduced it in 1924.

It is an extremely simple and uncomplicated form of balanced traction. The underlying principle is the application of two forces at the knee, which tend to establish a resultant of their pull more or less in the axis of the femur.
Non-Operative Treatment of intertrochanteric fractures may follow one of the two fundamentally different approaches –
1) **Early mobilization:**

In this approach, the patients are mobilized immediately, just as if they had been operated. They are given analgesics and placed in a chair daily. If the physical condition improves, they are begun on non-weight bearing crutch walking. Shaftan and colleagues reported that fracture pain after a few days is rarely more severe than wound pain after open reduction. They also stressed that non-operative treatment by their technique did not prevent the fracture from healing.

However, in this approach, a deformity of varus, external rotation, and shortening is accepted.

2) **Traction: Aufranc**

Recommended skeletal traction in balanced suspension for 10 to 12 weeks. The leg is kept in slight abduction, which allows easier reduction and maintenance of the normal head-neck angle. The patient is then mobilized and allowed partial weight bearing until fracture healing is solid.

Aufranc and associates noted that partial weight bearing might be required for 6 months before good fracture stability is obtained and that varus displacement could occur as late as 3 to 4 months after fracture.

If conservative treatment is elected, especially those methods requiring prolonged traction, great care must be taken to avoid the
secondary complications of pneumonia, urinary tract infection, pressure sores over the sacrum and heels, equinus contractures of the foot and thromboembolic disease. Finally, the cost of this method of treatment should be considered.

**OPERATIVE MANAGEMENT:**

The treatment of choice of intertrochanteric fractures should be operative, employing some form of internal fixation.

The goals of operative treatment is –

- Strong and stable fixation of the fracture fragments.
- Early mobilization of the patient.
- Restoration of the patient to his or her pre-operative status at the earliest.

*Kaufer, Matthews and Sonstegard* have listed the variables that determine the strength of the fracture fragment-implant assembly.

The variables are –

- Bone Quality.
- Fracture Geometry.
- Reduction.
- Implant Design.
- Implant Placement.

The bone quality and fracture geometry, are beyond the control of the surgeon. Therefore the surgeon has within his control the quality of reduction and the choice and placement of implant to achieve a stably
Management of Subtrochanteric Fractures

reduced and internally fixed intertrochanteric fracture.

**Surgical Techniques:**

In the 19th century, patients with intertrochanteric fractures were simply placed in bed for prolonged periods of time until healing or more commonly until death.

**Plate and Screw Devices:**

The first successful implants in the treatment of intertrochanteric fractures were **Fixed Angle Nail Plate devices** (e.g., Jewett nail, Holt nail) consisting of a triflanged nail fixed to a plate at an angle of 130 to 150 degrees.

These devices provided stabilization of the femoral head and neck fragment to the femoral shaft, but they did not affect fracture impaction. The collapse of the fracture fragments led to inadvertent penetration of the tip of the nail into the hip joint through the superior portion of the femoral head. Other technical problems with these devices were difficulty in obtaining a satisfactory fit of the side plate to the shaft of the femur or failure to obtain adequate purchase within the cancellous bone of the femoral head. Unstable fractures still had a tendency to heal in varus with broken or bent nails, broken side plates, and screw fractures or pulling out of the screw from the femoral shaft.

These experiences led to the modification of the fracture site rather than the implants. Later it was documented that the osteotomies were not without problems, since rotation was difficult to estimate, shortening of the leg was common and the valgus position of the proximal fragment with medial displacement of the distal fragment often led to genu valgum.
The stage was thus set for the introduction of an entirely new device that would allow controlled fracture impaction.

The **Sliding Nail Plate devices** were devised with the following solution – **Screw threads on the hip nail** – to improve purchase in the porotic bone of the femoral head. **Blunt tip on the screw** – to minimize the chance of head penetration. **Sliding feature** – to allow collapse and impaction of the fracture while maintaining the neck-shaft angle and controlling rotation. **Tongue in groove barrel collar** – to control rotation and provide additional strength at the nail plate junction. One early modification to the sliding hip screw maximized fracture impaction by allowing the proximal lag screw to telescope within the plate barrel and the plate to slide axially along the femoral shaft. To accomplish this bi-directional sliding, the plate was modified by replacing the round screw holes with slotted screw holes – **Egger’s Plate**.

More recently, a two-component plate device, the **Medoff Plate** was introduced in which a central vertical channel constrains an internal sliding component.

The **Smith Petersen nail** (SP Nail) is named after it’s founder **Marius Nygaard Smith-Petersen** was a physician and orthopaedic surgeon.

The Smith Petersen Nail (SP nail) is a three-flanged nail that used for stabilizing fractures by preventing rotation of the neck of the femur. In 1925, Smith-Petersen introduced the three-flanged steel nail for insertion across the fracture site in hip fractures, an innovation that considerably improved recovery and mortality rates from hip fractures.
This special nail that has on cross section has three flanges, used for stabilizing fractures (fractura colli femoralis) by preventing rotation of the neck of the femur.

This was used in Sven Christian Johansson's method in 1931. The nail was originally made from stainless steel, later changed to Vitallium. There were short comings of the SP nail during the surgery due to the following reasons. Firstly, complete reduction by open operation is not by any means certain. It is difficult to expose the fracture sufficiently for the human eye to see it in both the antero-posterior and lateral planes at once. Secondly, the operation is a difficult one and undoubtedly carried a certain morbidity. Thirdly, when there is a large incision as in case of this surgery, undoubtedly exposes the patient more to the risks of infection than when the incision is confined to half an inch. Fourthly, frequently encountered was a certain amount of fibrosis associated with the opening of the capsule of the hip joint, with resultant limitation of movement.

Mainly the criticisms which have been leveled at the operation are that reduction may not be complete and that there is difficulty in placing the nail centrally in the neck. It became necessary to modify the Whitman technique. Occasionally, lateral traction on the shaft of the femur or, possibly, excessive internal rotation, may be required. There may be difficulty in inserting the nail accurately, not so much in the antero-posterior plane as in the lateral plane, for in this plane the neck of the femur is very narrow. The length of the nail to be used must be accurately determined. As Watson Jones has pointed out, in the extreme medial fracture, unless the nail is centrally-placed, it may not have a sufficient grip and may break out.

To facilitate the correct placement of the SP nail, there were
introduction of the device which help place the nail in the most ideal position that is central in the antero-posterior as well as lateral plane. There are a many devices for accurately placing a pin or wire over which the cannulated Smith-Petersen nail may be inserted. The simplest of these is the time tested Bailey guide.

By means of the device, Smith-Petersen nail (SP Nail) may be positively and simply placed in correct position without guide wires.

The device is presented in the belief that the principles on which it is based are mechanically sound, and that its use will simplify the operative procedure and significantly shorten the operating time. This will benefit both, the patient and the surgeon too.

Advantages of adjustable nail-plates- like the McLaughlin nail-plate are as follows. It is easy to insert, causing minimal damage to the lateral femoral cortex. It can be fitted accurately to the fracture without fixation under stress. A large stock of nail-plates in varying lengths and angles is unnecessary, and cold-bending of the nail-plate is avoided.

In unstable trochanteric fractures in patients with severely osteoporotic bone some authors have suggested the use of Polymethylmethacrylate (PMMA) to augment the fixation and improve the stability.

The Alta Expandable Dome Plunger is a modified sliding hip screw designed to improve fixation of the proximal fragment by facilitating cement intrusion into the femoral head. Cement is kept away from the plate barrel so that the device’s sliding potential is maintained. The method of insertion is similar to that of the sliding hip screw, except that the dome unit is manually
pushed into the pre-reamed femoral neck and head proximal fixation is achieved as the plunger is then advanced, expanding the dome in the cancellous bone of the femoral head and extruding the contained cement.

**Intramedullary Devices:**

Intramedullary fixation of the intertrochanteric fractures from the medial side began with Lezius in 1950, who inserted the nail at the junction of the proximal and middle thirds of the femur.

In 1964 Kuntscher moved the point of insertion to the medial femoral condyle, where the cortex was thinner and minimal soft tissue requiring less exposure. The results were impressive, but the large diameter of the nail, the use on guide wire and inflexibility of the nail led to problems with its use.

Ender in 1970 advocated the use of multiple, flexible nail known as Ender’s Nail inserted just above the adductor tubercle to hold these fractures in reduction. These devices are inserted under image intensification in a retrograde manner. The advantages of this technique are –

- The incision remote from the fracture site reducing bleeding and infection.
- Minimal soft tissue dissection simplifying the surgery and thereby shortening the operative and anesthetic time.
- Intramedullary placement allowing for fracture impaction with weight bearing, while maintaining the normal neck shaft angle.
- As they are placed close to the mechanical axis of the femur, they are subjected to smaller bending moments than a plate and screw device.

They have been associated with a significant incidence of complications such as –
Management of Subtrochanteric Fractures

- Rotational deformity.
- Supracondylar femur fracture.
- Proximal migration of the nails through the femoral head.
- Back out of the nail with resultant knee pain and knee stiffness.

Other intramedullary devices such as the Gamma Nail, Intra medullary Hip Screw, Proximal Femoral Nail and Russell Taylor Reconstruction Nail have been used for the fixation of intertrochanteric fractures. Second generation of interlocking nails called the Trochanteric Gamma Nail can be used without extension into the subtrochanteric area.

The Gamma Nail being an intramedullary device lies medial than the standard sliding compression hip screw and plate, hence less force is dissipated on the implant with weight bearing. The device transmits the patient’s body weight closer to the Calcar, resulting in greater mechanical strength. The duration of surgery and blood loss is minimal.

The Intramedullary Hip Screw couples a sliding hip screw with a locked intramedullary nail. This design offers several potential advantages –

- The intramedullary fixation, because of its location, theoretically provides more efficient load transfer than does a sliding hip screw.
- The shorter lever arm of the intramedullary device can be expected to decrease tensile strain on the implant, thereby decreasing the risk of implant failure.
- As it incorporates a sliding hip screw, the advantage of controlled fracture impaction is maintained.
- It theoretically requires shorter operative time and less soft tissue dissection.
These devices are associated with the risk of late femoral fractures at the tip of the device or the distal locking screws.

The **Russell Taylor Reconstruction nail** has been recommended for use in unstable intertrochanteric fractures or in fractures with reverse obliquity or subtrochanteric extension.

**Prosthetic Replacement:**

Prosthetic replacement for intertrochanteric fractures has not gained widespread support.

The indications for primary prosthetic replacement remain ill defined. Most authors cite elderly, debilitated patients with a comminuted, unstable intertrochanteric fracture in severely osteoporotic bone, as the primary indication for prosthetic replacement.

The indications for primary prosthetic replacement as per **Kenneth J. Koval** are –

1. Symptomatic ipsilateral degenerative hip disease, where a total hip replacement is ideal.
2. Attempted open reduction and internal fixation that cannot be performed because of extensive comminution and poor bone quality, where the procedure should be aborted and a hemiarthroplasty should be carried out.

Primary prosthetic replacement is much more extensive and invasive procedure than internal fixation, with the potential for increased morbidity and complications including prosthetic dislocation. Furthermore, the cost of the prosthesis is high.
Hence, prosthetic replacement is a useful technique for the occasional patient with an intertrochanteric non-union and failure of fixation.

**External Fixators:** The application of external Fixators in the management of intertrochanteric fractures is simple, safe and economical. It is the method of choice in high-risk geriatric patients.

Two or three 6.5mm Cancellous Shanz pins are passed percutaneously, into the femoral neck under image intensification, after reducing the fracture on a fracture table. Three or more preloaded 4.5mm Cortical Shanz pins are passed percutaneously transversely into the shaft. These pins are then connected to the tubular rods with universal clamps.

The application as well as removal of the external fixator is simple, and it can be done under local anesthesia. The patients can be mobilized on the first post-operative day with the help of crutches.

The advantages of external fixation are –

- Short operative time
- Minimal blood loss
- Early mobilization.

The complications with external fixation are

- Pin tract infection
- Varus collapse at the fracture site
- Pin breakage
- Proximal pin migration.
MANAGEMENT OF SUBTROCHANTERIC FRACTURES

CLINICAL DIAGNOSIS:

Depending on the extent of the fracture of clinical picture resembles that in a patient with an intertrochanteric or femoral shaft fracture. Open fractures, although uncommon, do occur and signify severe soft tissue and bone injury. Because forces required to produce this fracture are substantial, associated injuries, both of the same extremity and especially elsewhere in the body should be suspected. Hemorrhage in the thigh may be significant and the patient should be monitored for hypovolaemic shock. Emergency splinting with a Thomas splint will prevent further soft tissue damage and haemorrhage. Associated vascular and neurologic injury is not common in subtrochanteric fractures.

RADIOLOGICAL DIAGNOSIS:

Anterior-posterior and true lateral X-ray is necessary to assess the extent of fracture clearly. As in all patients with femoral fractures an X-ray of the pelvis is essential to rule out associated dislocation of the hip or pelvic fracture. The X-ray of the hip and the pelvis is viewed to determine the presence or degree of osteoporosis in elderly patients before a decision regarding open versus closed treatment is made.

TREATMENT:

Subtrochanteric fractures of femur are difficult to manage. Subtrochanteric fractures may occur as an extension from a trochanteric fracture or as an isolated fracture. Most commonly these fractures are seen in two groups of patients. Older patients suffering a minor fall in which the
fracture occurs through the weakened bone, who are involved in high-energy trauma.

Problems in treating subtrochanteric fractures are complicated by malunion and delayed or nonunion. Allis in 1981, recognized the complications of shortening, angular deformity and rotational malalignment following this fracture. With the help of muscular force analysis he explained the etiology of these deformities. Slower rate of union and higher rate of malunion is attributed to predominance of cortical bone, which is often comminuted and highest amount of biomechanical stress present in the subtrochanteric area. The cortical bone vascularity and surfaces available for healing are less than in cancellous bone surfaces in the intertrochanteric fixation devices before bony union occurs.

Koch and Ryddl have shown the magnitude of the mechanical stresses in the subtrochanteric region and this directly influences the rate of failure of internal fixation. Froimson has shown that because of muscle activity, the proximal fragment tends to be abducted, flexed and externally rotated with shortening and angulation at the fracture site. This is true if the trochanter remains attached. It makes treatment of subtrochanteric fractures exceedingly difficult by traction or other non operative methods. If non operative treatment is required or selected, traction of the distal femur with the extremity in a 90-90 position hip and knee in 90 degree flexion is usually preferred, since no direct control of the proximal fragment is possible, the distal fragment must be placed in adduction and external rotation to match the proximal counterpart.

The risk or problems after pertrochanteric and subtrochanteric fractures are claimed to be higher than after other types of femur fracture.
Malunion, nonunion and mortality have claimed to be 40%. Systemic complication related to effect of injury and immobilization in elderly includes cardiorespiratory, thromboembolic, gastro intestinal and pressure sores as well as debilitation of prolonged inactivity. Local complications include early loss of fixation, delayed union, late fixation failure usually to nonunion or infection and late hardware complications.

TRENDS IN SUBTROCHANTERIC FRACTURE TREATMENT

Non-operative Treatment:

Non-operative modalities of treatment are less commonly practiced. The indications are said to be severely comminuted sub trochanteric fractures where, stable osteosynthesis is not possible to attain and in open subtrochanteric fractures. Non-operative modalities of treatment claim for high mortality and morbidity and the final outcome may be varus angulation and rotational deformity.

Operative treatment:

Open reduction and internal fixation restores anatomy and allows early mobilization is the treatment of choice in subtrochanteric fractures provided stable osteosynthesis can be achieved at the time of operation. Because of comminution, stable internal fixation is difficult. These fractures are often extending into diaphyseal bone, which has decreased vascularity and therefore has poor healing potential. This increases the need for stable internal fixation to reduce implant failure. Satisfactory postoperative subtrochanteric fracture stability is determined by;
Bone quality • Fragment Geometry • Reduction • Fixation Device • Device Placement

1. Bone Quality:

The mechanical properties of bone (hardness, elasticity and strength etc) vary considerably depending on age, sex, race, general state of the health, muscle mass and level of activity. Bone strength varies between in the same individual as well as different areas in the same bone. Pertrochanteric and sub trochanteric fractures occurring in elderly people are relatively low energy trauma injuries occurring in atrophic, osteoporotic or osteomalacic bone. A reliable method of determining the quality of bone associated with a pertrochanteric and subtrochanteric fracture would have considerable prognostic and therapeutic value. The X-ray density of bone is dependent on technique and the overlying soft tissues and hence is a relatively insensitive index.

Singh et al have developed a roentgenographic method for determining bone strength that is based on the trabecular pattern of the proximal femur. This method is simple, readily available, requires no special equipment, correlates well with histologic controls, is sufficiently sensitive and prognostically useful. Loss of continuity of the primary tension trabeculae (i.e., Grade III) marks the transition between the bone capable of holding an internal fixation device and bone so weak- that these device become ineffective. In a laboratory study of cadaveric femoral using cyclic loads, at was found that regardless of other variables, internal fixation failed in 80% of fractures of the bone of Grade III or less, but was successful in
80% of cases with bone of Grade-IV or better. Clinical experience confirms that regardless of other variables, complications of fixation are most frequent in bone of poor quality.

2. Fragment Geometry:

Much clinical attention has been focused on the number, size, shape, location and displacement of sub trochanteric fracture fragments. De Lee used the concept of stable and unstable fractures in place of specific classification system. Stable subtrochanteric fractures are those in which it is possible to re-establish bone to bone contact of the medial and posterior femoral cortex anatomically, when this is possible. an internal fixation device will act as a tension band on the lateral femoral cortex, and impaction and weight bearing can occur directly through the medial cortex (Frankel and Brustein, 1970; Muller, 1970 and Seinshemimer, 1978). In unstable fractures, medial cortical oppositions is not attainable secondary to comminution or fracture obliquity. Any lateral plate or intramedullary device will be subjected mainly to bending stress and the loads will concentrate in one area of the implant. This will result in implant failure or loss of fixation.

3. Fixation Device:

High incidence of complications reported after surgical treatment has lead to series of internal fixation devices. Various commonly employed internal fixation devices are

I) Extra medullary Devices:

S.P Nail  6. Medoff's axial compression Screw

II) Intramedullary Devices:

1] Condylocephalic- Enders pins

2] Cephalomedullary; i) AP Gamma Nail ii) Russel and Taylor reconstruction Nail , iii) Zickels Nail, iv) Uniflex Nail, v) Proximal Femoral Nail

Fixed angle nail plates:

The use of fixed angle nail-plates of the Jewett type in pertrochanteric and subtrochanteric fractures has been met with mixed results. Froimson reported that the heavy duty Jewett nail supplemented by circumferential wire and screws when indicated was reliable in the management of the unstable comminuted sub trochanteric fractures. Postoperatively however, patients were allowed partial weight bearing only after two months.

Hamson and Tullos demonstrated 88% union rate after a single operation using a nail plate device. They recognized that implant failure was secondary to the nonunion and not the reverse.

Fielding noted an increasing incidence of nonunion and implant failure with fixed angle nail plates as the fracture site moved more distally, since 57% of his type-III failed to unite. However, Fielding believed that the internal fixation with strong Jewett nail, possibly supplemented by an anterior plate and bone grafting was the best method available then. Fielding and Magliato recommended a valgus reduction and axial plate fixation in type-I fractures to increase bony stability and prevent medial migration of the distal fragment.
A high incidence of varus deformity, acetabular penetration and implant failure associated with the Jewett nail led to the discontinuance of this type of implant for routine use in subtrochanteric fractures (Teitge, 1976; Waddell, 1979). Waddell also fixed with angle plates of Jewett or of McLaughlin type, especially in comminuted subtrochanteric fractures.

**AO Blade Plate:**

Both Schatzker and Waddell recommended the use of the AO Blade plate in selected subtrochanteric fracture. They believe that it is best suited for those fracture that are slightly more distal in the pertrochanteric and the subtrochanteric region so that an accessory cancellous screw can be inserted beneath the blade into the calcar to increase proximal fixation.

Asher and associates and Cech and Sosna also recommended the use of AO Blade plate and stressed the importance of restoring medial cortical stability by the use of interfragmentary compression of medial cortical fragments. Velasco and Comfort supported the use of the blade plate especially in fractures that were transverse and multiple large fractures that could be anatomically reduced to restore medial stability.

Waddell reported failure with the AO Blade plated in 20% of fractures. He related failure to poor reduction of fracture fragments, and hence loss of medial cortical support, and to the initiation of weight bearing too early in the postoperative course.

In 1989, Kinast and associates presented a series of pertrochanteric and subtrochanteric fractures treated with a 95-degree condylar blade plate using a new technique of reduction. The goal of this new technique is to avoid soft tissues stripping. No attempt at anatomical restoration of medial
cortical buttress is made. This group of patients was compared to a second group in which the anatomical direct reduction was performed and fixation was obtained also with a 95-degree condylar blade plate. The group that underwent indirect fixation had a nonunion rate of 0% compared to 16.6% in the group that underwent direct internal fixation.

The authors suggest that indirect reduction with preservation of soft tissue and pretensioning of the plate will produce faster healing time, lower nonunion, and lower infection rate. They also suggest that bone grafting of these fractures may be superfluous if this indirect method of reduction is used.

**Dynamic hip screws (DHS):**

Biomechanical and clinical studies have indicated that pertrochanteric and subtrochanteric fractures can be adequately fixed with hip compression screws and side plate combination. Newer systems have improved fatigue characteristics and loss of fixation usually occurs from cut of the screw from the femoral head rather than from fracture of the plate as occurred with older designs.

Waddell reported satisfactory result in 21 of 24 pertrochanteric and subtrochanteric fractures using the sliding compression hip screw. Although the slide plate has increased strength, this does not nullify the importance of medial buttress reconstitution.

Burman and Coworkers reported 38 consecutive pertrochanteric and subtrochanteric fractures using the compression interfragmentary screw fixation to secure comminuted fracture to the main fragments the use of the Hirschoms device (used to produce compression beneath the plate) for
compression of the short oblique and transverse fractures and bone grafting in all cases with comminution. Using these methods, they had no nonunion, implant failures or varus displacement.

The large proximal screw in the compression hip screw system obtains better purchase in the proximal fragment than do nail plate devices. The large sliding screw has a blunt nose, which results in less penetration of the femoral head and acetabulum in those fractures with self-impaction after nailing. The ability of the screw shaft to slide in the collar of the plate allows for impaction at the fracture surfaces, a fact of considerable importance in Fielding type I fractures. This tends to reduce the bending moment and resulting forces that lead to collapse of the medial buttress and varus displacement. For this sliding to occur, the plate must not be fixed with screws into the proximal fragment. Therefore the implant is most useful in the most proximal subtrochanteric fractures. Schatzker and Waddell recommended the use of sliding compression hip screw in high pertrochanteric and subtrochanteric; fractures in which medialization of the shaft and impaction of the fracture are possible. They suggested that low fractures do better with AO side plate fixation if the medial cortex can be reconstituted. Complications are however still common (Doherty and Lyden 1979, Matthews Sonstegard and Dumbleton 1981, Wolfgang, Bryant and O Neil 1982, Manoli 1986, Amis, Bromage and Lar Vin 1987, Tronzo 1987, Simpson, Varty and Dodd 1989, Davis et al 1990). Problems include the need for considerable dissection, the lateral fixation of the side plate and insecure fixation of comminuted pertrochanteric and subtrochanteric fractures leading to delayed mobilization.

**Smith Petersen Nail (SP Nail):**
The Smith Petersen nail is named after it’s founder **Marius Nygaard**. 

**Smith-Petersen** was a physician and orthopaedic surgeon.

The Smith Petersen Nail (SP nail) is a three-flanged nail that used for stabilising fractures by preventing rotation of the neck of the femur. In 1925, Smith-Petersen introduced the three-flanged steel nail for insertion across the fracture site in hip fractures, an innovation that considerably improved recovery and mortality rates from hip fractures.

This special nail that has on cross section has three flanges, used for stabilising fractures (fractura colli femoralis) by preventing rotation of the neck of the femur.

This was used in Sven Christian Johansson's method in 1931. The nail was originally made from stainless steel, later changed to Vitallium. There were short comings of the SP nail during the surgery due to the following reasons. Firstly, complete reduction by open operation is not by any means certain. It is difficult to expose the fracture sufficiently for the human eye to see it in both the antero-posterior and lateral planes at once. Secondly, the operation is a difficult one and undoubtedly carried a certain morbidity. Thirdly, when there is a large incision as in case of this surgery, undoubtedly exposes the patient more to the risks of infection than when the incision is confined to half an inch. Fourthly, frequently encountered was a certain amount of fibrosis associated with the opening of the capsule of the hip joint, with resultant limitation of movement.

Mainly the criticisms which have been leveled at the operation are that reduction may not be complete and that there is difficulty in placing the nail centrally in the neck. It became necessary to modify the Whitman technique. Occasionally, lateral traction on the shaft of the femur or,
possibly, excessive internal rotation, may be required. There may be difficulty in inserting the nail accurately, not so much in the antero-posterior plane as in the lateral plane, for in this plane the neck of the femur is very narrow. The length of the nail to be used must be accurately determined. As Watson Jones has pointed out, in the extreme medial fracture, unless the nail is centrally-placed, it may not have a sufficient grip and may break out.

To facilitate the correct placement of the SP nail, there were introduction of the device which help place the nail in the most ideal position that is central in the antero-posterior as well as lateral plane. There are a many devices for accurately placing a pin or wire over which the cannulated Smith-Petersen nail may be inserted. The simplest of these is the time tested Bailey guide.

By means of the device, Smith-Petersen nail (SP Nail) may be positively and simply placed in correct position without guide wires.

The device is presented in the belief that the principles on which it is based are mechanically sound, and that its use will simplify the operative procedure and significantly shorten the operating time. This will benefit both, the patient and the surgeon too.

**Medoffs Axial Compression Screw:**

Medoff has designed a device that allows axial compression through the metaphyseal pertrochanteric and subtrochanteric portion through a sliding device that is incorporated into the plate attachment to the shaft of the femur. The compression slide acts as an intermediate segment, capturing the lag screw proximally and engaging barreled side plate distally in a sliding track. The barreled side plate is attached to the femoral shaft with
bone screws directed in two planes. Medoff recommends the axial compression screw for transverse, high pertrochanteric and subtrochanteric with or without reverse obliquity, and for most unstable intertrochanteric fractures.\textsuperscript{45}

**Biomechanical Study:**

During the past century a better understanding of the biomechanics of pertrochanteric and subtrochanteric fracture has led to the development of better implants and radical changes in treatment modalities. Koch analyzed mechanical stresses on the femur during weight bearing and found that compression stresses exceeded 1200 Lb per sq inch in the medial subtrochanteric area 1 to 3cms distal to lesser trochanter lateral tensile stresses measured about 20\% less. Frankel and Burstein demonstrated significant stress forces on the hip and proximal femur with activities such as flexing and extending the hip while supine indicating continuous stresses on the implant system even with bed rest.

Fielding, Cocharan and Zickel called attention to the necessity of a medial cortical buttress to minimize implant stresses and noted that nonunion was the cause of implant failure. Rybicki, Simonen, and Weis found that higher forces are generated with eccentrically placed devices, such as plate and screw devices, compared with centromedullary devices. Tordis noted the torsional effect of stresses in the pertrochanteric and subtrochanteric region, an important development in relation to current concept of static interlocking techniques because rotational shear forces may lead to implant failure cyclical loading. In response to the biomechanical studies, various implant devices have been introduced for
subtrochanteric fracture treatment. Tencer et al in 1984 evaluated 7 of these implants to Cadaver models, osteotomies and segmental defects were created to stimulate pertrochanteric and sub trochanteric femoral fractures. Their results showed that interlocking nails and Zickel nails had greater bending stiffness than Ender pins and hip compression screws.

Torsional testing revealed that slotted open section nails and Ender pins restarted < 5% of normal femoral torsional stiffness. Plate and screw devices restarted <5% of normal femoral torsional stiffness. Plate and screw devices restarted approximately 40% of normal femoral torsional stiffness. In single load to failure testing, slotted nails failed at 350 % to 400% of body weight, plate and screw devices failed at approx. 200% of body weight. More recently compression screw and side plate devices with higher strengths and longer fatigue lives have been developed and approved for pertrochanteric and sub trochanteric fracture. A subsequent study by Tencer, Calhoun and Miller showed marked improvements in bending stiffness, torsional stiffness, and axial load to failure testing with closed section interlocking devices\textsuperscript{45}.
Extra Medullary Device

Intra Medullary Device

Bending-Momentum on Extra and Intramedullary Implant
Condylcephalic nailing:

Enders pins:

Ender and Simon-Weidner published the first accounts of the nailing using three pins that were smaller and more flexible and patterned after the 3/16 inch Rush pin. A later report by Ender and Simon-Weidner in 1974 included a modification of the hook end of the pins to a flattened end, with a hook that allowed the use of hook extractor.

This is a closed method that is minimally invasive. Moreover that orientation of the nails is mechanically efficient and allows early weight bearing with pertrochanteric and subtrochanteric fractures. The complications reported are painful irritation at the knee, decreased range of motion at knee, distal and proximal migration of the nails, penetration of the hip joint and cortical fracture at the distal site of the insertion of the nails. Rotational deformity at the fracture site is also common complication. Harper Walsh found the variables and correlated with the failure rate to be the quality of the reduction of the fracture, number of nails used, experience of the surgeon with technique and degree of fracture stability\(^5\).

Zickels Nail:

The first successful intramedullary device was developed by Zickel in the early 1960s. This was the single most effective device used in pertrochanteric and subtrtrochanteric fracture through the 1970s and early 1980s. In a series of pertrochanteric and subtrochanteric fracture at Hennepin county medical center treated with the Zickel nail and telescoping screw with early bone grafting, success was high.
The Zickel appliance consist of a specially shaped medullary nail with a tunnel through its proximal par. A triflanged nail is inserted through this tunnel into the femoral head and neck and then locked in place with setscrew. This accomplished secure fixation of both the proximal and distal fragments and is designed to permit early mobilization and ambulation. The present design consists of a tapered medullary rod 17 mm in diameter proximally with stem diameter of 11, 13 and 15 mm. The tunnel in the proximal end of the rod through which the triflanged nail is inserted passes through at an angle of 125 degrees with stem. The disadvantages of the procedure are, it has an open operating technique and the present design does not provide any compression mechanism for the femoral neck component of the implant and also does not provide distal locking facility. Earlier reported series made a mention of intraoperative comminution of greater trochanter, rotational and varus deformity.

**Russel Taylor Reconstruction Nail:**

Klemm and Schellman, Grosse, Kempf and Lafforgue initially established guidelines for medullary nailing of femoral fractures. Stable fractures of the isthmus (transverse, short oblique, spiral or mildly comminuted fracture of the lateral cortex) are treated with unlocked nails, fracture proximal to isthmus are treated with proximally locked nails and more distal fractures are treated with distally locked by one or two screws. Although excellent results have been reported with the use of these guidelines, most large series report postoperative shortening because of unrecognized undisplaced cortical fracture or overestimation of fracture stability. Union can be obtained in almost all pertrochanteric and sub trochanteric fractures with static interlocking and that rotation and length
can be better controlled. Regular interlocking medullary nails may be used for fixation of most femoral fractures between distal fifth of the femur and a point just distal to lesser trochanter.

Russel Taylor reconstruction femoral nails are available in diameter of 12, 13, 14 and 15mm. The proximal 8cm section of the nail is expanded to 15mm to give extra strength for lag screw insertion into the femoral head. Proximally the inferior screw is 6.4mm. Both screws are self tapping and partially threaded to allow sliding compression. Distally 6.5mm fully threaded self tapping bone screws are used to allow bicortical fixation and reduce the possibility of screws backing out.

**Uniflex Nail:**

This implant was introduced by Biomet Inc. (Warsaw, Indiana). This nail provides proximal two holes which are obliquely placed for lag screw insertion of same diameter. The diameter of the nail is uniform throughout. The nail has a collapsible slot throughout its length. This implant was popularly used for treating pathological subtrochanteric fractures. It has got all the advantages and disadvantages of other popular interlocking nails. Its uniform diameter compromises its strength in proximal portion, when used in narrow femurs\(^{13}\).

**Interlocking Nails: (Grosse Kempf, AO)**

The introduction of special intramedullary nails such as Grosse Kempf nail, which allows the insertion of proximal and distal transfixing or locking screws, has extended the indications for locking screws provides rotational stability of the fracture and prevents shortening and varus angulation. These devices are useful only in subtrochanteric fractures below
the level of lesser trochanter and without involvement of greater trochanter. The ability to insert these devices without opening the fracture site and preventing further devascularisation of fracture fragments has improved union in these fractures.

**AP Gamma Locking Nail:**

Halder introduced this new intramedullary device for the treatment of unstable pertrochanteric and subtrochanteric fractures. Because this device is intramedullary it lies more medial than the standard sliding compression hip screw and plate therefore less force is dissipated on the implant with weight bearing. The device therefore transmits the patients body weight closer to the calcar than the sliding compression hip screw. This results in greater mechanical strength.

Duration of surgery and blood loss is minimal with this implant. Halder reports no cases of fatigue fracture or implant failure and has noted no nonunion with the use of this implant. Coxa vara has occurred in minimal number of patients. Despite good results the authors have noted some cases in which nail cut out of femoral head and neck.

According to Davis and associates, the additional advantage of Gamma nail includes its closed method of insertion, which allows fixation without periosteal stripping and it is load sharing and not load sparing device\(^{10}\).

Leung and colleagues compared the use of gamma nail and DHS for pertrochanteric and subtrochanteric fractures and concluded that Gamma nail was associated with shorter operating time, smaller incision, less blood loss and quicker return to full weight bearing.
Bridle and co-workers recommended Gamma nail for intertrochanteric fractures with subtrochanteric extension and intertrochanteric fractures with reverse obliquity.

K S Leung noted intraoperative fracture of lateral cortex with Gamma nail and also noted postoperative stress fracture of femoral shaft same as noted by Bridle et al and Halder 1992.

More or less the length of AP Gamma nail was found to be inadequate to fix comminuted pertrochanteric and sub trochanteric fracture extending into middle 1/3 of femoral shaft. These intramedullary methods of treatment of intertrochanteric fractures require extensive operative experience with the technique and expensive operating equipment, image intensification. The high incidence of complication reported with their use has resulted in a loss of popularity of these devices.

**Proximal Femoral Nail (PFN):**

In 1996, the AO/ASIF developed the proximal femoral nail (PFN) as an intramedullary device for the treatment of unstable per-, intra- and subtrochanteric femoral fractures.

Proximal femoral nail has all the advantages of an intramedullary device, such as decreasing the moment arm, can be inserted by closed technique, which retains the fracture hematoma an important consideration in fracture healing decreases blood loss, infection, minimizes the soft tissue dissection and wound complications.

In addition to all advantages of a nail to be implanted intramedullarily, it has several other favorable characteristics. Pre-drilling is not necessary, it
can be dynamically locked, it has a high rotation stability, and mechanical stress concentration on the implant-bone interface is low.

The currently used Gamma nail as an intramedullary device also has a high learning curve with technical and mechanical failure rates of about 10% (collapse of the fracture area, cut-out of the implant, fracture of the femur shaft). The Arbeitsgemeinschaft fur Osteosynthesefragen (AO ASIF) therefore developed the proximal femoral nail with an antirotational hip pin together with a smaller distal shaft diameter to avoid these failures.

In an experimental study, Gotze et al. (1998) compared the loadability of osteosynthesis of unstable per- and subtrochanteric fractures and found that the PFN could bear the highest loads of all devices.

Simmermacher et al., in a clinical multicenter study reported technical failures of the PFN after poor reduction malrotation or wrong choice of screws in 5% of the cases. A cut-out of the neck screw occurred in 0.6%\textsuperscript{18}.

Christian Boldin et al found no fracture of the femoral shaft and no break in the implant, in comparison to the Gamma nail. This is because of the tapered narrow tip of the nail which prevents the stress concentration\textsuperscript{27}.

Harris, I Rahme, D in their study of subtrochanteric femur fractures treated with a PFN compared to a 95 degree blade plate found that the fixation failure rated was 24% in the blade plate group. There no fixation failures in the PFN group\textsuperscript{25}.
MATERIAL AND METHODS

The present study was carried out in PRAVARA RURAL HOSPITAL (PIMS), LONI, District AHMEDNAGAR from July 2009 to July 2011. The study consisted a total of 40 adult patients of peritrochanteric fractures of femur satisfying the inclusion criteria, who are treated with Proximal Femoral nail (20 cases) and Dynamic Hip Screw (20 cases). It was a COMPARATIVE STUDY.

All the cases in the study were having intertrochanteric or subtrochanteric fractures. Patients from age group 18 years and above were selected. Majority of the fractures were treated with closed method of reduction followed by either operated by Proximal Femoral Nail (PFN) or Dynamic Hip Screw (DHS). All the peritrochanteric fractures were considered except grade 4 type of intertrochanteric (IT) fracture as per Boyd and Griffin’s classification and grade 5 according to Seinsheimer’s classification.

In all the patients along with personal data, mode of trauma, type of fracture, type of surgery, intra operative & post operative complications, follow up examination including hip joint examination, duration of full weight bearing were considered.

INCLUSION CRITERIA

- Type I, II, III of Fracture pattern
  - Boyd and Griffin’s Classification
  - Evans Classification
  - Seinsheimer’s Classification
Material And Methods

- Tronzo’s Classification
- AO Classification/OTA

➢ Also Radiologically fractures with
  - Intact lateral cortex
  - Intact entry point i.e Greater trochanter

➢ Minimum of 6 months of follow up.

EXCLUSION CRITERIA

- Patients with Type IV, V fracture pattern.
- Patients who are medically unfit for surgery.

CHOICE OF NAIL USED

Hollow tubular Nail was chosen. The nail was made up of AISI 316 L stainless steel.

In the present study we have used nails of uniform length of 25 mm in all 20 cases. Proximal diameter of nail is 17 mm (proximal 8 cm of nail) while the distal diameter ranging from 9 to 12 mm. Proximal femoral nail of 130 & 135 degree with 10 degree of anteversion was used. This nail has a radius of 3000 mm in antero posterior & 4 degrees of mediolateral curvature.

Proximal portion of the nail has provision to accommodate two screws, the lag screw is of size 7.9mm and is available in different lengths ranging from 55mm to 115 mm. There is a set screw which is of size 6.4 mm and is available in different lengths ranging from 55mm to 115mm. This
screw controls the rotation (ANTI ROTATION SCREW).

**Threaded cap** is available to prevent in growth getting trapped in the proximal threads of the nail.

Distal end of nail has two parallel holes to accommodate distal interlocking bolts. Amongst the proximal holes of the nail the upper one is for static locking while the lower one is for dynamic locking.

**MEASUREMENT OF NAIL LENGTH**

In our study nails of uniform size length i.e **25 mm** were used in all cases.

**MEASUREMENT OF DIAMETER OF THE NAIL**

It was done by taking conventional radiographs of normal femur & by measuring the inner diameter between the cortices at the level of the **isthmus** of femur was made.

We also took help of the ruler provision from the PACS system of x rays which is used in our hospital. By this technique direct measurement of diameter of bone can be made on the computer monitor. However, nails of all sizes were kept ready for operation i.e 9 mm to 12 mm size.
RICHARDS DYNAMIC COMPRESSION SCREW:

It consists of:

- A cannulated lag screw with a 19 mm or 29 mm threaded distal portion of 12.7 mm diameter and a proximal unthreaded portion (shaft) of 8.7 mm diameter. It came in various lengths from 50-110 mm. It was cannulated to accept a 3.2 mm guide wire.
Material And Methods

- The lag screw was inserted into the barrel attached to a side plate into which it can slide.

- There was a groove in the shank of the lag screw, which corresponds to the key in the barrel. This prevents the rotation.

- The side plate was available in 2-20 holes, which accommodate 4.5 mm cortical bone screws. Mostly 4 or 5 holed plate was used.

Data collection:

After the patient with trochanteric or subtrochanteric fracture was admitted to our hospital, all the necessary clinical details were recorded in proforma prepared for this study. After the completion of the hospital treatment patients were discharged and called for follow up at outpatient level at regular intervals for serial clinical and radiological evaluation.

The patients were followed up till fracture union and function recovery after surgery at regular interval and if necessary subsequent follow up was done.
Management of patients:

As soon as the patient with suspected subtrochanteric or trochanteric fracture was seen, necessary clinical and radiological evaluation done and admitted to the ward after necessary resuscitation and splintage using skin traction.

The following investigations were done routinely on all the patients preoperatively:

Blood:

Hb%, total leucocyte count, differential count, blood grouping, crossmatching, fasting blood sugar, blood urea, serum creatinine, serum electrolytes.

Urine:

Albumin, sugar and microscopic examination.

X-rays:

- Pelvis with both hips-AP view.
- Involved side hip with femur full length-AP and Lateral view in all patients.
- Chest-PA view in necessary patients.

All the patients were evaluated for associated medical problems and were referred to respective departments and necessary treatment was given. Associated injuries were evaluated and treated simultaneously. All the patients were operated on elective basis after overcoming the avoidable anesthetic risks.
Pre-op planning:

1) Determination of nail diameter: Nail diameter was determined by measuring diameter of the femur at the level of isthmus on an AP x-ray.

2) Determination of neck shaft angle: Neck shaft angle was measured on the unaffected side on an AP x-ray using goniometer.

3) Length of the nail: A standard length PFN nail (250mm) is used in all our cases.

OPERATIVE TECHNIQUE (PFN)

Patient positioning and fracture reduction:

The patient was placed in supine position on fracture table with adduction of the affected limb by 10 to 150 and closed reduction of the fracture was done by traction and gentle rotation. The unaffected leg was flexed and abducted as far as possible in order to accommodate to image intensifier. The image intensifier was positioned so that anterior-posterior & lateral views of the hip and femur could be taken.

The patient was then prepared and draped as for the standard hip fracture fixation. Prophylactic antibiotic was given to all patients 30 minutes before surgery.

Percutaneous fixation of fracture:

In Trochanteric fractures we fixed the fracture percutaneously using two “k” wires which pass along the anterior cortex of greater trochanter and neck of femur into the head of femur. By doing so we can prevent the fracture opening up on adduction of limb for nail insertion.
Approach:

The tip of the greater trochanter was located by palpation in thin patients and in hefty patients we used image intensifier and 5 cms longitudinal incision taken proximal from the tip of the greater trochanter. A parallel incision was made in the fascia lata and gluteus medius was split in line with the fibres. Tip of the greater trochanter is exposed.

Determination of the entry point and insertion of guide wire:

In AP view on C-arm, the entry point is on the tip or slightly lateral to the tip of the greater trochanter. In lateral view, guide wire position confirmed in the center of the medullary cavity. The guide wire is inserted in this direction to a depth of 30cms with a T handle.

Opening of the femur:

Over the guide wire, a cannulated rigid reamer is inserted through the protection sleeve and manual reaming was done as far as the stop on the protection sleeve.

Insertion of the PFN:

After confirming satisfactory fracture reduction an appropriate size nail as determined pre operatively was assembled to the insertion handle and inserted manually as far as possible into the femoral opening. This step was done carefully without hammering by slight twisting movements of the hand until the hole for 8mm screw is at the level of inferior margin of neck. In cases where satisfactory reduction was not possible by closed means, open reduction was done.

Insertion of the guide wire for neck screw and hip pin:
These are inserted with the help of the aiming device tightly secured to the insertion handle and using the colour coded drill sleeve systems. A 2.8 mm guide wire was inserted through the drill sleeve after a stab incision with its position in the caudal area of the femoral head for neck screw. This guide wire is inserted 5 mm deeper than the planned screw size. The final position of this guide wire should be in the lower half of the neck in AP view and in the center of the neck in lateral view. Proper positioning of the nail will aid in proper anteversion of the neck screw as there is inbuilt anteversion in the hole on the nail.

A second 2.8 mm guide wire is inserted through the drill sleeve above the first one for hip pin. The tip of this guide wire should be 5mm deeper than the planned hip pin but approximately 25-20 mm less deep than planned neck screw.

**Insertion of the hip pin:**

The hip pin is inserted first to prevent the possible rotation of the medial fragment when inserting the neck screw. The length of the hip pin is indicated on measuring device and is calculated 5 mm before the tip of the guide wire. Drilling is done over the guide wire with 6.5 mm drill bit to a depth upto the length of hip pin previously measured. The same length 65 mm hip pin is inserted with the help of hexagonal cannulated screwdriver. Length and position to be confirmed with C-Arm Guide wire is then removed.

**Insertion of the neck screw:**

A measuring device is inserted over the 2.8 mm guide wire until it touches the bone. The correct length is indicated on the measuring device
and calculated to end approximately 5 mm before the tip of the guide wire. This length is set on the 8 mm reamer by securing the fixation sleeve in correct position. Drilling is done over 2.8 mm guide wire till the fixation sleeve prevents further drilling. Tapping is not done as the neck screw is self tapping. Neck screw is inserted using cannulated screw driver. Final position confirmed with image intensifier.

**Distal locking:**

Distal locking is usually performed with two cortical screws. For standard PFN, aiming was used. A drill sleeve system was inserted through a stab incision. A drill hole is made with 4 mm drill bit through both cortices length is measured directly from the drill marking. Locking screw is inserted through protection sleeve position confirmed with image intensifier.

**Closure:**

After the fixation is over, lavage is given using hydrogen peroxide, povidone iodine and normal saline. Incision closed in layers. Sterile dressing is applied over the wounds and compression bandage given.

**After treatment:**

Postoperatively, patients pulse, blood pressure, respiration, temperature were monitored. Foot end elevation is given depending on blood pressure. Antibiotics were continued in the post operative period, I.V for 5 days and oral antibiotics till suture removal(14th Day). Analgesics were given as per patients compliance. Blood transfusion was given depending on the requirement. Sutures removed on 14th postoperative day.

Patients were encouraged to sit in the bed after 24 hours after surgery.
Patients were taught quadriceps setting exercises and knee mobilization in the immediate post operative period. Patient was taught gait training before discharge from the hospital. Only in very unstable fracture patterns weight bearing was not advised. Rest of the patients were encouraged to weight bear partially with axillary crutches or walker depending on the pain tolerability of individual patient.
Discharge:

Patients were discharged from the hospital when independent walking was possible with or without walking aids.

Follow up:

All patients were followed up at an interval of 6 weeks till the fracture union is noted and then after once in 3 months till 1 year.

At every visit patient was assessed clinically regarding hip and knee function, walking ability, fracture union, deformity and shortening.

Modified Harris Hip scoring system was used for evaluation.

X-ray of the involved hip with femur was done to assess fracture union and implant bone interaction.
OPERATIVE TECHNIQUE (DHS)

Pre operative Investigations and Anesthesia fitness was done prior to surgery similar to that in Proximal femoral nailing.

Pre operative planning and estimation of implant (DHS)

Prior to the surgery, Radiographs of pelvis with both hips (PBH) in AP and Lateral view (side to be operated) was done. The Richard screw (Lag screw) length and angle of barrel plate was estimated.

Pre operative preparations:

Preparation of operative site was done in ward, a day prior to surgery and prophylactic antibiotic IV was given 30 min before surgery.

Anaesthesia: Spinal / Epidural anaesthesia was given in all cases but some required general anaesthesia

Steps of Operation:

1. After anaesthesia, patient was placed on radiolucent fracture table with buttocks on pelvic rest.

2. Reduction of fracture was done as suggested by Tronzo

Type 2: Fracture reduced with traction only.

Type 3: Fracture reduced by first giving traction and 20° abduction (to correct varus deformity) and then limb was externally rotated gently and finally internally rotated up to neutral position.
**Type 4:** Fracture reduction was attempted as above manner and if not possible then Dimon - Hughston medial displacement osteotomy was planned.

**Type 5:** Fracture was fixed by notching out the shaft fragment so that neck can be jammed into if for stabilization.

3. Reduction position seen on C-Arm image intensifier or the check X-Ray was taken.

4. Patient’s preparation Pre operative scrubbing with savlon and povidone iodine scrub for at least 10 minutes was done and mopped off with spirit.

5. Painting & drapping Painting was done with 5 % povidone iodine and spirit. Drapping was done with sterile sheets.

6. **Incision:** The vastus lateralis splitting approach was used. Lateral skin incision was taken from distal edge of greater trochanter. Subcutaneous tissue, tensor fascia lata were cut in the same line and vastus lateralis was split from trochanteric crest to expose the greater trochanter and upper pail of shaft up to 2 inches. The incision was extended distally for plate application.

7. **Guide wire placement:** To determine femoral neck anteversion, a Kirschner wire was passed over the front of femoral neck. Using the appropriate DHS angle guide with ‘T’- handle. The K- wire was gently hammered into the head.

The DHS angle guide was placed against the middle of femoral shaft.
and positioned so that the guide tube pointed to the center of femoral head.

The lateral cortex was opened with 2 mm drill bit. The guide wire was inserted into the center of femoral head and advanced to subchondral bone.

The level of insertion of guide wire varies with angle of plate used.

The proximal aspect of osseous insertion of gluteus maximus and the tip of lesser trochanter, which are 2 cm below the vastus lateralis ridge, help to identify the level of entry of 135° angle plate.

If higher angle side plate is used move the entrance site 5 mm distally for each 5° increase in barrel angle.

The guide wire should remain in place throughout the procedure.

Threaded ends help to secure it in bone and prevent it from sliding out.

The guide wire should lie in middle of the femoral neck in both AP and Lateral views.

The guide wire position was checked and if its position was not perfect than it was changed before proceeding further.

8. The direct measuring device was slided over the guide pin and reading of length of pin inside femoral neck and head was taken.

9. Reaming of neck and head: The triple reamer was set 10mm shorter than the reading of the direct measuring device. The triple reamer was placed over the guide wire and the neck portion was reamed. (The DHS triple reamer provides three functions i.e. reaming for the screw for the barrel plate and plate - barrel junction. Reamer depth is adjustable in 5 mm increments.)
10. **Tapping:** Generally for osteoporotic bone there was no need to tap. Tap was inserted with the help of short centering sleeve to cut the threads into reamed portion of head and neck in the hard cancellous bone. Tapping was continued until the advancing portion of positive stop rests against the cortex guide.

11. **Richard’s Screw insertion:** Before inserting a lag screw, a proper size of Richard’s screw was measured by direct measuring gauge. (A fully inserted lag screw that equals the length determined by direct measuring gauge allows 5 mm compression when compression screw is used or 5mm of fracture collapse before the shaft of the lag screw begins to back out, a 5mm shorter lag screw will allow an additional 5mm compression.) To insert the screw into head and neck the coupling screw guide shaft and the hip screw were assembled. The coupling screw was inserted through the hollow guide shaft into the hip screw. The ridge and the slot between the guide shaft and the screw must inter-digitate. The wrench was inserted into the long centering sleeve. The assembled coupling screw, guide shaft and the selected screw were then inserted into the wrench and this whole assembly slided over the guide pin and the centering sleeve was introduced into the predrilled hole. The screw was driven into the femoral neck by turning the wrench, until the zero mark on wrench reached the lateral cortex. This meant that with this selected length of screw, the tip of screw was 10mm from joint. (In osteoporotic bone, screw can be inserted 5 mm more deeper). The ‘T’ handle of wrench was made perpendicular with femoral shaft at the end of insertion, to
allow proper keying of the lag screw to the barrel plate.

- The **wrench with the centering sleeve** was removed and the DHS plate was slid into shaft of Richard’s screw and the coupling screw and guide shaft were removed.

- With the **impactor**, the plate was hammered against cortex of femur.

- The plate was fixed to the femoral shaft in usual manner, traction was released and compression achieved by tightening the top screw.

- For unstable intertrochanteric fracture i.e. the fracture with comminution of calcar arch or with posteromedial fragment involving shaft, Dimon Hughston procedure was done. Great emphasis was placed on restoration of medial continuity for successful internal fixation of these types of fracture

16. Wound was closed in layers over the suction drain\textsuperscript{175}.

**DIMON- HUGHSTON PROCEDURE\textsuperscript{132}**:  

- Patient was placed supine on radiolucent fracture table with involved leg secured to traction.

- Position of abduction not more than 10°, foot in internal ration was given.  
  (If abduction was more than 30°, fracture opens up medially. If internal rotation done fracture open up posteriorly)

- Preparation and painting - drapping was done. Fracture was exposed through lateral approach. The neck and trochanteric area were palpated for large fracture fragment of posterior cortex.
The lateral cortex may be intact, may have narrow spike or may be severely comminuted. If lateral cortex was intact, transverse osteotomy was done 1.5 cm below the prominence of trochanter, using multiple drill hole and osteotome. The fragment containing greater trochanter was retracted superiorly to expose the proximal fragment.

If the lateral cortex was comminuted the greater trochanter was retracted superiorly without osteotomy.

A strong steinmann pin was passed into the head and neck fragment without obstructing the path of guide wire. This was done to lever the proximal fragment. Shaft was displaced medially, the calcar portion of proximal fragment was put into the medullary canal of the distal fragment. Once the temporary reduction was achieved, reduction was undone and a guide wire was passed up the proximal fragment with the varus inclination, in an effort to end up in the inferior part of head.

- Guide wire position was confirmed on AP and Lateral view of C-arm image intensifier.
- Desired length was calculated.
- A short barrel of 135° lag screw, and side plate assembly was used. The screw was inserted over the guide wire after reaming and tapping, and the side plate was inserted over the screw.
- Reduction was achieved as obtained previously.
- The extremity was abducted so that the barrel plate was in contact with shaft of femur.
• Plate was fixed to the shaft in usual manner.
• Bone fragments were allowed to fall in their own place.
• Traction was released.
• Wound was closed in layers over the suction drain.  

Gluteus medius
Post-operative care:

1. Operated limb was elevated for a day.
2. Broad spectrum antibiotics (Inj. Cefotaxime 1 gm 12 hrly IV and Inj. Gentamycin 80 mgs.) IV 8 hourly were given for 5 days and then shifted to oral antibiotics.
3. IV fluids were given post surgery till patient started orally.
4. Suction drain was removed after 48 hours.
5. Static quadriceps exercises were begun on 2nd post-operative day.
6. Active quadriceps exercises and hip flexion exercises were started on 4th or 5th post operative day.
7. Patient was ambulated non-weight bearing with axillary crutches.
8. Sutures were removed on 12th (alternate) and complete suture removal done on 14th post-operative day.
9. Partial weight bearing was started after reviewing clinically and radiologically at about 6 weeks post operatively.
10. Full weight bearing allowed after the confirmation of radiological and clinical union.

Follow up protocol

Patient was called for follow-up every month. On follow up following points were noted:

1. Complaints of pain if any
2. Deformity
3. Shortening
4. Range of hip and knee movements  
5. Ability to squat and sit cross legged  
6. Walking ability with or without support  
7. Whether the patient returns to pre-injury occupation

X-Ray pelvis with both hip AP-view and lateral view of operated hip were looked for:

1. Signs of union  
2. Neck - shaft angle  
3. Failure of fixation  
4. Failure of implant  
5. Reaction to metal

RESULTS OF THE SURGERY:

Functional Results:

Assessed based following hip scoring system adopted.

Harris Hip Scoring System (Modified)

- Maximum points possible - 100  
  Pain relief- 44  
  Function- 47  
  Range of motion- 5  
  Absence of deformity- 4

(1) Pain (44 Possible)
- None or ignores it (44)
- Slight, occasional, no compromise in activities (40)
- Mild pain, no effect on average activities, rarely moderate pain with usual activity; may take aspirin (30)
- Moderate pain, tolerable but makes concessions to pain, some limitation of ordinary activity or work; may require occasional medicine stronger than aspirin (20)
- Marked pain, serious limitation of activities (10)
- Totally disabled, crippled, pain in bed, bed ridden (0)

(2) Function (47 Possible)

**Gait** (33 POSSIBLE)

(A) LIMP
- None (11)
- Slight (8)
- Moderate (5)
- Severe (0)

(B) SUPPORT
- None (11)
- Cane for long walks (7)
- Cane most of the time (5)
- One crutch (3)
- Two canes (2)
- Two crutches (0)
- Not able to walk (0)

(C) DISTANCE WALKED
- Unlimited (11)
- Six blocks (8)
- Two or three blocks (5)
- Indoors only (2)
- Bed and chair (0)

**Activities (14 Possible)**

**(A) STAIRS**

- Normally without use of railing (4)
- Normally use of railing (2)
- In any manner (1)
- Unable to do stairs (0)

**(B) SHOES AND SOCKS**

- With ease (4)
- With difficulty (2)
- Unable (0)

**(C) SITTING**

- Comfortably in ordinary chair one hour (5)
- On a high chair for half an hour (3)
- Unable to sit comfortably in any chair (0)

**(D) ENTER PUBLIC TRANSPORTATION (1)**

**(3) Absence of deformity (All yes=4; Less than 4=0)**

- Less than 30 degrees of fixed flexion contracture.
- Less than 10 degrees of fixed adduction.
- Less than 10 degrees of fixed internal rotation in extension.
- Limb length discrepancy less than 3.2 cm.

**(4) Range of motion (5 Possible) (**Normal**)**

Total degree measurements, then check range to obtain score

- Flexion (*140 degrees)
- Abduction (*40)
- Adduction (*40)
- External rotation (*40)
- Internal rotation (*40)

**Range of motion scale**

- 210-300 (5)
- 161-210 (4)
- 101-160 (3)
- 61-100 (2)
- 31-60 (1)
- 0-30 (0)

**Total Harris Hip Score**

<table>
<thead>
<tr>
<th>Score</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-100</td>
<td>Excellent</td>
</tr>
<tr>
<td>80-89</td>
<td>Good</td>
</tr>
<tr>
<td>70-79</td>
<td>Fair</td>
</tr>
<tr>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>&lt;70</td>
<td>Poor</td>
</tr>
</tbody>
</table>
OBSERVATIONS AND RESULTS

The following observations were made from the data collected during this comparative study of proximal femoral nail and dynamic hip screw in the treatment of 40 cases of Peritrochanteric fractures of proximal femur in the Department of Orthopaedics, PRAVARA RURAL HOSPITAL (PIMS), LONI, District AHMEDNAGAR from July 2009 to July 2011.
### TABLE 1: AGE WISE DISTRIBUTION OF CASES

<table>
<thead>
<tr>
<th>Age(Year)</th>
<th>No. of patients in PFN</th>
<th>No. of patients in DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30</td>
<td>2 (10%)</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>30-40</td>
<td>2 (10%)</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>40-50</td>
<td>2 (10%)</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>50-60</td>
<td>5 (25%)</td>
<td>5 (25%)</td>
</tr>
<tr>
<td>60-70</td>
<td>4 (20%)</td>
<td>4 (20%)</td>
</tr>
<tr>
<td>70-80</td>
<td>4 (20%)</td>
<td>5 (25%)</td>
</tr>
<tr>
<td>80-90</td>
<td>1 (5%)</td>
<td>1 (5%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>20</strong></td>
</tr>
</tbody>
</table>
In our series, majority of the cases i.e.10 were seen in the age group of 50-60 yrs, both in PFN and DHS group 5 cases each (25%).

Mean age in years of patients treated with PFN: 56.6

Mean age in years of patients treated with DHS: 58.5

Youngest patient was 24 years old while the oldest was 86 years old in the study.

**TABLE NO .2: SEX WISE DISTRIBUTION**

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of patients in PFN</th>
<th>No. of patients in DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>15(75%)</td>
<td>12(60%)</td>
</tr>
<tr>
<td>Female</td>
<td>05(25%)</td>
<td>08(40%)</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>
Observations and Results

![Chart showing the number of patients for PFN and DHS]
Observations and Results

<table>
<thead>
<tr>
<th>Mode of trauma</th>
<th>PFN</th>
<th>DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road traffic accident</td>
<td>06 (30%)</td>
<td>8 (40%)</td>
</tr>
<tr>
<td>Domestic fall (fall at home)</td>
<td>13 (65%)</td>
<td>12 (60%)</td>
</tr>
<tr>
<td>Assault</td>
<td>01 (5%)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Most of our patients were 50 years and above in them domestic fall (fall at home) and trivial trauma was main reason behind fracture while in road traffic accident (RTA) young patients were affected.
TABLE NO.4: SIDE OF INJURY

<table>
<thead>
<tr>
<th>Side</th>
<th>PFN</th>
<th>DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>12 (60%)</td>
<td>9 (45%)</td>
</tr>
<tr>
<td>Right</td>
<td>08 (40%)</td>
<td>11 (55%)</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>
TABLE NO.5: ACCORDING TO TYPE OF FRACTURE

According to type of fracture

We have included patients with type I, II and III fracture pattern as per Boyd & Griffins classification, Evans Classifications and Seincheimer’s classification.

<table>
<thead>
<tr>
<th>Type of fracture</th>
<th>PFN</th>
<th>DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter trochanteric</td>
<td>14 (60%)</td>
<td>16 (80%)</td>
</tr>
<tr>
<td>Sub trochanteric</td>
<td>06 (30%)</td>
<td>04 (20%)</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

As per fracture pattern seen in intertrochanteric fractures only.

Total 14 (60%) cases of intertrochanteric fractures seen amongst 20 cases treated by PFN and 16(80%) cases of intertrochanteric fractures seen
amongst 20 cases treated by DHS.
TABLE NO. 6: ASSOCIATION BETWEEN TYPE OF FRACTURE AND SIDE OF INJURY

<table>
<thead>
<tr>
<th>Type of fracture</th>
<th>PFN Left</th>
<th>PFN Right</th>
<th>DHS Left</th>
<th>DHS Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter trochanteric</td>
<td>8 (66.67%)</td>
<td>6 (75%)</td>
<td>7 (77.77%)</td>
<td>9 (81.81%)</td>
</tr>
<tr>
<td>Sub trochanteric</td>
<td>4 (33.33%)</td>
<td>2 (25%)</td>
<td>0 (22.22%)</td>
<td>2 (18.18%)</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>8</td>
<td>09</td>
<td>11</td>
</tr>
</tbody>
</table>

Value of $x^2 = 3.17$, d.f=1, significant $p<0.05$

After applying Chi-square test there is a significant association between side of injury and type of fracture (i.e. $p<0.05$)
TABLE NO.7: STABILITY PATTERN OF INTERTROCHANTERIC FRACTURES

<table>
<thead>
<tr>
<th></th>
<th>PFN</th>
<th>DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable</td>
<td>06 (42.85%)</td>
<td>10 (62.5%)</td>
</tr>
<tr>
<td>Unstable</td>
<td>08 (57.14%)</td>
<td>06 (37.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>16</td>
</tr>
</tbody>
</table>
TABLE NO. 8: TIME DURATION FOR SURGERY

<table>
<thead>
<tr>
<th>Time duration for surgery (Days)</th>
<th>PFN</th>
<th>DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>08 (40%)</td>
<td>08 (40%)</td>
</tr>
<tr>
<td>5-10</td>
<td>06 (30%)</td>
<td>08 (40%)</td>
</tr>
<tr>
<td>10-15</td>
<td>05 (25%)</td>
<td>03 (15%)</td>
</tr>
<tr>
<td>15-20</td>
<td>01 (5%)</td>
<td>01 (5%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>20</strong></td>
</tr>
</tbody>
</table>

![Graph showing the distribution of time duration for surgery](image)
**TABLE NO 9: TYPE OF REDUCTION**

<table>
<thead>
<tr>
<th></th>
<th>PFN</th>
<th>DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>5 (25%)</td>
<td>3 (15%)</td>
</tr>
<tr>
<td>Closed</td>
<td>15 (75%)</td>
<td>17 (85%)</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>
TABLE NO. 10: LENGTH OF PROXIMAL SCREWS USED

PFN

<table>
<thead>
<tr>
<th>Screw Length (in mm)</th>
<th>Cases with length of screw used as ante rotation screw (6.4 mm)</th>
<th>Cases with length of screw used as lag screw (7.9 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of cases</td>
<td>Percentage</td>
</tr>
<tr>
<td>50</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td>55</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td>60</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td>65</td>
<td>3</td>
<td>15%</td>
</tr>
<tr>
<td>70</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>75</td>
<td>8</td>
<td>40%</td>
</tr>
<tr>
<td>80</td>
<td>7</td>
<td>35%</td>
</tr>
<tr>
<td>85</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td>90</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td>95</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td>100</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td>105</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td>110</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td>115</td>
<td>0</td>
<td>00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Length of Ante rotations (Derotation screw) is 10 mm less than Lag screw
### DHS

<table>
<thead>
<tr>
<th>Lag Screw Length (in mm)</th>
<th>No. of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0</td>
<td>00%</td>
</tr>
<tr>
<td>55</td>
<td>0</td>
<td>00%</td>
</tr>
<tr>
<td>60</td>
<td>0</td>
<td>00%</td>
</tr>
<tr>
<td>65</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>70</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>75</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>80</td>
<td>7</td>
<td>35%</td>
</tr>
<tr>
<td>85</td>
<td>5</td>
<td>25%</td>
</tr>
<tr>
<td>90</td>
<td>2</td>
<td>10%</td>
</tr>
<tr>
<td>95</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>100</td>
<td>0</td>
<td>00%</td>
</tr>
<tr>
<td>105</td>
<td>0</td>
<td>00%</td>
</tr>
<tr>
<td>110</td>
<td>0</td>
<td>00%</td>
</tr>
<tr>
<td>115</td>
<td>0</td>
<td>00%</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>100%</td>
</tr>
</tbody>
</table>
TABLE NO.11 : ASSOCIATED INJURIES

<table>
<thead>
<tr>
<th>Injuries</th>
<th>No.of patients</th>
<th>No.of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PFN</td>
<td>DHS</td>
</tr>
<tr>
<td>Head injuries</td>
<td>00</td>
<td>02 (50%)</td>
</tr>
<tr>
<td>Blunt abdominal injury</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>Blunt chest trauma</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>Fracture lower end radius</td>
<td>02 (66.67%)</td>
<td>02 (50%)</td>
</tr>
<tr>
<td>Fracture calcaneum</td>
<td>01 (33.33%)</td>
<td>00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>03</strong></td>
<td><strong>04</strong></td>
</tr>
</tbody>
</table>

- Two patients had closed head injury CT brain study impression normal report and were managed conservatively. (patients operated in the DHS group)
• Two patients (in each group PFN & DHS) had distal radius fracture. Two of them (DHS group) were treated conservatively with closed reduction and below elbow cast application while other two (from PFN group) were treated with open reduction and internal fixation with Ellis(buttress) plating.

• One patient (from PFN group) had calcaneum fracture and it was treated by open reduction and internal fixation (ORIF) with reconstruction plate.
## TABLE NO. 12: COMPLICATIONS SEEN

<table>
<thead>
<tr>
<th>Complications</th>
<th>No. of patients PFN</th>
<th>No. of Patients in DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic complications</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chest infection</td>
<td>1 (5%)</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Respiratory distress</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>1 (5%)</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>Urinary retention</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Deep vein thrombosis</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Local complication</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Superficial wound infection</td>
<td>1 (5%)</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>Deep wound infection</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Death</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
TABLE NO 13: ROTATIONAL MALALIGNMENT

<table>
<thead>
<tr>
<th></th>
<th>No. of Patients in PFN</th>
<th>No. of Patients in DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>External rotation</td>
<td>01 (5%)</td>
<td>0</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Varus deformity of hip</td>
<td>01 (5%)</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>Valgus deformity</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>shortening</td>
<td>01 (5%)</td>
<td>3 (15%)</td>
</tr>
<tr>
<td>------------</td>
<td>--------</td>
<td>--------</td>
</tr>
</tbody>
</table>

![Bar chart showing the number of patients in PFN and DHS for various conditions.](chart.png)
### TABLE NO.14: IMPLANT RELATED INTRAOPERATIVE COMPLICATIONS

**PFN**

<table>
<thead>
<tr>
<th>Intra operative complications</th>
<th>No.of patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ill fitting jig</td>
<td>4</td>
<td>20%</td>
</tr>
<tr>
<td>Improprate length of proximal screws</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Difficulty in distal locking</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fracture of greater trochanter</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fracture below tip of nail</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Revision surgery</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**DHS**

<table>
<thead>
<tr>
<th>Intra operative complications</th>
<th>No.of patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty in Reduction</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>Shattering of Lateral Cortex</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>Fracture below the plate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Breakage of plate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>-------------------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Breakage of screw</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
TABLE NO.15: RADIOLOGICAL COMPLICATIONS ENCOUNTERED (POST OP)

### PFN

<table>
<thead>
<tr>
<th>Complications</th>
<th>No of patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut out of neck screw</td>
<td>00</td>
<td>0</td>
</tr>
<tr>
<td>Z effect</td>
<td>00</td>
<td>0</td>
</tr>
<tr>
<td>Reverse Z effect</td>
<td>02</td>
<td>10%</td>
</tr>
<tr>
<td>Breakage of nail</td>
<td>01</td>
<td>5%</td>
</tr>
<tr>
<td>Bolt breakage</td>
<td>00</td>
<td>0</td>
</tr>
</tbody>
</table>

### DHS

<table>
<thead>
<tr>
<th>Complications</th>
<th>No of patients</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive Lag Screw back out</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>Plate breakage</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cortical Screw Loosening</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Observation</td>
<td>Value 1</td>
<td>Value 2</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Cortical Screw breakage /bending</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Observations and Results

PFN

- Bolt breakage
- Breakage of nail
- Reverse Z effect
- Z effect
- Cut out of neck screw

DHS

- Cortical Screw breakage/bending
- Cortical Screw loosening
- Plate breakage
- Lag Screw back out
Table no. 16: Hip range of motion (Calculated by Harris Hip Score)

<table>
<thead>
<tr>
<th>Range of Motion</th>
<th>PFN</th>
<th>DHS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Flexion</td>
<td>5(25%)</td>
<td>10(50%)</td>
</tr>
<tr>
<td>Abduction</td>
<td>4(20%)</td>
<td>10(50%)</td>
</tr>
<tr>
<td>External rotation</td>
<td>4(20%)</td>
<td>10(50%)</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>4(20%)</td>
<td>10(50%)</td>
</tr>
</tbody>
</table>
Period of Hospitalization:

Intraoperative details:

In our study, we considered various intraoperative parameters such as duration of radiographic screening—more exposure in case of comminuted fractures with difficult reduction. We took less exposure time in cases of intertrochanteric fracture where reduction was not a problem. We took more exposure time for the initial few cases but as we got experience the radiation exposure was less.

Duration of surgery was more for the initially operated cases. More in cases of subtrochanteric fractures when compared to trochanteric fractures and in fractures where we had to do open reduction.

Blood loss—measured by mop count (each fully soaked mop containing 50ml blood) more blood loss was seen in patients who require open reduction.

Table – Intraoperative details

| Mean duration of screening (in seconds) | 80 |
| Mean duration of operation (in minutes) | 90 |
| Mean blood loss (in milli litres)       | 120 |

Average time for which patient was admitted in our wards was 3 weeks i.e. 21 days.
In two patients who had superficial infections of would the hospital stay was prolonged for one week.

**Follow up**

We have done follow up examination at the end of

- One month
- Two months
- Three months
- Six months Following surgery

**Average time of union:**

Average time of union in all our 40 patients was 16 weeks (Range: 12 weeks to 20 weeks).
DISCUSSION

Fractures of intertrochanteric femur have been recognized as a major challenge by the Orthopaedic community, not solely for achieving fractures union, but for restoration of optimal function in the shortest possible time that to with minimal complications. The aim of management accordingly has drifted to achieving early mobilization, rapid rehabilitation and quick return of individuals to premorbid home and work environment as a functionally and psychologically independent unit.

Operative treatment in the form of internal fixation permits early rehabilitation and offers the best chance of functional recovery, and hence has become the treatment of choice for virtually all fractures in the trochanteric region. Amongst the various types of implants available i.e. fixed nail plate devices, sliding nail/screw plate and intramedullary devices, the compression hip screw is most commonly used (still remains the GOLD STANDARD) but recently techniques of closed intramedullary nailing have gained popularity.

In this study an attempt was made to survey, evaluate, document and quantify our success in the management of such individuals by using Proximal femoral nail (PFN) and Dynamic Hip Screw (DHS) implants and compare the result in these two groups. The study was conducted on forty patients (20 cases by PFN and 20 cases by DHS) of proximal femoral fractures attending out patient/casuality department of Orthopaedics, Rural Hospital, Pravara Institute of Medical Sciences, Loni, District Ahmednagar from July 2009 till July 2011.
1. **Age distribution:**

Most of patients in present study were from age group of 5\textsuperscript{th} to 7\textsuperscript{th} decade of life\textsuperscript{64}. Mean age in years for group operated by PFN = 56.5. Mean age in years for group operated by DHS = 58.5. Mean age in years both groups combined = 57.5. This signifies the fact that patients from these age groups are involved in low energy trauma like domestic fall (fall at home)\textsuperscript{7,86,94,105,125}

Gallaghar et al (1980) reported an eight fold increase in trochanteric fractures in men over 80 years and women over 50 years of age\textsuperscript{186}.

Average age reported by other workers is as follows

<table>
<thead>
<tr>
<th>Name of the worker</th>
<th>Age in years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaveland and Thompson, 1947</td>
<td>76.0</td>
</tr>
<tr>
<td>Murray and Frew, 1949</td>
<td>62.5</td>
</tr>
<tr>
<td>Boyd and Griffin, 1949</td>
<td>69.7</td>
</tr>
<tr>
<td>Scott, 1951</td>
<td>73.3</td>
</tr>
<tr>
<td>Evans 1951 -</td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>62.6</td>
</tr>
<tr>
<td>Females</td>
<td>74.3</td>
</tr>
<tr>
<td>Wade and Campbell (1959)</td>
<td>72.0</td>
</tr>
<tr>
<td>Sarmiento, 1963</td>
<td>71.9</td>
</tr>
<tr>
<td>Gupta, RC, 1974</td>
<td>51.2</td>
</tr>
</tbody>
</table>
The reason why trochanteric region is the most common site of senile osteoporosis as the age advances. Hip joint being a major joint in the mechanism of weight bearing, this already weakened part cannot withstand any sudden abnormal stress. The space between bony trabeculae is enlarged and loaded with fat, whilst ensheathing compact tissue is thinned out and calcar is atrophied.

Cleveland et al\textsuperscript{165} pointed out there are higher incidences of multiple fractures, as of the same or opposite side, which may occur at different occasions. This fact directs one’s attention to the underlying instability and inherent weakness of the bone structure of the elderly which predisposes them to the injury. More wide spread measures to correct or prevent osteoporosis should be instituted. The elderly should be freed of potential danger of poor lighting, slippery floor, wet slippers etc. For some patients whose general conditions (i.e Senility) makes them vulnerable to fall and fracture, total restriction of independent ambulation is indicated.

Due to early fixation of such fractures and early mobilization, these patients could gain full range of movement at an early date with minimal loss of productivity.

2. **Sex distribution:**

Most of patients from present study were males. There was a male preponderance in our patient. Amongst them majority were in 5\textsuperscript{th}-7\textsuperscript{th} decade of life, while young patients were from 2\textsuperscript{nd} to 4\textsuperscript{th} decade of life. Most of the females were in the age group of 5\textsuperscript{th} - 7\textsuperscript{th} decade.
The ratio of males to female was 2:1 for both the groups. This clearly reflected the preference and better acceptance of surgery by males and higher incidence of trochanteric fractures of femur in male population due to their more active lifestyles. David G. Lovelle found trochanteric fractures more common in women than men by a margin of three to one. Melton J.L., Ilstrup DM, Riggs BL et al (1982) released a study titled 'fifty years trend in Hip fracture incidence' and reported a female to male ratio of $1.8:1^{55}$. This variation is probably because our study measured the male female ratio amongst operated fractures that reported for follow up and not the actual sex incidence for all trochanteric fractures.

As ours is a rural setup, the majority of the patients in the series were male as they are more outgoing and engaged in activities like agriculture, driving of motor vehicles and are more likely to be involved or prone to accidents/ fall. Females play a more dormant role and are involved more in household activities.

Cleveland et al $^{165}$ in their study had 87.7% of female patients. They had given the following explanations for their observations which are as follows:

a. Females have slightly wider pelvis with a tendency to having coxa vara.

b. They are usually less active and are more prone to senile osteoporosis.

H. B. Boyd and L. L. Griffin $^{166}$ in their study of 300 cases found a marked sex difference. 226 (75.8%) of the patients were females and 74 (24.2%) were males.
Helfenstein (1947) suggested that, by stimulation of osteoclasts due to post menopausal deficiency of steroid hormones is responsible for greater osteoporosis.


In this series of 28 patients, 67.85 % of patients were male and 32.15% were females. Males were affected more because of their exposure to trauma during their day-to-day life was greater.

B. B. Ohari and Hatim Shaikh from Indore (1957) also found males predominantly affected in their series.

Ratio of males : females in other series is given below :-

<table>
<thead>
<tr>
<th>Series</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyd and Griffith (1949)</td>
<td>74</td>
<td>226</td>
</tr>
<tr>
<td>Murray and Frew 1949</td>
<td>56</td>
<td>46</td>
</tr>
<tr>
<td>Scott (1951)</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>Robey 1956</td>
<td>46</td>
<td>53</td>
</tr>
<tr>
<td>Clawson 1957</td>
<td>75</td>
<td>102</td>
</tr>
</tbody>
</table>

3. Mode of Injury

Most of our patients were 50 years and above in them domestic fall (fall at home) and trivial trauma was main reason behind fracture while in
road traffic accident (RTA) young patients were affected. In the cases treated by PFN there were 13 cases (65%) due to domestic fall while there were 6 cases (30%) due to Road traffic accident (RTA) 1 case (5%), it was due to assault.

While those patients treated by DHS, there were 12 cases (60%) where the mode of injury was due to domestic fall, while 8 cases (40%) was due to Road traffic accident (RTA). There were nil assault cases.

This may be attributed to the following factors as enumerated by Cummings and Nevitt in 1994. Inadequate protective reflexes, to reduce energy of fall below a certain critical threshold. Inadequate local shock absorbers e.g. muscle and fat around hip. inadequate bone strength at the hip on account of osteoporosis or osteomalacia.

Young patients with intertrochanteric or subtrochanteric fractures sustained trauma either as a result of road traffic accident or fall from height, there by reflecting the requirement of high velocity trauma to cause fracture in the young. Keneth J. Koval and Joseph D. Zuckerman (1996) observed that 90% of hip fractures in the elderly result from a simple fall. Hip fractures in young adults were observed to result most often with high energy trauma such as motor vehicular accidents or a fall from height.

Horn & Wang stated that mechanism of injury is not direct but due to failure of Stress resisting forces during sudden bending or twisting. A direct blow on the lateral side of thigh would result in contusion, comminution on the lateral surface of the greater trochanter and cause valgus deformity.
G.N. Spears & J.T Owens noticed in cadaveric femora that the femora classed as poorly mineralized broke more under dynamically applied loads as compared to well mineralized bone. They produced a fracture with a swinging pendulum, simulating a direct blow over the greater trochanter. They found that the fracture line passed through the trabeculae that have thinned out.

4. Type of fractures

In our present study, we have 14 (70%) intertrochanteric fractures with variable degree of comminution, 6 (30%) cases were of subtrochanteric fractures which were treated by PFN.

Out of 14 intertrochanteric fractures amongst 20 cases majority i.e. 8 cases were of unstable fracture pattern.

While 16 (80%) of intertrochanteric fractures and 4 (20%) of subtrochanteric fractures were treated by DHS.

According to Mervyn Evans the Inter trochantric fractures are considered as stable or unstable depending upon integrity of posteromedial cortex. Fractures with intact posteromedial cortex are considered as stable fractures while fractures with loss of posteromedial cortex are considered as unstable fractures. Postero medial cortex constitutes mainly the lesser trochanter.

This also correlated with the finding of Jacobs and coworker (1980) that incidence of comminuted usable intertrochanteric fractures is increasing.
5. Side of fracture

We have studied 40 cases of different types of intertrochanteric and subtrochanteric fractures in our present study. Amongst the 20 cases operated by PFN, 12(60%) patients were found to have proximal femoral fractures on the left side while 8(4%) patients were having fracture on the right side.

Amongst the 20 cases operated by DHS, 9(45%) patients were found to have proximal femoral fractures on the left side while 11 (55%) patients were having fracture on the right side.

6. Time duration between hospital admission and surgery

Majority of patients in present study series were operated within 10 days following admission in hospital (30/40). But in some patients (10/40) operative procedure was delayed due to medical problems (Hypertension and Diabetes) and financial constraint of patients. Average time lapse for surgery: 7.25 days. Amongst patients who had a delay in operative intervention two patients came to hospital following 10 days of trauma.

Urgent surgical intervention is necessary, as it not only avoids development of complications like hypostatic pneumonia, catheter sepsis, cardio respiratory failure, Decubitus ulcers, but also early rehabilitation and mobilization is possible which generate self confidence in patient. Thereby improvement in the general well being of the patient occurs. According to Evans 30% mortality rate occurs in conservative line of treatment using long term immobilization. Active surgical approach decrease the mortality to less than 15%. In patients young age there are also appear socioeconomic problems, long lasting elimination from working process of
even loss of job.

In A1 and A2 fractures axial loading leads to fracture impaction, whereas in A3 fractures such impaction does not occur, and medial displacement of the distal fragment of the fracture is common due to the instability.\textsuperscript{125,181}

Presence of extensive comminution & marked angulations, displacement, sagging at fracture site warrants use of extramedullary device like the DHS.\textsuperscript{28}

7. Associated Injuries

In present study series we have found 3 patients with associated injuries amongst 20 patients operated by PFN, out of which 2 patients were having fractures of distal end radius (both were in age group of 7\textsuperscript{th}-8\textsuperscript{th} decade) and one patient had ipsilateral fracture calcaneum (patient was between 2\textsuperscript{nd} -3\textsuperscript{rd} decade). Two patients with fracture distal end radius on contra lateral side were treated in same operative setting by closed manipulation reduction and followed by cast application (As patients were given general anesthesia & to minimize the risk of conservative method was chosen). While one patient with ipsilateral fracture calcaneum was treated conservatively.

We have not found patients with head injury, blunt abdominal, blunt chest injury, Also there were no patients with ipsilateral fracture shaft femur in the patients treated by PFN.

While in the patients operated by DHS, 2 patients were found to have head injury for relavant CT Brain was advised and done accordingly. There was no major findings on CT scan except cerebral edema. Two cases of
ipsilateral distal end radius fractures were present for which Open reduction and internal fixation by buttress plating (Ellis) was done in the same sitting.

8. Average length of nail used & Average size of barrel plate:

In our present study we have used of uniform length i.e. 25mm long nail.

As in present study we have included intertrochanteric fractures of type I, II and III as well as Sub trochanteric fractures according to Boyd & Griffin, Evans and Seinshimers classification. But we have not included subtrochanteric fractures variable extension in to femoral shaft and also trochanteric and subtrochanteric fractures with ipsilateral fracture shaft femur. So, need for using long length proximal femoral nail was eliminated\textsuperscript{7,170} The barrel plate used in the cases treated by DHS was generally 135° 4 holed plate. As per the fracture configuration and fracture line extension the number of holes in the barrel plate increased.

9. Diameter of the Nail

In present study series nails of diameter 9mm to 12mm were available. In four cases we have used nail of diameter 9mm, In 15 cases nail of 10 mm diameter while in one case nail of 11mm diameter was used. No patient was found to have medullary diameter of 12mm so PFN of that diameter was not used. In Indian population average diameter of medullary canal is found to between 9-10 mm\textsuperscript{7,124}. Proximal femoral nail has two segments i.e. proximal and distal. Proximal segment is of 8 cm and is of uniform diameter i.e. 17mm irrespective of diameter of distal fragment.

10. Length of proximal screws used:

In present study series we have used leg screw in range of 75mm to
115mm. Amongst them, in 3 cases (15%) we have used 75mm screw, in 2 cases (10%) we have used 80mm screw, in 8 cases (40%) we have used 85mm screw, 4 cases (20%) 90mm screw and in 3 cases (15%) we have used 95mm screw.

Anti rotation screw or hip pin screw was used in range of 65-80 mm dimensions.

In 3 cases (15%) we used screw of 65mm, in 2 cases (10%) 70mm, in 8 cases (40%) 75mm and in 7 cases (35%) 80mm screws were used.

Proximal femoral nail has provision to insert two proximal screws.

1. Larger lag screw which inserted through distal slot and has uniform diameter of 7.9mm.

2. Smaller anti rotation screw has uniform diameter of 6.4mm. It is inserted through the proximal slot of PFN.

3. Lag screw is designed to carry most of the load. It is of larger dimension i.e. 7.9 mm while hip pin provides rotational stability, it is smaller in dimension (i.e. 6.4 mm)

The length of the hip pin is less than the lag screw hence if the hip pin becomes longer than the lag screw, vertical forces will increase on the hip pin and would thus start to cut out. This will result in ‘Z’ effect. This might force the pin to migrate into the joint and lag screw slide laterally. Cut out rate of PFN is 6-8%.\(^{172}\)

When hip pin was 10mm shorter than lag screw percentage of total load carried by hip pin ranged from 8-39% (average 2/7). There was no cutout from the femoral head or unacceptable placement of implant or fracture displacement were observed.\(^{110,172}\)
Lag screw should be inserted into femoral head as deeply as noted in AP view and centrally in lateral view. Tip of lag screw should always be inferior to centre of femoral head. (TAD less than 25mm).\textsuperscript{20,121}

Anatomic and biomechanical studies have shown superomedial quadrant of femoral head is weakest part if the implant is placed in that position. Hence proper positioning of the screw should be emphasized. Cut out is usually as a result of poor positioning of the proximal screw.\textsuperscript{173}

Length of Richard’s screw (Lag Screw) used in DHS were in the range of 65 mm to 95 mm length. Amongst them, 1 case(5%) 65 mm screw was used, 2 cases(10%) 70 mm screw was used, 2 cases (10%) 75mm screw was used, in 7 cases(35%) 80 mm screw, in 5 cases(25%) 85mm screw, in 2 cases(10%) 90 mm screw while n 1 cases(5%) 95 mm lag screw was used.

In DHS fixation for the Richard screw(lag screw) placement the rule also applies. The lag screw placement must be in the centre as far as possible i.e in both AP and lateral view. The TAD should be also less than 25 mm . As far as possible, must try and achieve the placement of lag screw 5-10 mm short of the subchondral bone.
The cutout of the lag screw is the most dreaded complication of use of dynamic hip screw in treatment of intertrochanteric fractures. This is identified on X-rays by superior cutout of Richards screw from proximal head fragment.
11. Complications

Systemic complications:

In patients treated with PFN as well as DHS, one patient in each group was found to have chest infection while in other patient we found complication of urinary tract infection (UTI).

The patients with chest infection were known case of COPD, as they were chronic bidi smoker.

This complication was noticed in preoperative phase and appropriate treatment was given.

The patients who had urinary tract infection which was due to prolonged catheterization. Accordingly appropriate treatment in the form of antibiotics was given.

12. Wound Complications

Superficial wound infection was seen in 3 cases in total. 1 case in patient operated by PFN while 2 cases were seen in those operated by DHS.

The patient who was operated by PFN had infection in distal lock site. While the 2 cases operated by DHS had superficial wound infection at the suture site. This may be attributed to low immunity status of patient as the patient was of asthenic built and belonging to low socioeconomic status & more soft tissue exposure, which is more in cases operated by DHS.

In all these patients treatment of IV Antibiotics was prolonged, in our protocol we gave IV antibiotics for 5 days but in presence of would infection
we continued use of IV antibiotics for 10 days. Dressing of wounds were done as per necessity.\textsuperscript{109}

In all the cases the wound healed in the end. In the series of patients operated by DHS by Dr. G.S Kulkarni\textsuperscript{174}, there were two cases of deep infections which were treated by removal of implant. The infected sinuses thus healed after implant removal.

\textbf{A. Bodoky, U. Neff, M. Heberer & F. Harder}\textsuperscript{139} from the department of surgery, Basel university of Switzerland advocated the use of two doses of cephalosporin antibiotics preoperatively in the patients managed with internal fixation of hip fractures. According to their study antibiotics prophylaxis significantly reduced the incidence of wound infection.

\textbf{Verley GW, Milner SA} \textsuperscript{175} (1995) in their study of 177 patients of proximal femoral fracture, in their surgeries they kept drain in the wound. They found out that those patients which drain was kept showed better wound healing in terms of ASEPSIS wound scoring system and had a reduced rate of infection.

\textbf{13. Implant related Intra operative complications}

In 4 cases(20\%) operated cases by Proximal Femoral Nailing(PFN), there was ill fitting of jig. Due to the corresponding holes of jig and nail was not matching at times the position of the proximal screws was a problem.

While in those cases operated by Dynamic Hip Screw(DHS) we encountered 1 case(5\%) having difficulty in reduction. This was due to delay in surgery as the patient presented late and also had co morbid condition(Diabetes)
There was one case (5%) of complication in which there was shattering of the lateral cortex while proximal reaming (triple reamer). Thus a long DHS plate had to be used which could counteract the difficulty faced.

Altner PC (1982) studied Implant failure in the form of cut out in the Richard screw from the femoral head was observed in one case. This was associated with varus collapse of the neck shaft angle and nonunion at the fracture site. Baumgaertner M.R Chvostoski (1995) reported the incidence of fixation failure to be as high as 20% in unstable fracture patterns. Osteoporosis was found to be the most important predisposing factor for this complication.\textsuperscript{61}

14. Rotational Malalignment

External rotation of 15° was noticed in one case (5%) operated by Proximal femoral Nail (PFN).

Osteosynthesis with the PFN offers the advantages of high rotational stability of the head-neck fragment.\textsuperscript{170,180}

Post operatively the angle was measured and compared to the normal side to assess the correction achieved. Again the neck shaft angle was determined at follow up to assess any variation from immediate postoperative.

Varus deformity was noted in one case (5%). It might be seen due to early backing out of screws.

In one case (5%) we noted shortening of one centimeter which was not significant functionally for patient. Shortening might have resulted due to comminution of variable degree at fracture site & concentric collapse at fracture site.\textsuperscript{7}

In 2 cases (10%) of Varus deformity was seen in the cases operated by DHS. Due to the pull of the muscle the distal shaft fragment has the
tendency to migrate upwards thus resulting in varus deformity. The other reason that patients had coxa vara deformity was due to inadequate reduction and failure to maintain neck shaft angle preoperatively. There were 3 cases (15%) of shortening seen in the cases operated by DHS. This shortening ranged from 1-1.5 cms. Patients were given shoe raise which compensated for the necessary shortening. Patients did not have any difficulty later while walking.

The deformities usually which is encountered is limb shortening and coxa vara.

In the series by K.D Harrington176, out of 72 cases there were 4 cases of coxa vara and 56 cases of limb shortening at an average of 1.5 cms. In his series, shortening was noted in unstable fractures in which Dimon Hughston procedure was done. In the series by Juluru P. Rao177 of the 124 cases of intertrochanteric fractures, 5 cases of unstable fracture had limb shortening.

15. Radiological complications

In present study, the cases that we operated by Proximal Femoral Nail (PFN) we have not encountered ‘Z’ effect while in two cases (10%) we have found reverse ‘Z’ effect.

One case (5%) nail was broken at site in between proximal screws & distal lock.

This complication was noticed when patient came for second follow up. On taking detailed history it was found that patient started unpermitted early full weight bearing i.e. immediately after discharge from hospital. This fact was kept hidden by him on first follow up & also this complication was not demonstrated on x rays but subsequently noted on second follow up.

But despite of this patient was able to walk with help of support, he was advised surgery but he refused.
The method was also used advantageously in laterocervical and stable pertrochanteric fractures, particularly due to its mini-invasiveness. A careful surgical approach and technique with a stable osteosynthesis have markedly contributed to a more rapid mobilization of patients and thus decreases of post-op operative complications.

PFN nail has been shown to prevent the fractures of the femoral shaft by having a smaller distal shaft diameter which reduces stress concentration at the tip.\(^{178}\)

In patients with unstable intertrochanteric fractures treated with proximal femoral nailing, technical or mechanical complications seem to be related to the fracture type, operating technique, and time to weight bearing rather than the implant itself.\(^{28,170}\)

Low rates of femoral shaft fractures and fixation failure suggest that the PFN is useful for treating stable and unstable trochanteric fractures.\(^{149}\)

**Fig. Lateral sliding of proximal screw**

In one case (5%) which was operated by DHS, it was seen that there was excessive back out of the Richard’s screw (lag screw).

**16. Period of Hospitalisation**

Average time for which patient was admitted in Pravara Rural hospital Loni was 21 days i.e. 3 Weeks. During postoperative period as per pain and
tolerance of patient, they were made to standup with help of support on 4-5th post operative day. Then gradually within next 2 to 3 days there were made to do non weight bearing walking with support. (Walker)

   Early mobilization of knee was permitted as soon as possible according to patients tolerance preferring to start on the 2nd post operative day.

   Patients were discharged after suture removal with instruction to non weight bearing mobilization with support. (Walker was advised to be purchased for home use)

   Even in the cases operated by DHS, we started Quadriceps drill on the 2nd post operative day followed by mobilisation of knee as per the pain tolerance of patients.

   Further the patients were made to stand with the help of walker on the non operative side and made to non weight bearing mobilization.

   Patient were instructed not to weight bear early but in older patients (> 70 yrs) we noticed that some of them bore weight early on the operated side without signs of pain and in subsequent follow up there was good clinical and radiological union found.

   In the series of B. Mall179 (30 patients) average time of ambulation was 14 days. In the series of Dr. G.S kulkarni174 ambulation was usually started after 11-12 days after the stitch removal.

   **17. Average time of Fracture Union**

   Average time of union in all our 40 patients was about 16 weeks28,178 (Range: 12 to 20 weeks) There is some controversy regarding criteria for time of fracture union in different studies. Some use radiological while some
use radiological and clinical union.

Assessment of early callus formation at fracture site & its subsequent progress was done with the help of ultrasonography in few cases. This was performed at subsequent intervals of 14th & 28th postoperative days. Neo vascularization & soft callus in early phases & consolidation of callus was noted in follow up ultrasonographic study.

We have used criteria for union as presence of bridging callus at fracture site. Most of the fracture circumference with density similar to adjacent cortical bone. Clinically, absence of pain at fracture site.

**Radiological time of union in other series:**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Series</th>
<th>Radiological union (in weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kevin D. Harrington⁴²</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>Juluru- P. Rao⁴⁰</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>Luis A. Flores⁴⁹</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>B. Mall³</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Present Series</td>
<td>16</td>
</tr>
</tbody>
</table>

18. **Intra operative radiation exposure and Mean blood loss**

In our study, we considered various intraoperative parameters such as duration of radiographic screening-more exposure in case of comminuted fractures with difficult reduction. We took less exposure time in cases of
intertrochanteric fracture where reduction was not a problem by Proximal femoral Nailing (PFN). We took more exposure time for the initial few cases but as we got experience the radiation exposure was less.

Duration of surgery was more for the initially operated cases. More in cases of subtrochanteric fractures when compared to trochanteric fractures and in fractures where we had to do open reduction.

As compared to those peri trochanteric fractures operated by Dynamic Hip Screw, we found out the radiation exposure was definitely lesser as compared to cases operated by Proximal femoral nail. Radiation exposure was needed in placement of guide wire and position of the Richard’s screw. Placement of plate and cortical screw insertion did not need facility of the image intensifier.

Secondly, Blood loss—measured by mop count (each fully soaked mop containing 50ml blood) more blood loss was seen in patients who require open reduction.

As the incisions taken in fractures treated by Proximal femoral nailing(PFN) are small, the mean blood loss was relatively lesser as compared to those treated by Dynamic Hip Screw(DHS). But with meticulous dissection and taking care not to damage the perforator we could get a good exposure even in cases operated by DHS. Thus even in our cases operated by DHS the mean blood loss measured was also comparable to that of PFN.

<table>
<thead>
<tr>
<th>Table – Intraoperative details (PFN)</th>
</tr>
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<tbody>
<tr>
<td>Mean duration of screening(in seconds)</td>
</tr>
</tbody>
</table>

172
Mean duration of operation (in minutes) & Mean blood loss (in milli litres)

<p>| | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>Mean duration of operation</td>
<td>90</td>
</tr>
<tr>
<td>Mean blood loss</td>
<td>120</td>
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**Table – Intraoperative details (DHS)**

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<table>
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<tbody>
<tr>
<td>Mean duration of screening</td>
<td>60</td>
</tr>
<tr>
<td>Mean duration of operation</td>
<td>80</td>
</tr>
<tr>
<td>Mean blood loss</td>
<td>180</td>
</tr>
</tbody>
</table>

**19. Range of Movement (As per Harris Hip Scoring system)**

The range of movement calculated by the Harris Hip Scoring system treated by both the implants i.e. PFN and DHS was good and was almost the same. The range of movements namely flexion, extension, external and internal rotation was good in most cases, excellent in a few. Very few there were poor results. The poor result was attributed to other associated factors namely a long interval between trauma and surgery & development of postoperative infection.

Trochanteric & subtrochanteric fractures are most frequently encountered in orthopaedic practice throughout the world, but they pose big challenge in as far as treatment is concerned. Incidence of these fractures is increased during recent decades due to automobile accidents, rapid industrialization. This is expected to increase due to higher life expectancy & change in life style of population.

These fractures are more commonly seen in elderly people particularly in 5th to 7th decades of life. Common mechanism of injury is trivial trauma due to fall, however in younger patients they are seen
following high energy trauma like Road traffic accident (RTA), fall from height etc. In older patients apart from osteoporosis as major risk factor, anemia, cachexia, cognitive dysfunction, visual impairment, social dependence are some other factors which makes these people more prone for such fractures\(^4\).

As compared to younger people, older population face greater difficulties of immobilization associated with fractures. They are threatened by complications like Decubitus ulcers, hypostatic pneumonia, catheter sepsis, cardio respiratory failure, deep vein thrombosis etc. Risk of such possible complications mandates treatment in the form of internal fixation & early mobilization\(^2,3,4,14,18,116\).

At the outset in 1958, the AO formulated four treatment principles, which were expected to improve the results of fracture treatment in general and of internal fixation in particular (Muller et al, 1982). Some forty years later, it appears timely to evaluate the extent to which these four principles have stood the test of time.

These are as follows:

1) Anatomic reduction: of fracture fragments particularly of joint fractures.

2) Stable internal fixation: designed to fulfill the local biomechnical demands.

3) Preservation of blood supply: to the bone fragments and thv. soft tissue by means of atraumatic surgical technique.
4) Early active pain free mobilisation of muscle and joint: Adjacent to the fracture, preventing the development of fracture disease.

In this context AO-ASIF group from Swiss has made valuable contribution by developing several methods of rigid internal fixation and evolving them into practical instrumentation.

DHS fixation technique is one of such methods that AO-ASIF group have defined, evolved and modified.

Variety of fixation methods are available today for fixation of trochanteric & sub trochanteric fractures. Today, amongst all fixation devices dynamic hip screw(DHS) is most widely used. It’s fixation is widely preferred by most of the orthopaedic surgeons. It is also time tested method\textsuperscript{7,125,149}. Load bearing is possible by these devices due to long lever arm associated with this device\textsuperscript{170}. But even Dynamic hip screw is associated with complications like varus collapse at fracture site, shortening of femoral neck. The fixation of this device also requires extensive tissue dissection so more blood loss during operation is seen, more chances of postoperative wound infection, possibility of implant failure.

To overcome these complications intramedullary devices are developed. They are placed close to mechanical axis of femur, so have short lever arm & they behave as load bearing devices \textsuperscript{2,7,116,170}. Gamma nail is one of the important example of cephalo medullary intramedullary device. This can be used for fixation of intertrochanteric & also subtrochanteric fractures. But there are potential disadvantages of this nail like protrusion of proximal screw & fracture shaft of femur below tip of nail\textsuperscript{7,9}.

Both devices (Extramedullary and Intramedullary) require equipped
operative setup. After closed manual reduction under anesthesia on traction table, the abducted position is maintained for fixation of dynamic hip screw (DHS) on the other hand for proximal femoral nail fixation limb is adducted to facilitate cephalomedullary entry, subsequently limb is made neutral or abducted to negotiate proximal hip screws.

Extramedullary devices (Dynamic hip screw) require long incision which is situated over the region greater trochanter (approximately 8 to 10 cm) while for intramedullary devices incision given is over tip of greater trochanter (approximately 5 to 6 cm). Soft tissue dissection, blood loss is more in extramedullary device fixation as compared to intramedullary device fixation eventually chance of post operative infection is more is extramedullary device fixation.

Dynamic hip screw is amongst most popular extramedullary device. It is time tested, cheap, & familiar treatment modality amongst orthopaedic surgeons.

It works on the principle of controlled concentric collapse of fracture, device is superior to other extramedullary devices which are rigid. The hip screws (DHS), initially introduced by Clawson in 1964, and the implant of choice because of its favorable results and low rate of non-union and failure. 6,111,125

Schumpelick (1955) 189 introduced sliding compression screw plate for trochanteric fracture which was further modified by Callender and in 1960 i.e device was developed independently by Richard's manufacturing company and Mr. Ian Makenzia of Royal National Orthopaedic hospital.

Following are the advantages of DHS :-
1. Screw threads on the hip nail which improves the purchase on the osteoporotic bone.

2. The blunt tip of the screw, which minimizes the chances of head penetration.

3. Sliding feature - to allow for collapse and impaction of the fracture while maintaining the neck - shaft angle and controlling rotation.

4. Groove and key mechanism, which controls rotation and provides additional strength at the nail plate junction.

    Extramedullary devices are placed away from mechanical axis of proximal femur so the moment arm is more in these devices, so tensile stress is more & they behave as load sharing device. Integrity of medial cortical buttress is required for fixation of extramedullary devices.

    Intramedullary devices are placed close to mechanical axis of femur so moment arm is less in them leading to less tensile stress, thus they behave as load bearing devices.²

    **Dynamic Hip Screw (DHS)**
There is provision of placement of single screw (Richard’s screw) in femoral head, which tends to provide controlled concentric collapse at fracture site by the mechanism of sliding of screw within barrel, but if this screw is not placed in centre then chance of implant cut out, rotational instability are more. Similar complications are also seen with first generation cephalomedullary nail (Gamma nail).

In contrary in proximal femoral nail there is provision for insertion of two screws namely the Antirotation screw or hip pin along with lag screw.

This makes implant construct more stable than extramedullary devices & gamma nail\textsuperscript{6,7}. Intramedullary devices are suitable for fixation of intertrochanteric, subtrochanteric fractures. This intramedullary device like the Proximal femoral nail (PFN) can also be used in the fixation of peritrochanteric fractures along with ipsilateral fractures of femoral shaft. However, presence of excessive commuinion fracture site makes use of intramedullary device unsuitable as entry point of nail is through pyriform
Discussion

or tip of greater trochanter as in PFN²,³.

Standard PFN measures 25 mm; it’s slotted throughout its length. There is provision for insertion of distal locking screws. There is absence of abrupt change in architecture of nail, which prevents stress riser effect distal to nail tip prevents low energy fracture below nail tip²,⁴,⁷. In PFN, cephalic screws which should be ideally placed in central & inferior position of femoral head, with tip apex distance less than 25 mm. This reduces chances of implant failure⁶,⁷,¹⁰,¹¹,¹²,²⁰.

A central position of screw is probably optimal for pertrochanteric fractures (Wolfgang et al. 1982)¹⁹⁰. The screw of intramedullary nail proved more likely to go up the central axis of the femoral neck, and to give a better screw position.

This may be because the entry point of the guide wire into the neck is controlled by the position of the nail within the medulla, close to the base of the neck, a point less variable than an entry point on the lateral cortex.
FIG: TIP APEX DISTANCE

**Placement of Screw in DHS:**

Position: The internal fixation device should be placed in that part of the head and neck where quality of bone is best. Placement of screw within the femoral head and neck should be central. It may be placed slightly inferior and posterior but never in the anterior or superior aspect.

Depth of Insertion: The depth to which lag screw is inserted within the femoral head is critical for maximal purchase on the proximal fragment.

Screw should be inserted within 1 cm of subchondral bone for optimum purchase. In cases with osteoporosis deeper placement of Richard screw / lag screw to within 5 mm to 8 mm of subchondral bone is recommended.

Biomechanically stable fixation even in old patients makes this device technically more demanding than extramedullary fixation devices.

Proximal femoral nail (PFN) appears better fixation device than others which are used in treatment of extracapsular fracture neck femur & subtrochanteric femoral fractures due to top presence of following advantages\(^{180}\) which are as follows:

- Biomechanically sound fixation.
• Minimal invasive surgery.
• Load sharing device.
• Less stress riser effect at tip of nail.
• Facilitates early mobilization of patients especially elderly.

This device has some potential disadvantages which are as follows:

• Limited indications (unsuitable in presence of extensive comminution, ipsilateral fracture shaft femur)\textsuperscript{2}
• High learning curve\textsuperscript{10}

   Ideal device for the fixation of trochanteric and subtrochanteric fractures still is controversial.

**Recently introduced new types of nails include:**

1) Proximal femoral nail antirotation (PFNA)
2) Intertan nail
3) Fixion nail
4) Short proximal femoral nail (TFN)
5) Vero nail

These new devices are being used now a days, however literature doesn’t furnish longer series & studies about these devices. Thus these devices have to be yet time tested.

Third generation cephalomedullary nail PFN is developed by AO/ASF in 1997 to overcome the possible complications of second generation nails (Gamma nails)\textsuperscript{181}. Proximal femoral nail has the following advantages over the other fixation devices:
• Addition of 6.4 mm anti rotation screw (Hip pin) helps to reduce the incidence of the implant cut out and rotation of cephalocervical fragment\textsuperscript{121,137}.

• Smaller diameter & fluting tip specially designed to reduce stress forces below the tip of the nail thereby reducing the incidence of low energy fractures at the nail tip\textsuperscript{7}.

• Greater implant length, small valgus angle & location of this angle at higher level.

• More proximal positioning of distal locking to avoid abrupt changes in stiffness of construct reducing stress riser effect.\textsuperscript{7,18,180}

• Entry point through tip of greater trochanter which is easy to identify, requires less tissue dissection, minimum interference with blood supply of femoral head\textsuperscript{2,181}.

• Technique is minimally invasive, so less soft tissue dissection required & it retains fracture hematoma necessary for fracture consolidation.

• Early mobilization of patient is possible\textsuperscript{7,107,108,116,170}

However learning curve associated with this fixation device is longer\textsuperscript{64}. Fracture fixation requires integrity of lateral cortex as entry point is through tip of greater trochanter\textsuperscript{2,28}. Presence of comminution at lateral cortex & fracture site makes use of this device unsuitable\textsuperscript{2}.

But this device is associated with complications such as follow:
Discussion

Z effect -

Werner described this term for the first time. It is a phenomenon of characteristic sliding of proximal screw to opposite direction during postoperative weight bearing.\textsuperscript{18}

Normally vertical forces passing from centre of femoral head tends to move the affected hip into varus position as soon as patient is mobilized. This leads to normal sliding of both proximal screws achieving expected compression at fracture site. Sometimes this sliding occurs only at one of proximal screws while other screw remains at initial position leading to protrusion of femoral head.

Possible explanation of this effect is impaction of hip pin into the proximal hole of nail, while neck (Lag) screw is normally sliding back during weight bearing. Proximal fragment & femoral head are moved back normally but impacted hip pin protrudes through femoral head.

This effect possibly can be avoided by using hip pin 10 mm shorter than lag screw. Then load carried by hip pin is from 8\% to 39\%.

Reverse Z effect -

This effect is described by Boldin\textsuperscript{18}

Movement of hip pin occurs towards the lateral side. Mechanism of this effect is similar to Z effect but here hip pin(Anti rotation screw) slides back, whereas neck screw remains impacted to hole of nail. Lateral sliding of screw is more in proximal femoral nail than Gamma nail because of impaction of fracture.
Good anatomical reduction of fracture, optimal positioning of implant, length of hip pin & lag screw are crucial for good results of proximal femoral nail fixation.

Minimal invasiveness brings about less postoperative pain, reduces the chances of wound infection & enables patient early rehabilitation.

Thus, proximal femoral nail (PFN) satisfies our needs by -

- Minimal invasive surgery.
- No disturbance of primary hematoma at fracture site.
- Biomechanically sound & stable fixation.

Above said things will facilitates -

- Early mobilization & weight bearing.\(^{64,94,111,116,122,170,181}\)
- Less chance of post operative infections.
- Controlled Concentric collapse at fracture site leading to shortening can be minimized or prevented.\(^7,170\)
- It appears a suitable fixation device for advancing age group.
- Less incidence of varus collapse.\(^{110,170}\)

However proximal femoral nail is having some disadvantages like -

- High learning curve.
- Occurrence of ‘Z’ & reverse ‘Z’ effects producing varus collapse, joint penetration implant back out leading to implant failure.\(^{170,180,182,183,184}\)
- Though uncommon incidence of stress riser effect at distal tip of nail producing fracture cannot be overruled.\(^7,170,181\)
- Limited indications due to presence of excessive comminution at
lateral cortex & fracture site.  

Thus numerous modalities are available for treatment of proximal femoral fractures however proximal femoral nail appears to be better treatment modality considering its biomechanical properties.

Technical & Mechanical complications of PFN published in the literature

<table>
<thead>
<tr>
<th>Author</th>
<th>Number of patients</th>
<th>Type of fracture</th>
<th>Technical failures</th>
<th>Cut out</th>
<th>Implant failure</th>
<th>Fracture below tip of nail</th>
<th>Z effect</th>
<th>Reverse z effect</th>
<th>Reoperation rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simmermacher</td>
<td>191</td>
<td>A2(67%)</td>
<td>4.7%</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>#</td>
<td>#</td>
<td>7%</td>
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<tr>
<td>Domingo</td>
<td>295</td>
<td>A2(59%)</td>
<td>12%</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>#</td>
<td>#</td>
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<tr>
<td>Banan</td>
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<td>A2(83%)</td>
<td>8.7%</td>
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<td>1</td>
<td>2</td>
<td>#</td>
<td>#</td>
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<tr>
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<td>-</td>
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<tr>
<td>Werner</td>
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<td>6</td>
<td>-</td>
<td>-</td>
<td>5</td>
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<tr>
<td>Boldin</td>
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<td>A3(62%)</td>
<td>18.7%</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
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<td>Fogagnolo</td>
<td>46</td>
<td>A2(64%)</td>
<td>23.4%</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>#</td>
<td>5</td>
<td>19.1%</td>
</tr>
</tbody>
</table>

Technical & mechanical complications of PFN published in literature (138)

AO fracture classification has been used.

In our present study, the 20 cases treated with Proximal femoral Nail (PFN) where there were 14 intertrochanteric and 6 subtrochanteric fractures.
The included cases were of type I, II, III according to Boyd & Griffin’s classification & Seinsheimer’s classifications. These mentioned classifications are easy to understand, recollect and apply. We found no cases with screw cut out, fracture below the tip of the nail & Z effect. There were 2 cases of reverse Z effect and 1 case of breakage of nail in between proximal screw and distal lock.
SUMMARY

With all the advancement in the field of technology, the road traffic accidents are increasing day by day. With the modern method of treatment and awareness of healthy living, average life expectancy of Indian population has increased almost double fold 35 years to 64 years, resultantly in tremendous increase in osteoporotic population and osteoporotic fractures. Increasing life expectancy, sedentary life style and increasing traffic on road, busy life style, lack of observing traffic rule result remarkable increase incidence of fractures. Trochanteric & sub trochanteric fractures are most frequently encountered fractures by orthopedic surgeons worldwide. The incidence of femur fractures is more than other of all fractures, proximal femoral fracture contribute higher in percentage.

Before the invention of operative treatment conservative treatment in the form of prolonged traction was preferred, however this treatment was associated with complications like bed sores, deep vein thrombosis, bronchopneumonia. Elderly people could not tolerate prolonged immobilization. This led to invention of evolution of operative treatment.

Intertrochanteric fractures of femur by Virtue of their great potential for union, regardless of the mode of treatment failed to draw the attention of early authors for many years. Once the impact of these injuries on the social and economic fronts was recognized, much has been published, both on the different methods of internal fixation as well as on the outcome and complications of these fractures.

Operative treatment permitted fixation of fracture, not only anatomical or in near anatomical position but also allowed rapid mobilization. Since 20th century numerous operative treatment modalities
have been evolved like Smith Peterson nail (S.P Nail), Jewett nail, Enders nail, Asnis screw, Medoffs plate etc. amongst them Dynamic hip screw (DHS) is most frequently used device.

Proximal femoral nail has been recently introduced in 1996 by AO/ASIF has began to compete with Dynamic hip screw in treatment of proximal femoral fractures. This intramedullary device has following advantages

1) Addition of 6.4mm antirotation screw.
2) Greater implant length.
3) Small valgus angle of 6 degrees.
4) Small diameter with flutting tip reducing stress riser effect below distal tip of nail
5) More proximal positioning of distal lock to avoid abrupt changes in stiffness of implant constructs.

Our present study was conducted in the Department of Orthopaedics, Rural Hospital, Pravara Institute of Medical Sciences (PIMS) Loni, District Ahmednagar during the period between July 2009 and July 2011.

Forty patients of trochanteric fractures managed operatively by internal fixation with Dynamic Hip Screw and Proximal Femoral Nail during the course of the study were sorted and each was followed for at least 6 months.

Follow up of all patients in both groups were carried out regularly with clinical and radiological assessment at successful visits till the patients achieved maximum possible functions of the injured limb. The data thus collected from patients of these two groups was analysed, evaluated,
compared with each other and the observations can be summarized as follows-

1. **Age:** There is no significant in age distribution in two groups. Most of the cases belongs to age group between 50-60 years. Mean age in years for group operated by PFN = 56.5. Mean age in years for group operated by DHS = 58.5. Mean age in years both groups combined = 57.5

2. **Sex:** There was a male preponderance in our patients. A male to female ratio was about 2:1. There were 15 males cases and 5 female cases operated by PFN, while there were 12 male cases and 8 female cases operated by DHS.

3. **Mode of Injury:** Most common mode of injury in young patients is the road traffic accident while most common mode of injury in older patients is the simple fall (Domestic fall). Just 1 case of assault was witnessed in the case operated by PFN.

   Majority of mode of Injury was simple fall (Domestic fall) followed by road traffic accident (RTA).

4. **Type of fractures:** In the study, we have 14(70%) intertrochanteric fractures with variable degree of comminution, 6(30%) cases were of subtrochanteric fractures which were treated by PFN.

   Out of 14 intertrochanteric fractures amongst 20 cases majority i.e. 8 cases were of unstable fracture pattern.

   While 16(80%) of intertrochanteric fractures and 4(20%) of subtrochanteric fractures were treated by DHS.
5. **Side of the fracture:** Amongst the 20 cases operated by PFN, 12 (60%) patients were found to have proximal femoral fractures on the left side while 8 (4%) patients were having fracture on the right side.

Amongst the 20 cases operated by DHS, 9 (45%) patients were found to have proximal femoral fractures on the left side while 11 (55%) patients were having fracture on the right side.

6. **Majority of patients** in present study series were operated within 10 days following admission in hospital (30/40). But in some patients (10/40) operative procedure was delayed due to medical problems (Hypertension and Diabetes) and financial constraints of patients. Average time lapse for surgery: 7.25 days. Amongst patients who had a delay in operative intervention two patients came to hospital following 10 days of trauma.

7. **In associated injuries,** 3 patients had associated injuries amongst 20 patients operated by PFN, out of which 2 patients were having fractures of distal end radius and one patient had ipsilateral fracture calcaneum. Two patients with fracture distal end radius on contralateral side were treated in same operative setting by closed manipulation reduction and followed by cast application. While one patient with ipsilateral fracture calcaneum was treated by open reduction and internal fixation (ORIF) with reconstruction plating.

There were no patients with head injury, blunt abdominal, blunt chest injury. There were no patients with ipsilateral fracture shaft femur in the patients treated by PFN. While in the patients operated
by DHS, 2 patients were found to have head injury for relevant CT Brain was advised and done accordingly. There was no major findings on CT scan except cerebral edema. Two cases of ipsilateral distal end radius fractures were present for which Open reduction and internal fixation by buttress plating (Ellis) was done in the same sitting.

8. **Average length of Nail used and average size of Barrel plate**: The PFN nail used used of uniform length of 25mm. The average barrel plate used in DHS was 135° 4 holed plate.

9. **Diameter of the nail** in PFN were from 9mm to 12mm. In four cases we have used nail of diameter 9mm, In 15 cases nail of 10 mm diameter while in one case nail of 11mm diameter was used.

10. **Length of proximal screws used**: In PFN, the lag screw in range of 75mm to 115mm. Amongst them, in 3 cases (15%) we have used 75mm screw, in 2 cases (10%) we have used 80mm screw, in 8 cases (40%) we have used 85mm screw, 4 cases (20%) 90mm screw and in 3 cases (15%) we have used 95mm screw.

11. **Anti rotation screw or hip pin screw** was used in range of 65-80 mm dimensions. In 3 cases (15%) we used screw of 65mm, in 2 cases (10%) 70mm, in 8 cases (40%) 75mm and in 7 cases (35%) 80mm screws were used.

While in DHS, Length of Richard’s screw (Lag Screw) used in DHS were in the range of 65 mm to 95 mm length. Amongst them, 1 case (5%) 65 mm screw was used, 2 cases (10%) 70 mm screw was
used, 2 cases (10%) 75mm screw was used, in 7 cases (35%) 80 mm screw, in 5 cases (25%) 85mm screw, in 2 cases (10%) 90 mm screw while n 1 cases (5%) 95 mm lag screw was used.

12. **Systemic complications:** In both the groups i.e. PFN as well as DHS, one patient in each group was found to have chest infection while in other patient we found complication of urinary tract infection (UTI). The patients with chest infection were known case of COPD, as they were chronic bidi smoker.

13. **Wound complications:** Superficial wound infection was seen in 3 cases in total. 1 case in patient operated by PFN while 2 cases were seen in those operated by DHS. **This was perhaps attributed to low immunity status of patient as the patient was of asthenic built and belonging to low socioeconomic status & more soft tissue exposure, which is more in cases operated by DHS.**

14. **Implant related intraoperative complications:** In 4 cases (20%) operated cases by Proximal Femoral Nailing (PFN), there was ill fitting of jig. Due to the corresponding holes of jig and nail was not matching at times the position of the proximal screws was a problem. While in the cases operated by Dynamic Hip Screw (DHS) there was 1 case (5%) in which we encountered difficulty in reduction. This was due to delay in surgery as the patient presented late and also had co morbid condition (Diabetes). The other complication seen in one case (5%) was that of shattering of the lateral cortex while doing proximal reaming (triple reamer).
15. **Rotational malalignment:** External rotation of 15° was noticed in one case (5%) operated by Proximal femoral Nail (PFN).

Varus deformity was noted in one case (5%). It might be seen due to early backing out of screws. In one case (5%) operated by PFN, there was shortening of one centimeter which was not significant functionally for the patient.

2 cases (10%) of varus deformity was seen in the cases operated by DHS. This could be due to the pull of the muscle the distal shaft fragment has the tendency to migrate upwards thus resulting in varus deformity.

3 Cases (15%) of shortening seen in the cases operated by DHS. This shortening ranged from 1-1.5 cms. Patients were given shoe raise which compensated for the necessary shortening. Patients did not have any difficulty later while walking.

16. **Radiological complications:** Among the cases that we operated by Proximal Femoral Nail (PFN) there were no cases with ‘Z’ effect, while in two cases (10%) of reverse ‘Z’ effect. In one case (5%), nail was broken at site in between proximal screws & distal lock. In one case (5%) which was operated by DHS, it was seen that there was excessive back out of the Richard’s screw (lag screw).

17. **Period of Hospitalisation:** Average time for which patient was admitted in hospital was 21 days i.e. 3 Weeks.
18. **Mobilization**: We found the mobilization of patients operated by both PFN and DHS was almost same but the weight bearing of patients from the PFN group was earlier.

19. **Average time of Fracture Union**: Average time of union in all our 40 patients was about 16 weeks. (Range: 12 to 20 weeks)

20. **Assessment of early callus formation** at fracture site & its subsequent progress was done with the help of ultrasonography in all cases. This was performed at subsequent intervals of 14th & 28th postoperative days.

21. **Intra operative radiation exposure and Mean blood loss**: There is comparatively less blood loss in patients managed by proximal femoral nail as compared to patients of Dynamic Hip Screw group. The mean blood loss in PFN group was 120 milli litres of blood while as compared to the mean blood loss in DHS group it was 180 milli litres.

22. The **average time of screening** by image intensifier was significantly lesser in cases operated by DHS as compared to those operated by PFN. Mean duration of screening was lesser due to the bigger exposure and visual placement of the guide wire in DHS. The screening time was more in PFN during the proximal screws placement.

23. **Range of Movement** (As per Harris Hip Scoring system) The range of motions that is flexion, abduction, internal and external rotations were good to excellent in most of the cases operated by
both the devices. We had on an average 70% good range of motion in all the patients. The fair to poor range of motion was attributed to the poor compliance of the patients for regular physiotherapy and also in some cases due poor reduction achieved at the time of surgery, thus not getting the best possible result.
CONCLUSION

In the present study which was carried out in Rural hospital, Pravara institute of medical sciences(PIMS), Loni district Ahmednagar from July 2009 to July 2011. 40 patients of Proximal femoral fractures (Intertrochanteric & subtrochanteric) were included. There were 20 patients operated by Proximal femoral Nail (PFN) and 20 patients operated by Dynamic hip screw (DHS).

In the study we aimed to evaluate whether these theoretical advantages could be proved in practice, by a comparison of the results of Proximal Femoral Nail (PFN) and Dynamic Hip Screw (DHS) implants.

1. The claimed advantage with Proximal femoral nail is that a smaller exposure is required than for a sliding screw, it may therefore be associated with lesser blood loss, shorter operating time and less morbidity. (minimizes the jeopardy to the vascularity)

2. There may also be mechanical advantages, because the shaft fixation is nearer to the centre of rotation of the hip, giving a shorter lever arm and a lower bending movement on the device (Kaufer, 1980)\textsuperscript{185}. It gives a biomechanically sound fixation.

3. In osteoporotic bones Proximal femoral nail fixation carries definitive advantage over Dynamic Hip Screw fixation devices.

4. Malrotation and deformity after trochanteric fracture fixation is usually a result of improper fixation of fracture fragments in rotation at time of surgery. In fractures managed by closed intramedullary nailing, incidence of malrotation & deformity is found to be lower.

5. In our study, we found that Proximal femoral nails prove to be more
useful in **difficult fractures** with a **subtrochanteric extension** or **reversed obliquity** and for high subtrochanteric fractures.

6. The **rotational stability** was higher when Proximal femoral nail is used in these fractures.

7. The incidence of **wound infection** was found to be lower with intramedullary implants which resulted in early ambulation of the patients.

8. A **central position of screw** is probably optimal for pertrochanteric fractures. We found that screw of Proximal Femoral Nail proved more likely to go up the **central axis** of the femoral neck. This is in coherence with findings of previous studies.

9. **Non-union** of trochanteric fracture although is a rare entity but most of non-unions follow unsuccessful operative stabilization with subsequent **varus collapse** and **screw cut out** through femoral head or due to an osseous gap secondary to inadequate fracture impaction. However, no case was found in our series of patients.

10. In our study, the **mean blood loss** was comparatively **less** in patients managed by Proximal Femoral Nail fixation as compared to the Dynamic Hip Screw fixation.

11. We did **not** encounter any **secondary femoral fracture** in patients managed by proximal femoral nails though this is one of common complication reported in some previous studies.

12. The fractures which were **severely comminuted** where treated better with the Dynamic Hip Screw(DHS) device as compared to Proximal femoral nail(PFN).
13. The learning curve for the treatment of fractures by Dynamic Hip Screw was smaller as compared to Proximal Femoral Nail.

14. The screening time with the help of image intensifier was much lesser in the cases operated by Dynamic hip screw (DHS) as compared to cases operated by Proximal femoral nail (PFN).

15. The implant related complications were much lesser in the patients treated with Dynamic Hip Screw (DHS).

16. Operative management which allows early rehabilitation and offers to the patient the best chances for functional recovery is the treatment of choice for virtually all trochanteric fractures. The preferred type of implant is still a matter of debate.

17. However, the rate of union was similar in two groups (PFN & DHS). Both the implants in their own right are excellent modalities in the management of pertrochanteric fractures of the femur.
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PERFORMA

• Name of the patient :-
• Age of the patient :-
• Sex of the patient :-
• Date of admission :-
• Date of operation :-
• Date of discharge :-
• Complaints of patient :-

• History of present illness :-

• Past history of patient :-

• Family history of the patient: -
• Personal history of the patient :-

EXAMINATION:

General examination:-

• Systemic examination :-
  • Respiratory system
Types of Reduction

- Cardiovascular system
- Central nervous system
- Per abdominal system

- **Local examination**
  - Inspection
  - Palpation

- **Investigations**
  - Routine investigations
  - Special investigations
    - X-ray
    - USG scan
    - CT scan

- **Surgical procedure**: -
  - Proximal femoral nail fixation
  - Dynamic Hip screw fixation

- **Post operative follow-up**

- **Follow up after discharge**
  - One month after discharge
  - Two months after discharge
  - Three months after discharge
  - Six months after discharge
KEY WORDS

IT  -  Intertrochanteric
ST -  Subtrochanteric
S  -  Stable
U  -  Unstable
CMR -  Closed manipulative reduction
ORIF -  Open reduction and internal fixation
AP -  Anteroposterior
Lat -  Lateral
PBH -  Pelvis with both hips
DHS -  Dynamic Hip Screw
PFN -  Proximal Femoral Nail
SLRT -  Straight Leg Raising Test

SIDE OF INJURY

R  -  Right
L  -  Left
### SYSTEMIC AND GENERAL COMPLICATIONS

<table>
<thead>
<tr>
<th>S1</th>
<th>- Death</th>
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<tr>
<td>S2</td>
<td>- Chest infection</td>
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<tr>
<td>S3</td>
<td>- Pulmonary embolism</td>
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<td>- Respiratory tract infection</td>
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<td>S6</td>
<td>- Deep vein thrombosis</td>
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<td>S7</td>
<td>- Superficial wound infection</td>
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<td>- Deep wound infection</td>
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### RADIOLOGICAL COMPLICATIONS

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<tr>
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<th>- Cut out of neck screw</th>
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<tr>
<td>B</td>
<td>- Z - Effect</td>
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<tr>
<td>C</td>
<td>- Reverse Z Effect</td>
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<tr>
<td>D</td>
<td>- Nail breakage</td>
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<tr>
<td>E</td>
<td>- Bolt breakage</td>
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<td>F</td>
<td>- Excessive lag screw back out</td>
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<tr>
<td>G</td>
<td>- Plate breakage</td>
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<tr>
<td>H</td>
<td>- Cortical screw loosening</td>
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</tbody>
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Types of Reduction

I - Cortical screw breakage/ bending

MODE OF TRAUMA

X - Road traffic accident (RTA)

Y - Domestic Fall

Z - Assault