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Intramedullary Interlocking Nailing Versus Fixed Angle Blade Plating for Subtrochanteric Femoral Fractures

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Abstract: Background: subtrochanteric Fractures of proximal third of the femur are a major cause of morbidity and mortality in patients with lower extremity injuries. Most fractures are sustained in young adults during high velocity injuries. **Patients and Methods:** Twenty four patients with subtrochanteric fracture were treated in Al– Karkh Hospital .Baghdad between October 2017 to September 2018. Twelve patients had been treated with open reduction and internal fixation using a fixed angle blade plate were matched to twelve patients treated with standard IM nailing, with regard to gender, age decade, and the Russell-Taylor classification of the fracture. **Results:** Four patients treated with ORIF versus only one patients treated with IM nailing had a revision surgery. Furthermore, we found significant difference with regard to time to union, non-union, implant failure or fracture between ORIF and IM nailing. Our results suggest that the rate of revision surgery is higher with ORIF using fixed angle blade plate for subtrochanteric femoral fractures. **Conclusions:** With the respect of two choices of implants for the fixation of subtrochanteric fracture of the femur, Internal fixation using a fixed angle blade plate for subtrochanteric femoral fractures has higher implant failure and revision rate, compared to closed intramedullary nailing.

Keywords:. subtrochanteric fractures, closed standard Intramedullary interlocking nailing, ORIF, fixed angle blade plating.

INTRODUCTION

The femur is the largest, strongest bone in the body and is enveloped by a thick mass of muscle .The femoral shaft is defined as the diaphyseal portion of the bone, which extends from below the lesser trochanter to above the metaphyseal portion of the distal femur.[Jay, R. *et al*., 2009] Fractures occurring in the area between the lesser trochanter and the isthmus of the femoral canal are considered subtrochanteric fractures. These fractures also have been described as those occurring within the first 5 cm distal to the lesser trochanter.[Canale. & Beaty, 2012]**, figure (1)** .. Subtrochanteric fractures are femoral fractures where the fractures occur below the lesser trochanter to 5 cm distally in the shaft of the femur. These fractures are the most difficult to manage in the femur.[Rockwood, R. W]

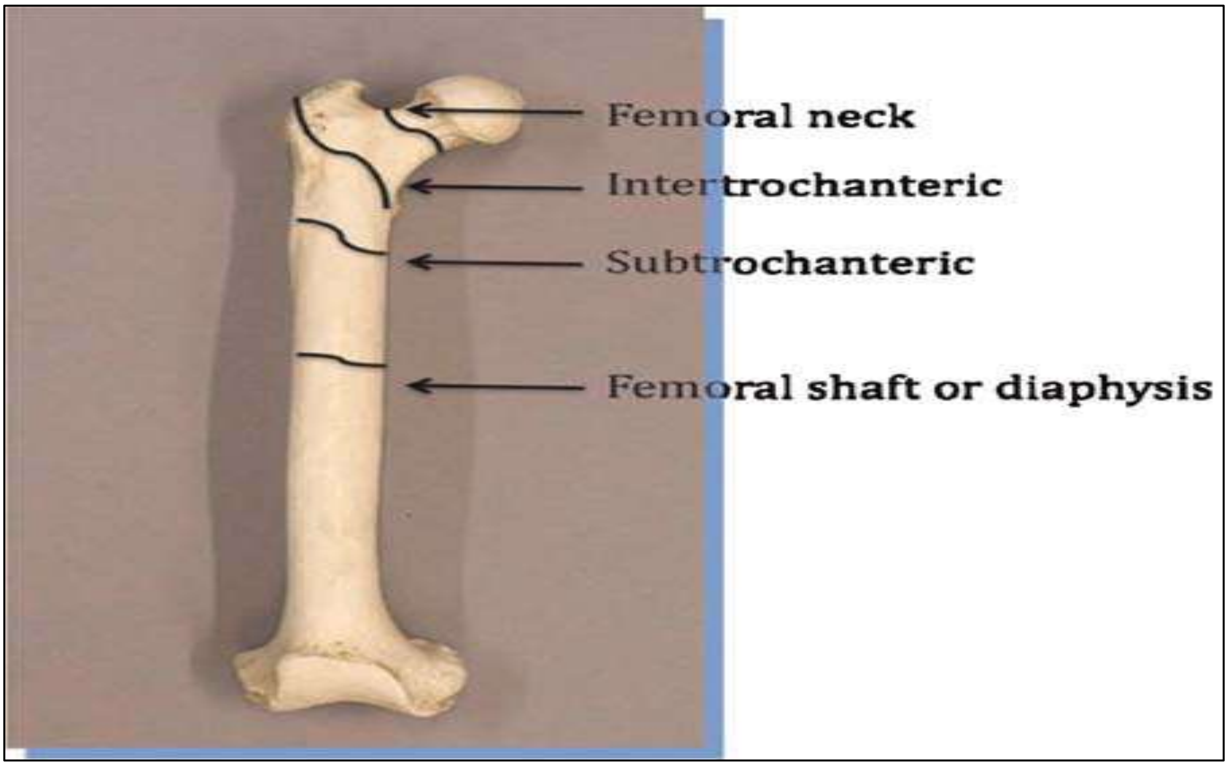

FIGURE 1: Locations of common hip and femur fractures.

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Subtrochanteric femoral fractures are common and account for 7 to 44% of all proximal femoral fractures, depending on the classification used.[Sims, S. H, 2002] A bimodal age distribution is noted where young patients (usually male) mostly present with high-energy injuries, and the elderly (usually female) present with osteoporotic low-energy fractures. [Velasco, R. U, 1978] Such fractures are associated with high complication rates, and include non-union and implant failure, which occur regardless of the fixation method, because of the unique anatomical and biomechanical features of the subtrochanter..[Gray, H, 1985] In addition to the anatomical location, subtrochanteric fractures are unique in their fracture characteristics. The fractures occur typically at the junction between trabecular bone and cortical bone where the mechanical stress across the junction is highest in the femur. This explains the frequent fracture comminution in this region, due to both the material property changes and the mechanical environment. [Rockwood, R. W]

Its cortex is thinner than the rest of the femoral shaft; it starts with the cancellous bone at the distal end of the intertrochanteric region and extends into the thick cortical bone of the proximal diaphysis. [Sofield, H. A, 1951] High compressive medial stresses and tensile lateral stresses were placed on fracture fixation devices..[Koch, J. C, 1917] The healing of the fracture is also special, as the high-energy trauma induces more vascular insults to the bone. The various muscle attachments in this region also cause marked displacement..[Rockwood, R. W] In the 1970s and 1980s, internal fixation was the standard treatment for femoral fractures, whereas open anatomic reduction and internal fixation with fixed angle blade plates was recommended for subtrochanteric fractures..[Asher, M. A. *et al*., 1976]

Plating is still recommended for fractures with proximal trochanteric extension, especially when medial cortical contact can be restored. Intramedullary nailing to incorporate fixation of the femoral neck and head has advantages, namely shorter operating times and less blood loss, as well as lower rates of infection, non-union, and implant failure.[van Doorn, R] Improvements in interlocking intramedullary nail design have allowed the technique to become our treatment of choice for nearly all femoral shaft fractures from the lesser trochanter to the femoral condyles. [Canale. & Beaty, 2012]

The history of intramedullary nailing

The history of intramedullary nailing for the treatment of long bone fractures is long and storied. Although intramedullary nailing is now the standard of care for the treatment of most diaphyseal fractures of long bone, introduction of the technique was met with a great deal of skepticism in both Europe and North America during the first half of the 20th century . In the latter half of the 20th century, intramedullary nailing of long bone fractures revolutionized the care of the multiply injured patient. **figure-(2)** .[Krettek, C, 1999]. Bernardino de Sahagun, a 16th century anthropologist, recorded the first account of the use of an intramedullary device . [Megas, P. *et al*., 2003].

Smith-Petersen's 1931 report of the successful use of stainless steel nails for the treatment of femoral shaft fractures . [Milner, S. A, 1997].The beginnings of intramedullary nailing of proximal femoral fractures are connected with the names of G. Küntscher and R. Maatz. In 1940, just after successfully introducing intramedullary nailing of femoral shaft fractures, Küntscher developed a conical nail for treatment of high subtrochanteric fractures..[Waddell, J.P. *et al*., 2011] Kuntscher first reported use of the V-shaped nail in 1940 and proposed the nail would act as an internal splint, rigid or semiflexible device for the immobilization of displaced or fractured parts of the body. [AO Trauma, 2010]. During the 1950s, two important techniques were developed and introduced the first use of intramedullary reamers to increase the contact area between the nail and host bone with the hope of improving stability of the fracture and the application of interlocking screws to enhance stability of the construct. [AO Trauma, 2010]. During the 1990s, the major advancements came with the expansion of indications for unreamed and reamed intramedullary nailing. Likewise, open femur fractures that previously were managed with unreamed nails, were now being treated with reamed nails. In addition, very proximal and distal tibia and femur fractures, once thought to be unsuitable for nailing, were benefiting from intramedullary fixation. Design achievements of the 1990s included the introduction of new titanium nails, cephalomedullary devices such as the Gamma nail, and retrograde supracondylar intramedullary nails. [AO Trauma, 2010]. While today's experience with intramedullary fixation for femur fractures has been quite good, there will

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most certainly be continued research to improve the technique.

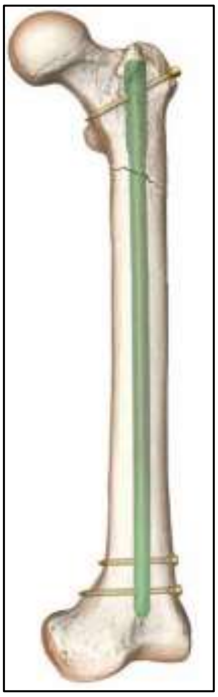

Figure-(2): Intramedullary interlocking nailing.[50]

1:3. The history of 95-degree fixed angle blade plate and screw fixation

In the early days of surgical fracture treatment, Jewett and McLaughlin nail plates were used for subtrochanteric fractures, with limited success and failure rates of up to 65%.[Waddell, J.P. *et al*., 2011] The AO-condylar plate, prefixed at an angle of 95 degrees, was one of the first implants for open reduction and internal fixation; results were significantly better than with conservative treatment.[Waddell, J.P. *et al*., 2011] However, because of iatrogenic devascularization, mainly of the posteromedial area for anatomic reduction, reduction under compression, and attempts to achieve absolute stability, the rate of complications such as nonunion, infection, and hardware failure was reported to be up to 20% in some series.[Waddell, J.P. *et al*., 2011] Results improved significantly once the surgical approach was modified to a more biologic indirect reduction technique that respected soft tissue and vascular integrity. Hence, the95-degree plate has its indications in situations in which intramedullary devices cannot be used safely. [Waddell, J.P. *et al*., 2011] Plate fixation with a fixed-angle device such as a blade plate or a dynamic condylar screw can be used on all subtrochanteric femur fractures regardless of location, but the open nature of the technique and the associated blood loss make its practical use limited to the most proximal fractures .The surgical approach is a direct lateral approach to the proximal femur. Dissection of the medial fragments during fracture reduction should be avoided because of the relatively high rate of nonunion (30%) with excessive periosteal dissection. Fixed-angle plates are load-bearing devices **Figure-(3)**, and early weight bearing should be avoided.[Jay, R. *et al*., 2009]

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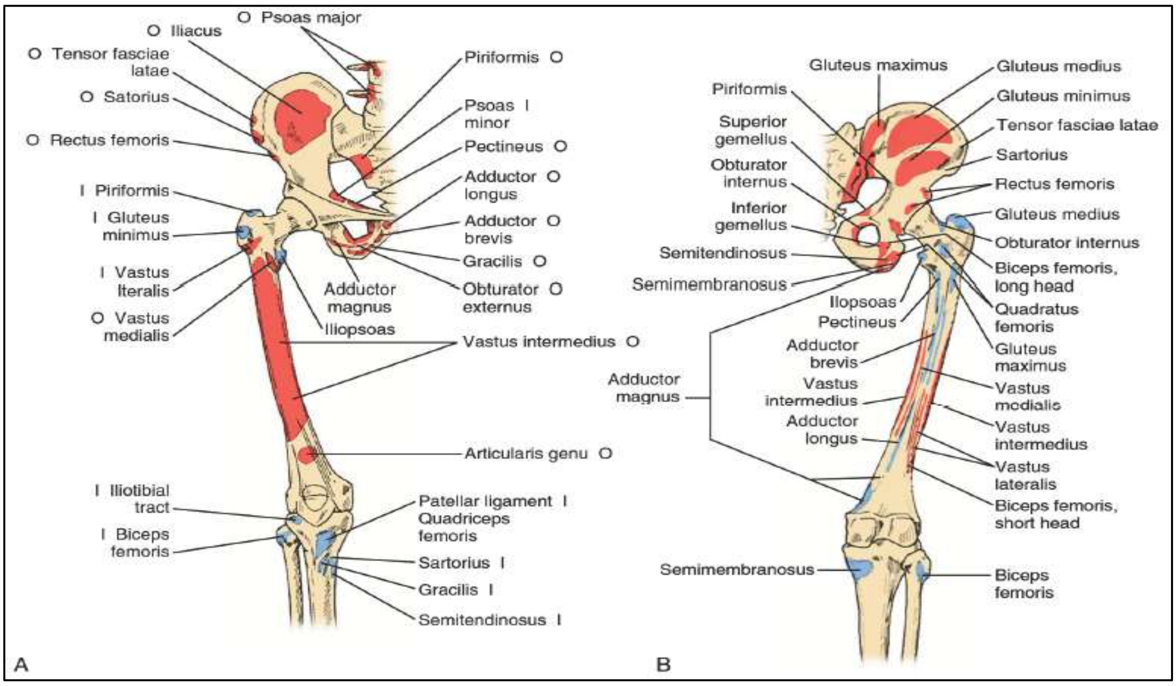
Figure-(3): 95 -Fixed angle blade plate..[Magee, D. J. *et al*., 2011]

Surgical anatomy of the femur

The femur is the largest bone of the body. The neck–shaft angle averages approximately 127 degrees, although it begins at 141 degrees in the fetus. The anteversion varies from 1 to 40 degrees but averages 14 degrees. The femur has an anterior bow. There are two femoral condyles; the medial condyle is larger. The more prominent medial epicondyle supports the adductor tubercle..[Shuler, F.D] **figure-(4).**



FIGURE–4: Origins and insertions of muscles of the hip and leg. A, Anterior view. B, Posterior view. O, origin (red areas). I, insertion (blue areas). Anatomy,II. Thigh.Review of Orthopaedics 2012.sixth Edition.[Shuler, F.D]

The circumflex femoral arteries encircle the uppermost shaft of the femur and anastomose with each other and other arteries, supplying the thigh muscles and the superior (proximal) end of the femur. The medial circumflex femoral artery is especially important because it supplies most of the blood to the head and the neck of the femur via its branches, the posterior retinacular arteries[Shuler, F.D]. **figure-(5).** The lateral circumflex femoral artery, less able to supply the femoral head and neck as it passes laterally across the thickest part of the joint capsule of the hip joint, mainly supplies muscles on the lateral side of the thigh.[Moore, K.L. *et al*., 2006] **figure-(5).**

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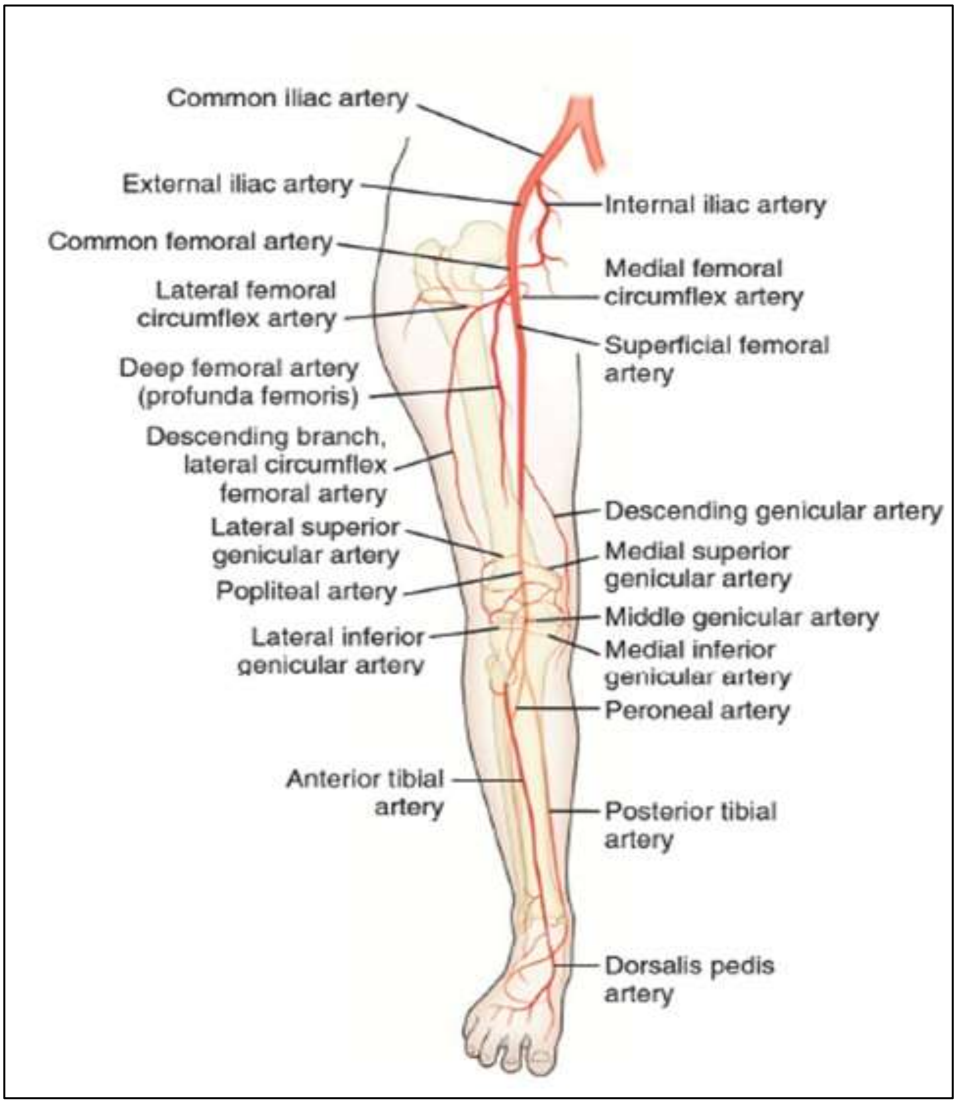

FIGURE 5: vessels of the lower extremity, Anterior view.Anatomy, II. Thigh,Review of Orthopaedics 2012.sixth Edition.p189.[Shuler, F.D].

Deforming forces after a fracture

Understanding the deforming forces (**Figure-6**) is extremely important in avoiding the typical malalignments and malunions associated with subtrochanteric femoral fractures..[Canale. & Beaty, 2012]

a. The abductors—gluteus medius and minimus—insert on the greater trochanter and abduct the proximal segment.
b. The iliopsoas inserts on the lesser trochanter and flexes the proximal fragment.
c. The adductor longus, adductor brevis, gracilis, and adductor magnus have a broad area of insertion on the distal femur and contribute to a varus force on the distal segment. [Jay, R. *et al*., 2009]

The deforming forces involved in subtrochanteric fractures of the femur are significant; obtaining and maintaining an adequate reduction in subtrochanteric fractures while performing internal fixation can be difficult. Malunion in the form of varus and proximal fragment flexion is not uncommon. Nonunion is associated with fracture comminution and excessive dissection in the area of the medial femur. Supplemental bone grafting is recommended when medial dissection is performed.[Jay, R. *et al*., 2009]

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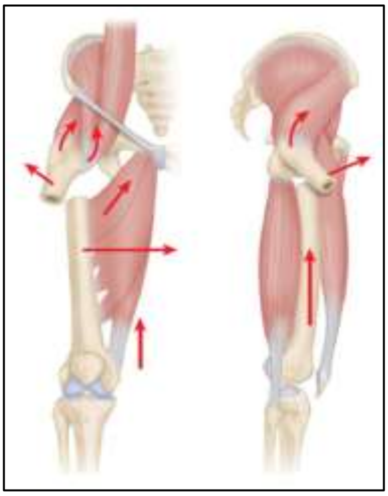

Figure-(6): Deforming forces acting on subtrochanteric femoral fracture.Campbell's Operative Orthopedics, 12th edition, 2012. [Canale. & Beaty, 2012].

CLINICAL EVALUATION

Subtrochanteric fractures are high-energy injuries, and associated major organ and skeletal injuries should be looked for. Significant haemorrhage may occur into the thigh, and frequently these patients are haemodynamically unstable. The fracture must be splinted immediately and early definitive fixation should be performed to limit further soft-tissue damage and haemorrhage..[Sivananthan, S. *et al*., 2012]

RADIOLOGICAL EVALUATION

Standard anteroposterior and lateral radiographs are adequate to evaluate fracture morphology and plan treatment.The hip and knee joints should also be included in the study.[Sivananthan, S. *et al*., 2012] The length of the proximal fragment and the diameter of the diaphysis distally should be evaluated. If there is any concern about fracture extension into the piriformis fossa or the greater trochanter, a computed tomographic scan can be obtained, or if one was obtained during the trauma workup, it can be reviewed for any proximal fracture lines.[Rockwood, R. W]

Classifications of Subtrochanteric fractures

There are a number of classifications for subtrochanteric fractures. Based on the pathoanatomy and the fracture mechanics, the medial cortical support and the fracture stability determine management outcome. To a certain extent, they also affect the choice of management for these difficult fractures. An ideal fracture classification should be able to guide the treatment plan, indicate prognosis and the complications that may occur, and aid in communication and facilitate documentation.[Rockwood, R. W]

Russell-Taylor

a. The Russell-Taylor classification system divides subtrochanteric fractures into four types, based on the involvement of the lesser trochanter and the piriformis fossa (**Figure 7**).
b. This system provides guidance for treatment: whether to treat the fracture with a nail, the type of nail to use, and when nailing should be avoided.[Jay, R. *et al*., 2009]

Type I: Fractures do not extend into piriformis fossa:
Type IA: Lesser trochanter is attached to the proximal fragment
Type IB: Lesser trochanter is detached from the proximal fragment
Type II: Fractures that extend into the piriformis fossa:
Type IIA: No significant comminution or fracture of lesser trochanter
Type IIB: Significant comminution of the medial femoral cortex and loss of continuity of lesser trochanter. .[Mostofi, S. B, 2006]

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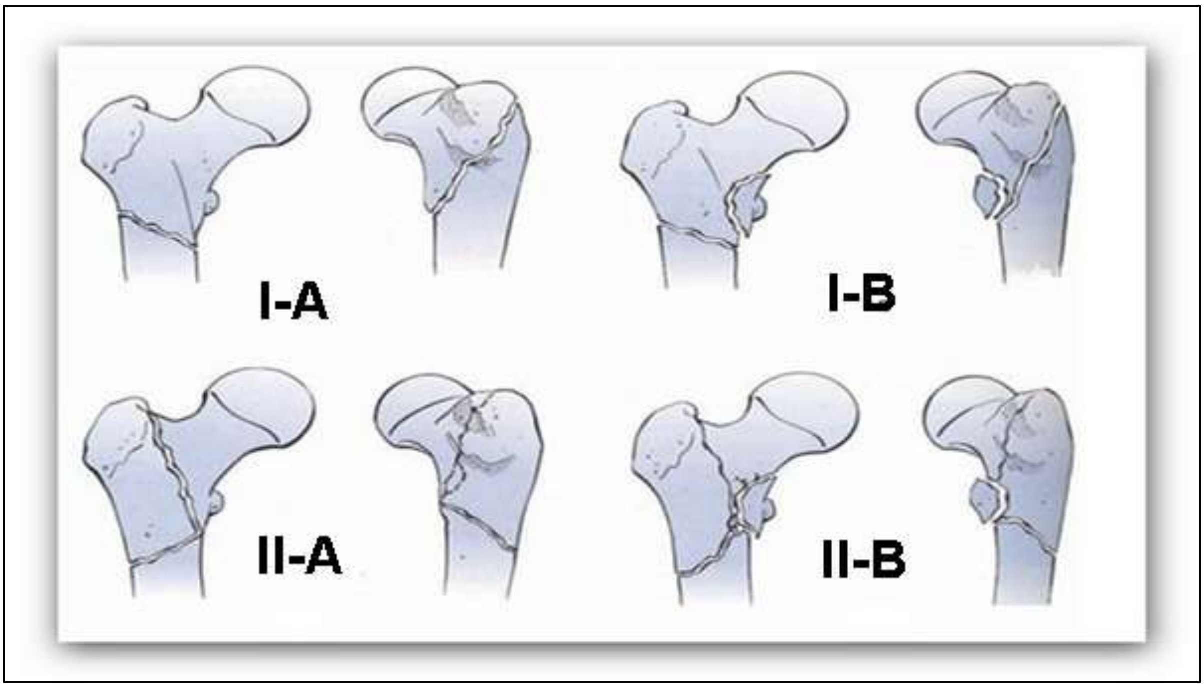

Figure 7: Russell-Taylor classification of subtrochanteric fractures.

AAOS Comprehensive Orthopaedic Review.2009.
The American Academy of Orthopaedic Surgeons.[Jay, R. *et al*., 2009]
Fielding Classification

Based on the location of the primary fracture line in relation to the lesser trochanter. [Mostofi, S. B, 2006] **(Figure -8).**

Type I: At level of the lesser trochanter
Type II: <2.5 cm below the lesser trochanter
Type III: 2.5cm to 5cm below the lesser trochanter

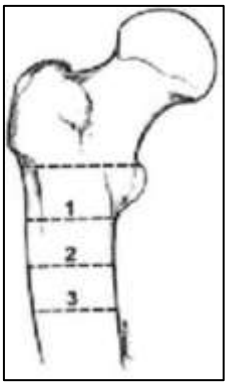

Figure -8: Fielding classification of subtrochanteric fractures.[Mostofi, 2006]

AO/OTA Classification
The AO classification (**Figure -9**) is a descriptive classification based on the fracture configuration. The OTA classification(**Figure -10**) is a very similar classification to AO, and the subtrochanteric fractures are more clearly depicted. The last numeric symbol indicates the subtrochanteric region, and its code will be 32-(X-#)-1[Rockwood, R. W]

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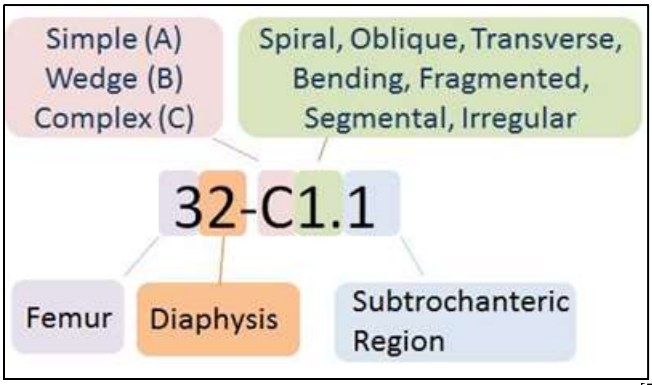

Figure -9: AO. Classification subtrochanteric fractures.[51]

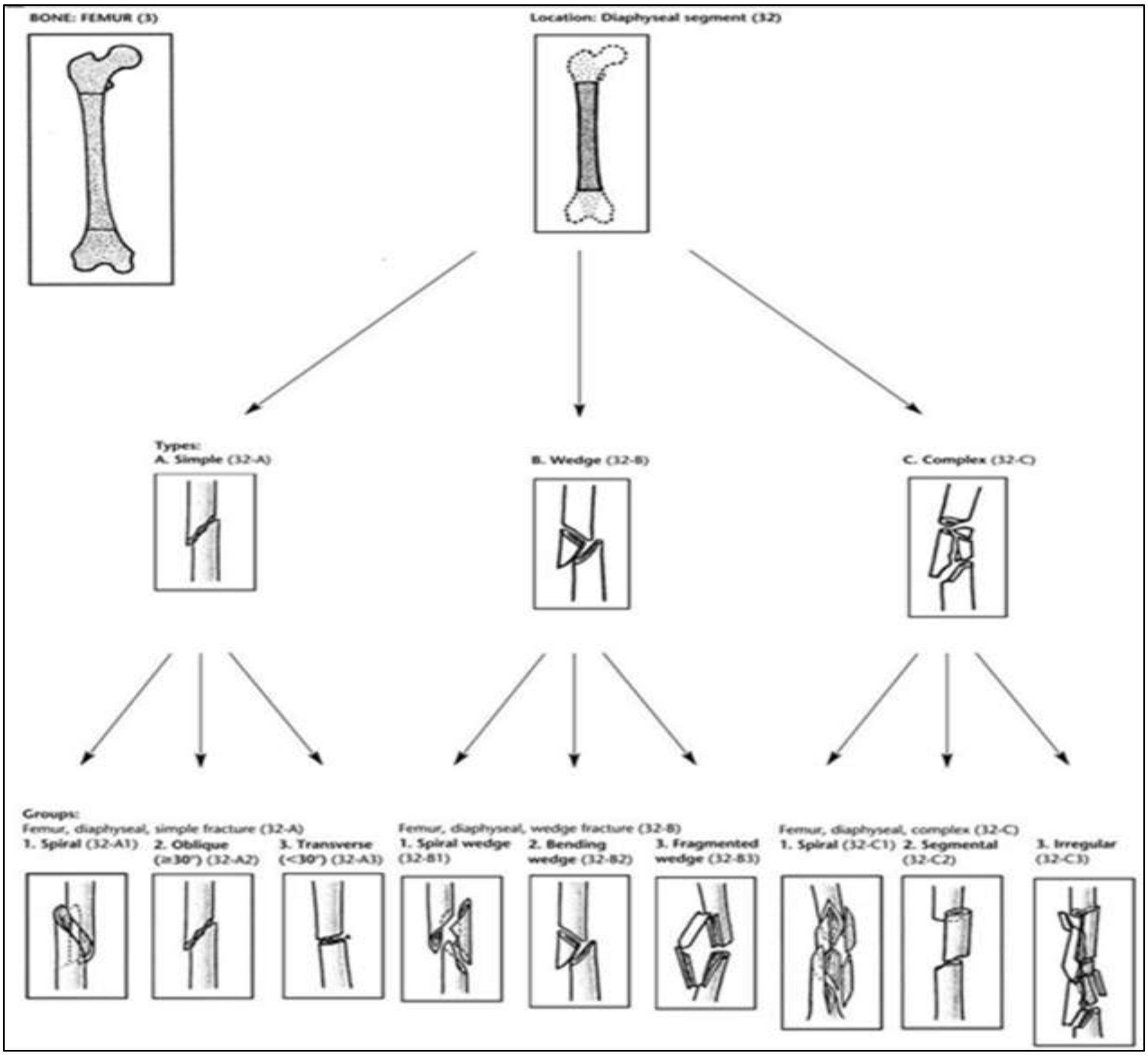

Figure -10: The Orthopaedic Trauma Association OTA classification of femoral shaft fractures. Type A fractures are simple fractures, type B are wedge fractures, and type C are complex fractures.[Jay, R. *et al*., 2009]

Seinsheimer Classification

The Seinsheimer classification is based on the number of major bone fragments and the location and shape of the fracture lines.**[**Mostofi, S. B, 2006**] (Figure -11)**

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Type I: Nondisplaced fracture or any fracture with <2mm of displacement of the fracture fragments.

Type II: Two-part fractures.
Type IIA: Two-part transverse femoral fracture.
Type IIB: Two-part spiral fracture with the lesser trochanter attached to the proximal fragment.
Type IIC: Two-part spiral fracture with the lesser trochanter attached to the distal fragment.

Type III: Three-part fractures.
Type IIIA: Three-part spiral fracture in which the lesser trochanter is part of the third fragment ,which has an inferior spike of cortex of varying length.
Type IIIB: Three-part spiral fracture of the proximal third of the femur, where the third part is a butterfly fragment.

Type IV: Comminuted fracture with four or more fragments.

Type V: Subtrochanteric-intertrochanteric fracture, including any subtrochanteric fracture with extension through the greater trochanter.

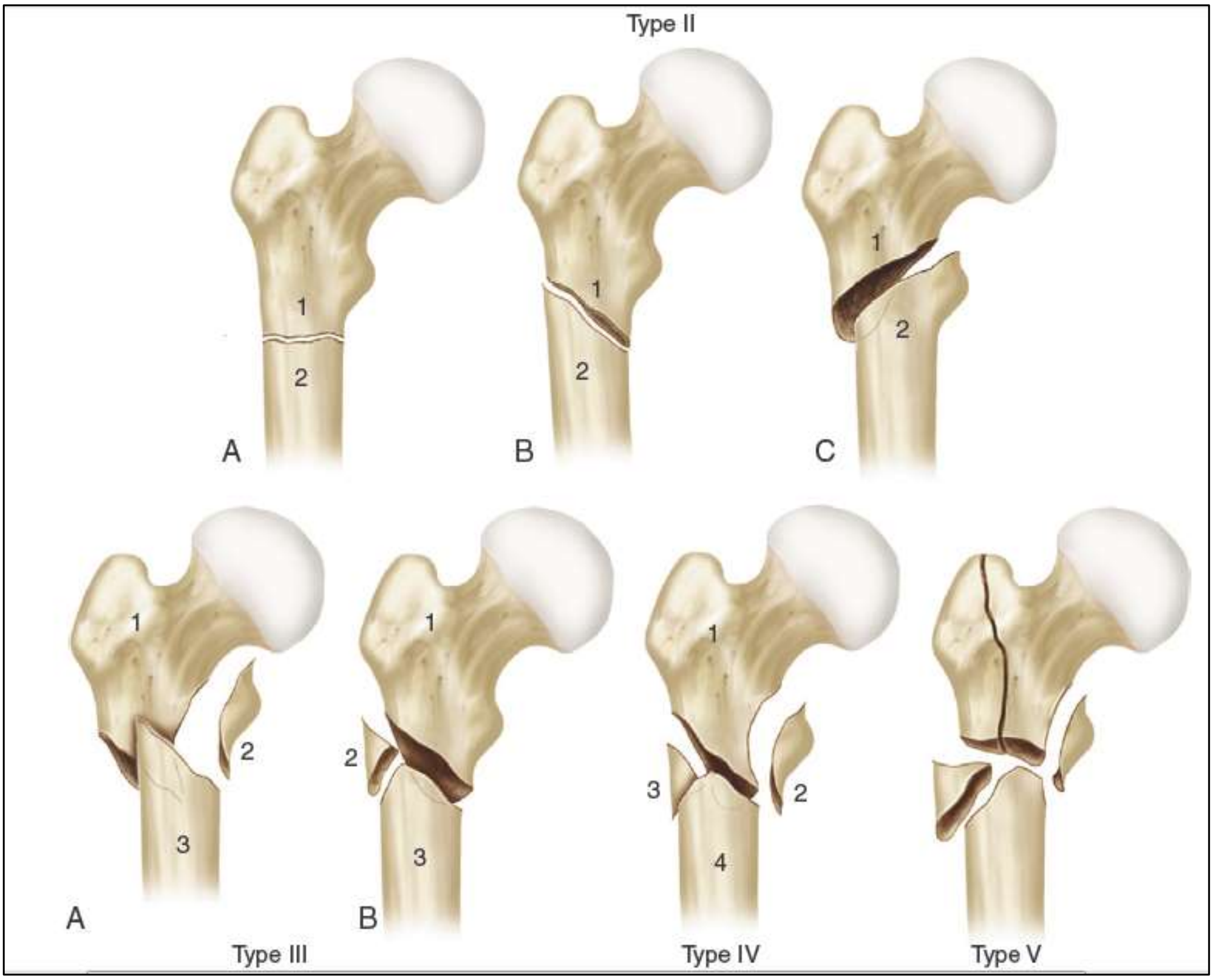

Figure -11: Seinsheimer classification of subtrochanteric fractures . (Redrawn from Seinsheimer F. Subtrochanteric fractures of the femur. *J Bone Joint Surg Am.*1978;60:300-6.)[Waddell, J.P. *et al*., 2011]

Waddell classification (Figure -12)
A, Transverse or short oblique fracture.
B, Long oblique fracture.
C, Comminuted fracture with extension into the trochanteric mass.[Waddell, J.P. *et al*., 2011]

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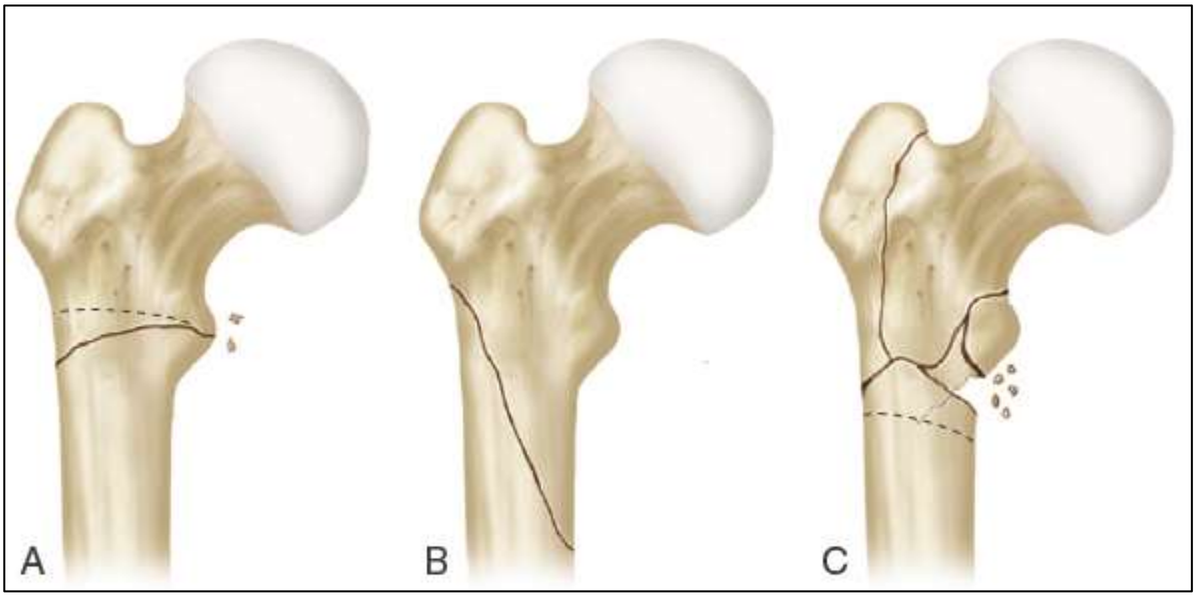

Figure -12: Waddell classification of subtrochanteric fractures

(Redrawn from Waddell JP Subtrochanteric fractures of the femur: a review of 130 patients. J Trauma 1979;19:582-91.)[Waddell, J.P. *et al*., 2011]

General considerations

a. Evaluation of the anatomic location and orientation of the fracture pattern guides selection of the most appropriate device and its application for these fractures.
b. The goals of internal fixation should be anatomic restoration of femoral alignment, maintenance of alignment, and minimization of the surgical insult.

Preoperative Planning: -(For both methods)

Preoperative planning begins with General assessment of the patient, prepare a cross matched blood, understanding of the fracture pattern, which is dependent on understanding of the mechanism injury and the applied force. It is critical that high-quality radiographs be available of the entire length of the femur. Evaluate the integrity of the proximal fragment (proximal fracture extension or lesser trochanteric involvement **(Figure -13.)**, the bone quality of the proximal fragment, the obliquity of the fracture, and a diameter of the femoral diaphysis distally. The lateral view can also alert the surgeon to the degree of femoral bowing which may influence device selection. [Rockwood, R. W]

Figure -13: Preoperative radiographs evaluate the integrity of the proximal fragment.

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The femoral neck-shaft angle varies from 125 to 135 degrees. Most nail designs tend toward a compromise of 130 degrees..[Waddell, J.P. *et al*., 2011] **(Figure -14.)**

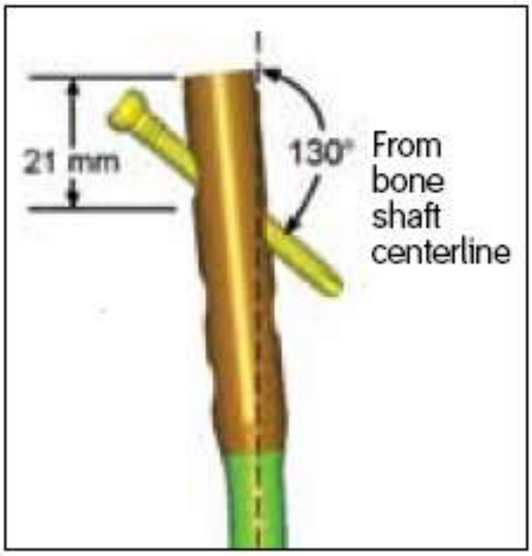

Figure -14: The femoral neck-shaft angle of standard Intramedullary interlocking nailing.Orthopaedic Smith & Nephew. Standard Femoral Lock(130º Standard Intramedullary interlocking nailing technique & Exchange) specifications 2011.[50]

Fixation with intramedullary locking Nails of Subtrochanteric fracture

a. Intramedullary nailing can be used for all subtrochanteric femur fractures that do not extend to the piriformis fossa or greater trochanter.

b. A standard nail with locking screws that do not enter the femoral head can be used in fractures that are below the level of the lesser trochanter as long as the device offers an oblique proximal locking option. [Jay, R. *et al*., 2009]

c. For fractures that extend to or involve the lesser trochanter, a cephalomedullary nail is required for adequate fixation.

d. Nailing can be performed in fractures that extend into the nail starting point, but it is not the preferred technique for most surgeons. [Jay, R. *et al*., 2009]

e. The main pitfall of intramedullary nailing is varus deformity with the proximal fragment also assuming a flexed position. Alignment must be restored before reaming and placement of the intramedullary nail.

f. Fracture reduction and intramedullary nailing can be facilitated by positioning the patient laterally on the fracture table. This allows the femur to be flexed in relation to the hip, matching the unopposed flexion of the proximal fragment.

g. Intramedullary nails are load-sharing devices, and early weight bearing can frequently be initiated.[Jay, R. *et al*., 2009]

Surgical Technique of interlocking nailing
Positioning of the Patient

Place the patient supine on a fracture table, with the injured extremity in traction through a skeletal traction pin or boot and the hip flexed 30 to 40 degrees. [Canale. & Beaty, 2012] The use of a fracture table greatly facilitates obtaining a clear proximal lateral fluoroscopic radiograph **(Figure -15)**, especially in heavy patients, and allows the surgeon to fine-tune the reduction, leg length, and alignment and hold it in place during the nailing procedure. [Rockwood, R. W. *et al*., 2006] Care should be taken to avoid nerve traction injury (eg. avoid prolonged and excessive traction). Small perineal posts and long durations of traction have been shown to increase the risk of pudendal nerve injury. If traction is used, it should be first applied to determine the "reducibility" of the fracture. Then it should be reduced during prepping and applied as needed. Large and well padded perineal posts should be used whenever possible.[Tornetta, P. *et al*., 2011]

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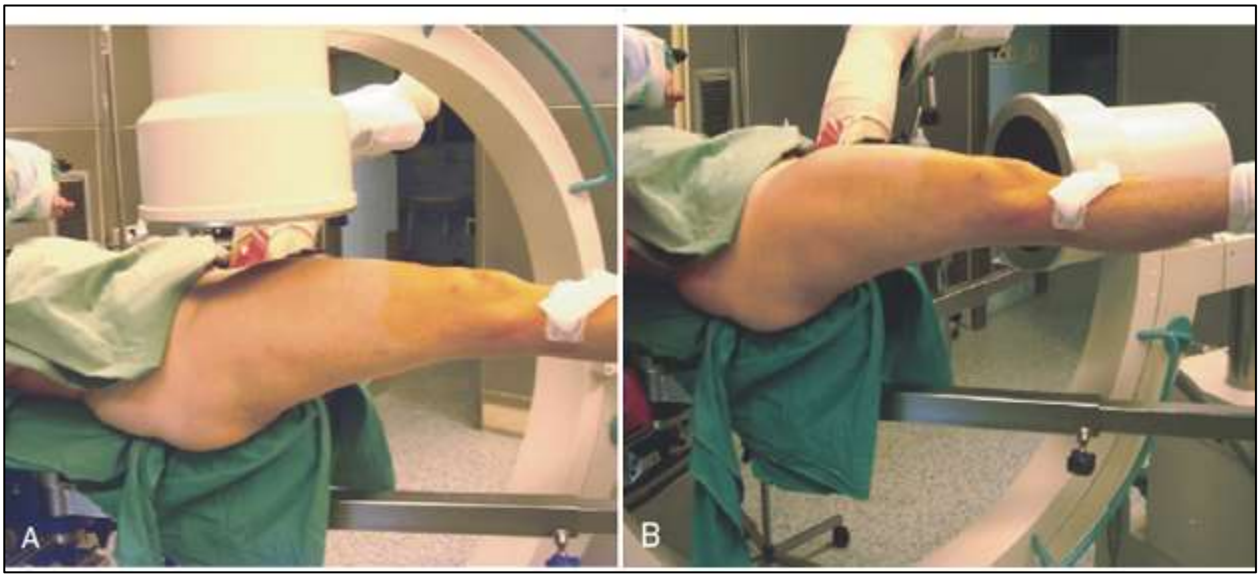

Figure -15: Patient in supine positioning with image intensifier should be positioned so that anteroposterior (A) and mediolateral (B) views of the trochanteric region of the affected femur can be easily obtained..[Waddell, J.P. *et al*., 2011].

Opening of the Medullary Canal

A. Incision of skin:

Small incision beginning approximately 3 cm proximal to greater trochanter and extended proximally. [Canale. & Beaty, 2012] A small incision is deepened through the fascia lata.It splits the abductor muscles approximately 1 to 2 cm immediately above the tip of the greater trochanter and thus exposes its tip. A self-retaining retractor or tissue protection sleeve is put in place.[Waddell, J.P. *et al*., 2011] **(Figure -16).**

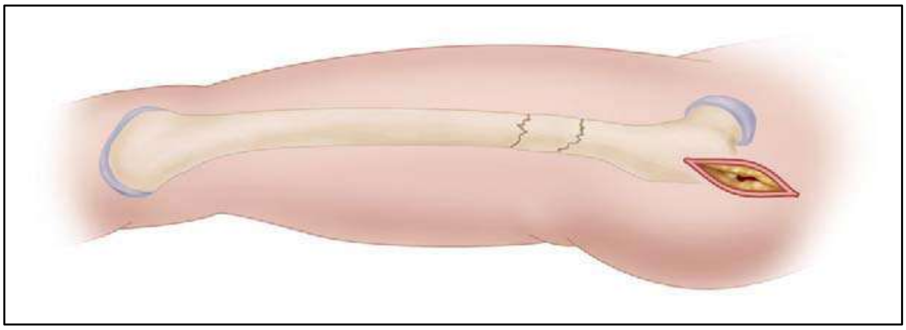

Figure -16: Incision of skin .Campbell's Operative Orthopedics, 12th edition, 2012. [Canale. & Beaty, 2012].

B .Entry point of the nail:

The medullary canal must be opened under image intensifier guidance and with a curved awl.Use the tissue protector.The correct entry point is located at the junction of the anterior one thirdand posterior two thirds of the tip of the greater trochanter and on the tip itself..[Waddell, J.P. *et al*., 2011] **(Figure -17).**

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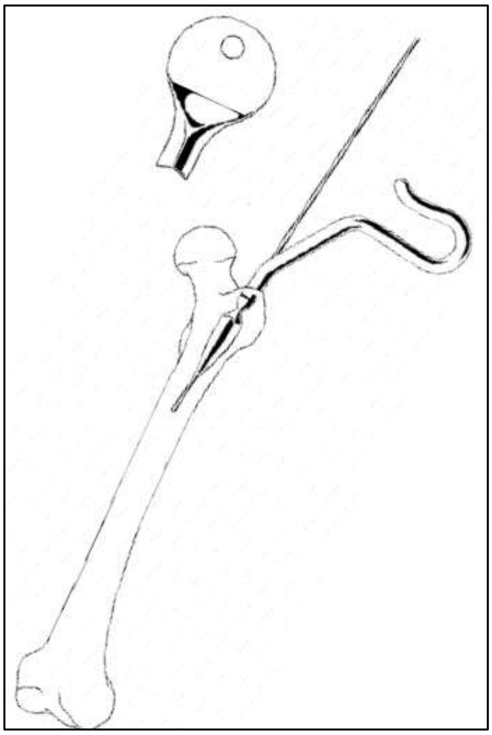

Figure -17: entry point. *James P. Waddell, MD, FRCSC, Fractures of the Proximal Femur:Improving Outcomes, Toronto, Ontario,Canada, 2011..[Waddell, J.P. et al., 2011]*

C. Insertion of the guide rod:

Place a 3.0mm x 100cm ball tip guide wire or tear drop guide wire through the tissue protection sleeve, all the way into the distal femur (**Figure -18.**). To aid in manipulation, bend the tip of the guide at about a 10o angle 5cm from the end. Under fluoroscopic guidance the guide rod should be centered within the distal fragment on anteroposterior and lateral views.

CAUTION: If the guide wire is bent shorter than 5cm from the end of the wire and/or more than 10 degrees it may be difficult to remove from the nail. If the wire becomes lodged inside the nail, utilize the guide wire gripper and mallet to remove the guide wire from the nail.[Zimmer- Natural Nail, 2013]

Figure -18: Insertion of the guide rod.[Zimmer- Natural Nail, 2013]

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D. Reaming the medullary canal:

Correct the typical deformities of the proximal segment and hold them corrected before reaming the proximal segment. [Canale. & Beaty, 2012]

Fracture reduction should be as anatomic as possible. If anatomic reduction is not feasible, reduction should be achieved in at least one plane. For “low” subtrochanteric fractures that have some intact diaphysis, reduction tools (“fingers”) can be used to assist with guide wire placement. These maneuvers are useless if the proximal fragments are short and capacious.[Rockwood, R. W]

If reduction cannot be obtained by closed means, then percutaneous or mini-open reduction will be necessary.A bone hook placed along the lesser trochanter,or even percutaneous joy-sticks or clamps, can be used to reduce the fragment without the need for substantial periosteal stripping or evacuation of the fracture hematoma.[Waddell, J.P. *et al*., 2011] **(Figure -19).**

Figure -19: Fluoroscopic images showing elevator and ball spike pusher used to correct sagittal and coronal plane deformities. Campbell's Operative Orthopedics, 12th edition, 2012. [Canale. & Beaty, 2012].

Reaming should be performed through the tissue protection sleeve. Start with a small reamer. Increase the diameter of the reamer by 0.5 - 1.0mm depending on the amount of resistance felt while reaming. (**Figure -20.**). When cortical chatter occurs, stop reaming. Choose a nail that is 1.5 - 2.0mm smaller than the last reamer used. The guide wire pusher can help prevent the guide wire from coming out of the femur during reaming.[Zimmer- Natural Nail, 2013]

Figure -20: Reaming the medullary canal. [Campbell's Operative Orthopedics, 12th edition, 2012.] [Canale. & Beaty, 2012].

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E. Replacement of the reaming rod and ball tip with the smooth guide wire:

The reaming rod with ball tip is replaced with the smooth guide wire. To prevent displacement of the bone fragments during this process, the medullary exchange tube is pushed over the reaming rod with ball tip. The reaming rod is then removed and replaced with the smooth guide wire (Ø 3.0mm) length 100cm. Finally, the medullary exchange tube is removed. **(Figure -21).**

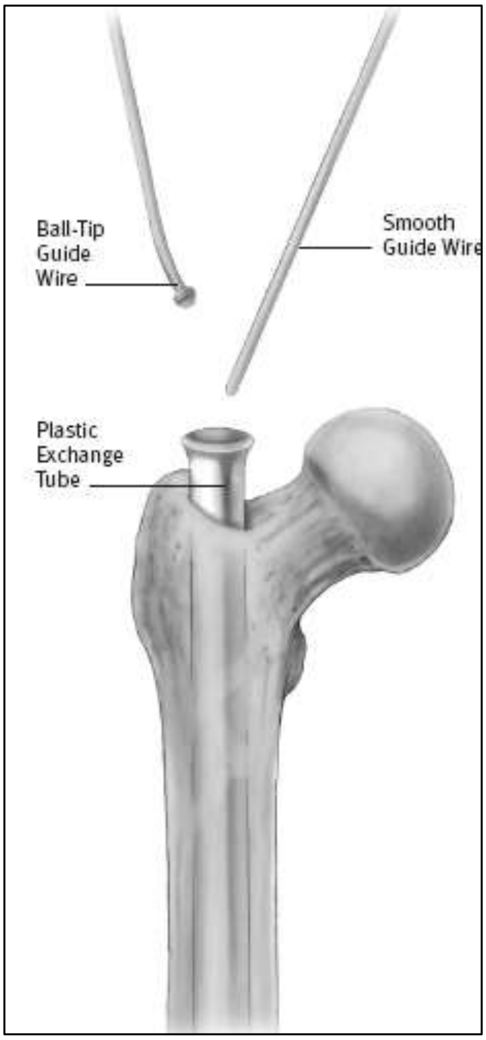

Figure -21: Replacement of the ball tip with the smooth guide wire.[50]

Insertion of the interlocking nail for femur

a. Attaching the targeting device:

The diameter and length of the nail have already been determined (using nail length gauge and last size of reamer utilized). Visualizing the reduced femur and/or the contralateral femur, determine which CCD angle is appropriate for the patient.

Attach the insertion device and proximal locking screw guide.[Zimmer- Natural Nail, 2013]

b. Insertion of the interlocking nail for femur with the targeting device

Choose a nail that is 1.5 - 2.0mm smaller than the last reamer used. The nail is connected to the targeting device. Before the operation, the implant and instrument assembly must be checked, to ensure that the targeting device angle corresponds to the chosen nail angle. The nail is inserted through the premade entry using a guide wire. If free hand insertion of the nail into the medullary canal is not feasible, it will be necessary to choose a thinner nail or to ream the medullary canal in 1 mm more. **(Figure -22).**

The final nail depth position is monitored with the image intensifier. Successful positioning of the nail depends on the femoral neck-shaft angle and the screw-nail angle. The guide wire is removed after the nail is inserted to within 2 cm of the final position of the nail tip and before the locking screws are inserted.[Waddell, J.P. *et al.*, 2011]

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Figure 22: Insertion of the interlocking nail for femur with the targeting device.[Zimmer- Natural Nail, 2013]

c. Removal of the smooth guide wire

When the nail has passed well into the distal fragment, remove the guide wire to avoid incarceration during final seating of the nail.

d. Confirmation of the final position of the intramedullary nail with the image intensifier

e. Proximal locking

After nail insertion, the correct tightening of all parts of the device must be checked. Make a stab incision and insert the drill sleeve assembly consisting of Protection Sleeve, Drill Sleeve and 4.0mm Trocar, into the hole of the insertion handle and advance it to the bone.

Remove the trocar. Drill through both cortices with the calibrated 4.0mm Drill Bit ,stopping the drill immediately after penetrating the far cortex. Confirm the drill bit position using the image intensifier. Make sure that the drill sleeve is pressed firmly to the cortex, and read the length of the locking bolt directly from the calibrated drill bit protruding at the back of the drill sleeve. **(Figure -23).**

Remove the drill and sleeve.

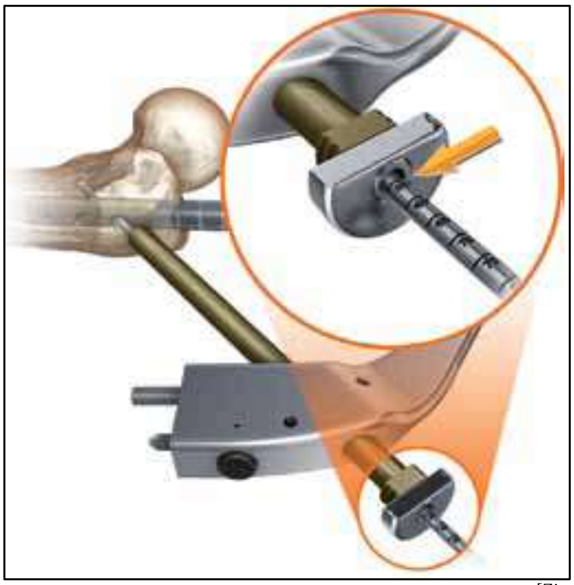

Figure -23: Drill & measuring the length of the locking bolt. [Zimmer- Natural Nail, 2013]

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■ Insert the screw of the proper length, and advance it manually until seated. **(Figure -24).**
■ Check the position with an anteroposterior and lateral image.

■ Evaluate that satisfactory length and rotational alignment has been restored before proceeding with distal interlocking.[Canale. & Beaty, 2012]

Figure -24: the position of the screw with checked with an anteroposterior image.

f. Using free hand technique for distal locking

Perform distal locking by using a freehand technique after "perfect circles" are obtained by fluoroscopy, (Figure -25). [Canale. & Beaty, 2012].

A, Awl is placed over proximal screw hole with its handle angled 45 degrees.

B-D, Awl is adjusted under image intensification until point is centered in screw hole and then is swung perpendicular to axis of bone

(C) and driven to lateral side of rod

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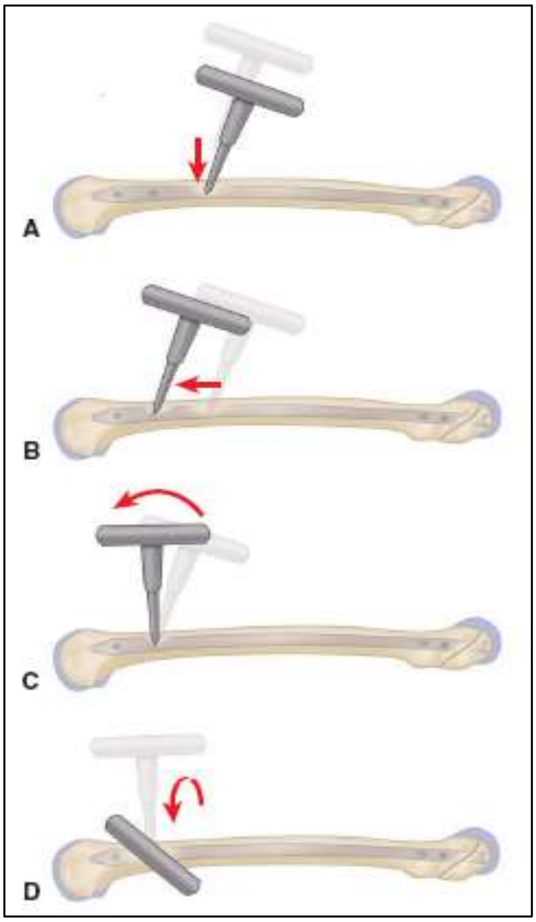

Figure -25: Free hand technique of distal locking. Campbell's Operative Orthopedics, 12th edition, 2012. [Canale. & Beaty, 2012].

g. Proceeding with distal interlocking.[Canale. & Beaty, 2012] (Figure -26).

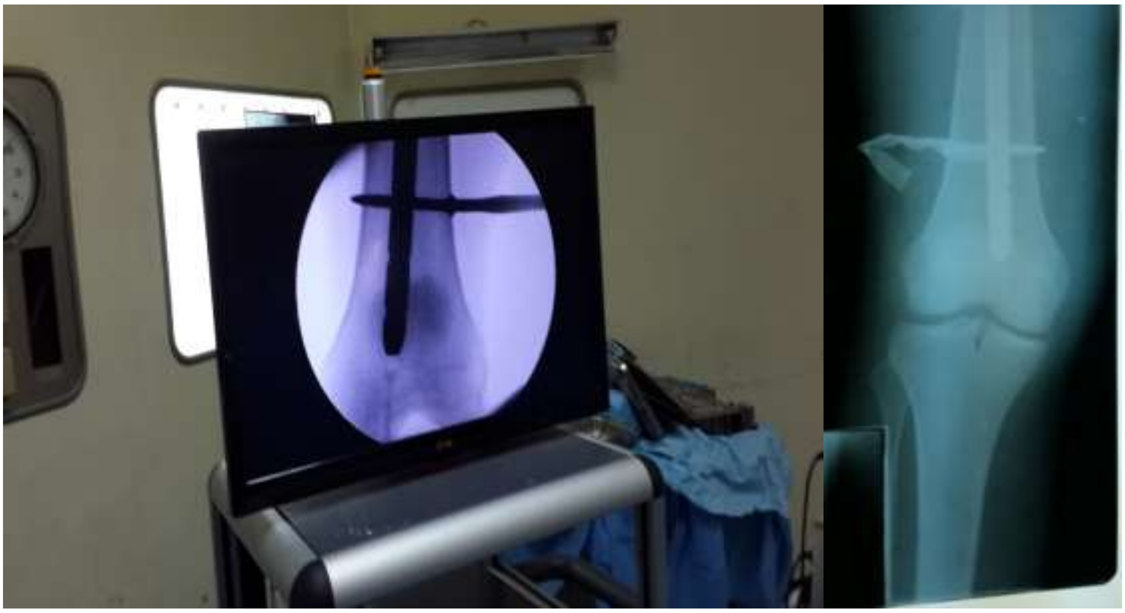

Figure -26: The position of the distal screw.

G.FINAL EVALUATION

■ Before leaving the operative suite, several key elements must be evaluated.

■ First, if the nail has been locked in standard fashion, evaluate the femoral neck with multiplanar fluoroscopic imaging to ensure that no occult femoral neck fracture is identified.

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■ Next, confirm the length and rotational reductions and compare with the uninjured limb to ensure symmetry.
■ Evaluate the thigh compartments, and if clinical concern exists, then obtain objective compartment measurements.
■ Examine the ligaments of the ipsilateral knee.
■ A postoperative anteroposterior pelvis radiograph with both hips internally rotated provides the optimal profile view of the femoral neck as a further check for occult femoral neck fractures and should be obtained and reviewed before anesthesia is discontinued.[Canale. & Beaty, 2012]

Compression plating - 95° angled blade plate (subtrochanteric fractures)-
Principles

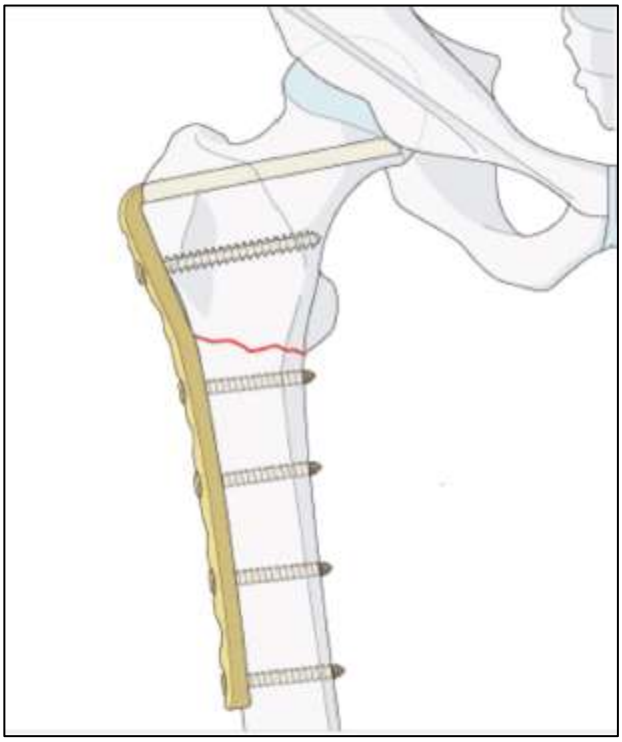

Figure -27: 95° angled blade plate for subtrochanteric fractures. [Magee, D. J. *et al*., 2011].

Angled blade plates have a blade with a "U" profile and a fixed angle between the blade and the plate. In the proximal femur, the blade needs to be inserted in the middle of the femoral neck and at a predetermined angle to the shaft axis. In addition, the plate portion of the angled blade plate must line up with the axis of the femoral shaft at the end of the procedure. **(Figure -27).** Because of these technical complexities, a preoperative plan and tactic ,vincluding a preoperative drawing, are essential, so that the operation can be conducted step by step. The surgeon must be precise and pay particular attention to anatomical landmarks, the siting and orientation of the angled blade plate, in both AP and axial views, as well as rotation of the blade about its axis (which determines the alignment of the plate with the femoral shaft). [Magee, D. J. *et al*., 2011].

Implant and instrumentation

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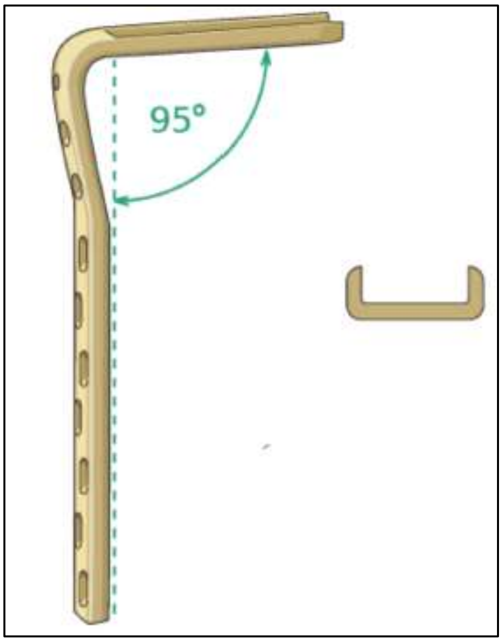

Figure -28: 95 -Fixed angle blade plating.[Magee, D. J. *et al*., 2011].

The two round holes next to the blade accept 6.5 mm cancellous bone screws; the remaining screw holes have a DCP profile and accept 4.5mm.cortical screws. The blades come in lengths of 50, 60, 70 and 80 mm. The 70mm blade is the one most commonly used in the adult proximal femur. **(Figure -28).** There are 7, 9 and 12 hole versions of the 95° angled blade plates.

Instrumentation

Several dedicated instruments are needed for the precise conduct of the angled blade plate insertion, in accordance with the preoperative plan.No fluoroscopy can substitute for a three-dimensional appreciation of the local anatomy, nor will it serve as a guide to the correct insertion of the guide wires.Correct insertion is based on certain anatomical landmarks and on the geometry of the 95º angled blade plate. The image intensifier is used to check the position of the definitive guide wire and the final position of the seating chisel. [Magee, D. J. *et al*., 2011].

a. Seating chisel. The seating chisel is used for cutting the track for the blade in the proximal femur. **(Figure -29)** It has a "U" profile that corresponds to the profile of the blade of the angled blade plate.The seating chisel guide that slides over the seating chisel, is used to determine the rotation of the seating chisel about its long axis.The flap of the seating chisel guide must remain in line with the long axis of the femoral shaft throughout chisel insertion.

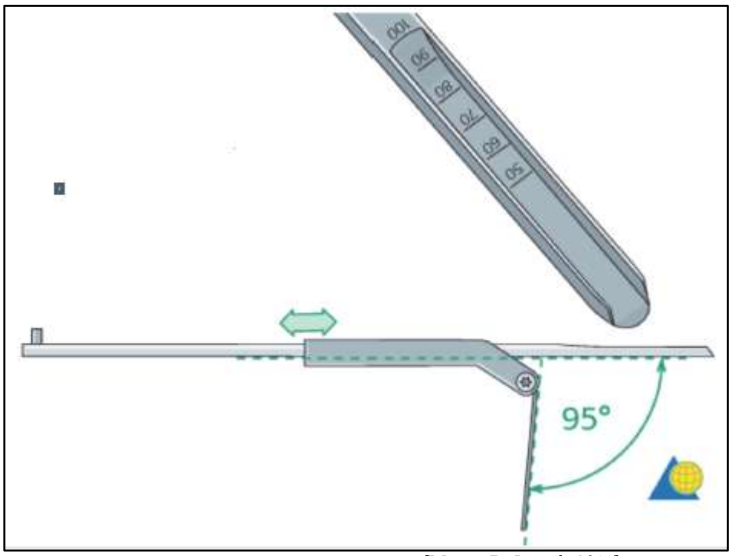

Figure -29: Seating chisel.[Magee, D. J. *et al*., 2011].

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b. Condylar blade guide. The angle between the flap and the body of the seating chisel guide may be set with the aid of the 85° condylar blade guide and is maintained by tightening the screw with a screwdriver. **(Figure -30.)**

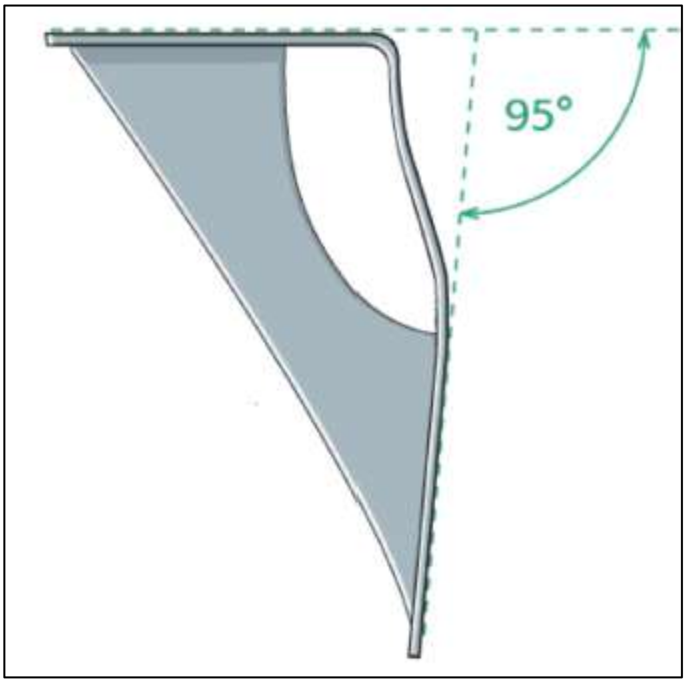

Figure -30: Condylar blade guide. [Magee, D. J. *et al*., 2011].

c. Slotted hammer. During insertion, the rotation of the seating chisel is controlled with the slotted hammer. The slotted hammer serves also for removal of the seating chisel, or for hammering out the plate holder when removing a blade plate. **(Figure -31).**

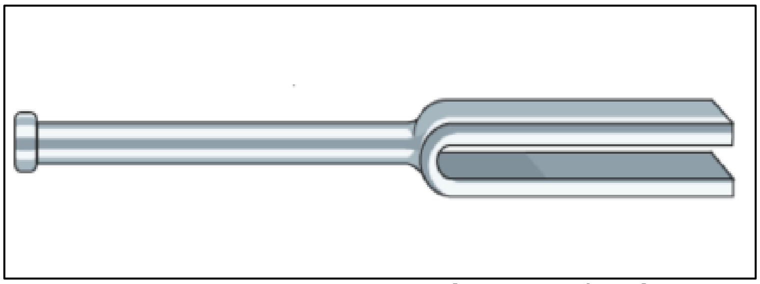

Figure -31: Slotted hammer. [Magee, D. J. *et al*., 2011].

d. Plate holder / introducer. The plate holder/introducer is used for insertion and removal of blade plates. The blade plate should be so fastened in the plate holder that its long handle is in line with the blade of the angled plate. **(Figure -32.)**

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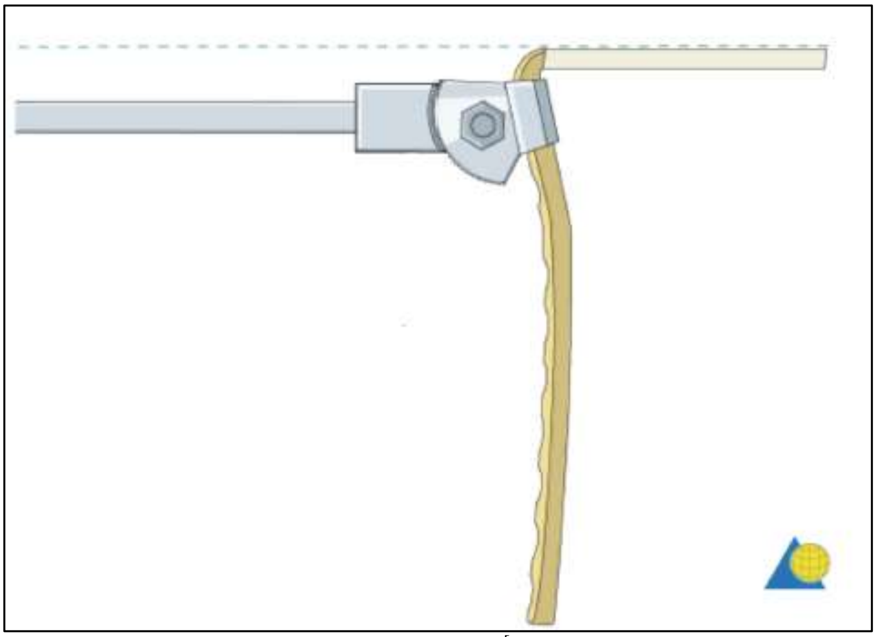

Figure -32: Plate holder / introducer. [Magee, D. J. *et al*., 2011].

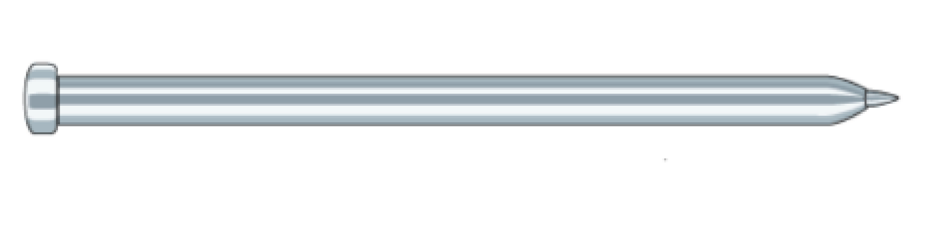

Figure -33 e. Impactor.

The impactor is used to drive the last 5 mm of the blade into the bone. [Magee, D. J. *et al*., 2011].

Surgical Technique of angled blade plate

Ideal position of the 95° angled blade plate within the proximal femur.

The trabecular anatomy and distribution of bone in the proximal femur determine the optimal position for the blade of the 95º angled blade plate. There is a zone within the head where the tension and compression trabeculae intersect. This is the zone offering good anchorage for the tip of the blade. The tip of the blade should come to lie just below this point of trabecular intersection on the AP image and in the center of the neck on the axial view. The blade of the 95º angled blade plate should pass approximately 10 mm below the superior cortex of the neck. **(Figure -34).** Note that the tip of the blade lies in the lower half of the femoral head. The blade passes below the superior cortex of the neck.

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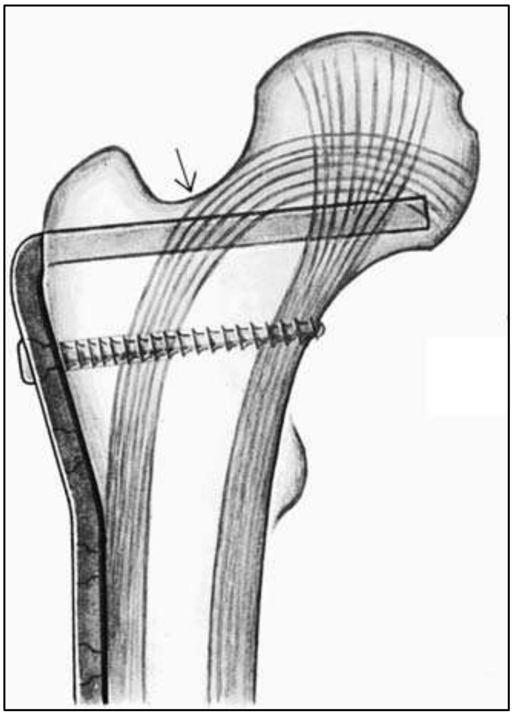

Figure -34: position of 95° angled blade plate.[52]

Drawing the plan

X-rays of the uninjured femur are taken to serve as a template for preoperative planning. The x-rays are taken with the hip in 15°- 20° internal rotation to correct for femoral neck anteversion. **(Figure -35).**

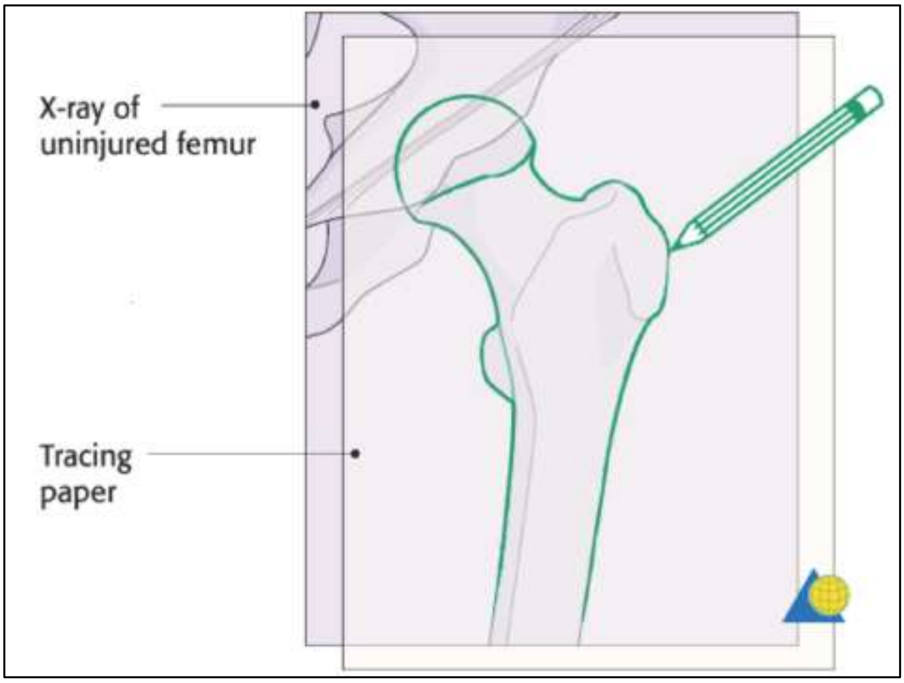

Figure -35: Drawing the plan on X-rays of the uninjured femur.

A tracing of the outline of the uninjured proximal femur is then reversed and the fracture lines are added. **(Figure -36).**

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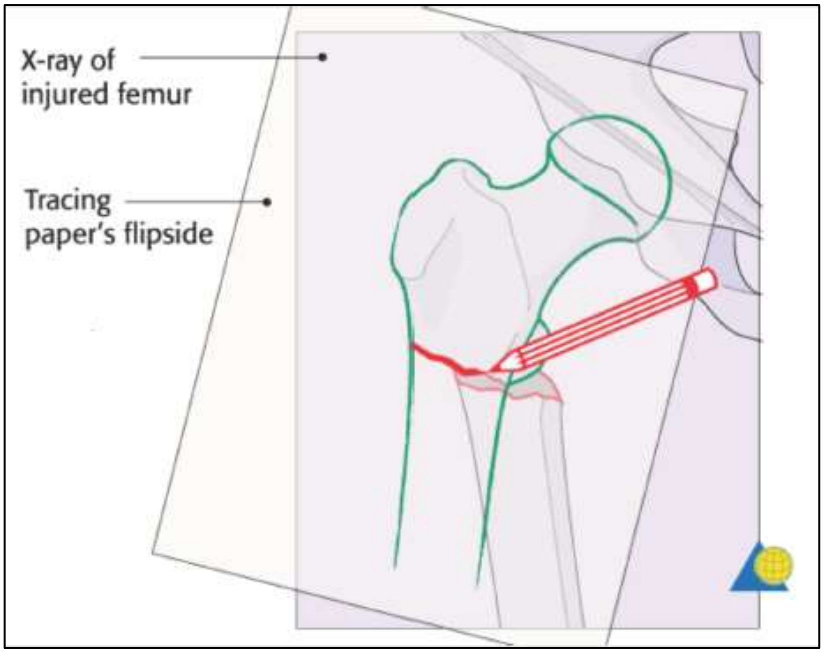

Figure -36: tracing of the outline of the injured proximal femur

The appropriate angled blade plate is then chosen, using the transparent implant templates and traced onto the plan.The appropriate angled blade plate is then chosen, using the transparent implant templates underlying the tracing. The outline of the chosen implant is then added to the tracing.To assist in the choice of the insertion point for the seating chisel ,measure the distance from the tip of the greater trochanter to the center of the insertion point. This measurement can be used intraoperatively to locate the insertion point. A step-by-step tactic is then derived from this drawing and should stipulate the order in which the various steps of the procedure will be performed. It should also indicate whether a gliding hole for an interfragmentary lag screw is to be predrilled prior to fracture reduction, depending on the inclination of the fracture plane. (Figure -37). These technical drawings and their derived tactic are mandatory for any angled blade plate procedure. [Magee, D. J. *et al*., 2011].

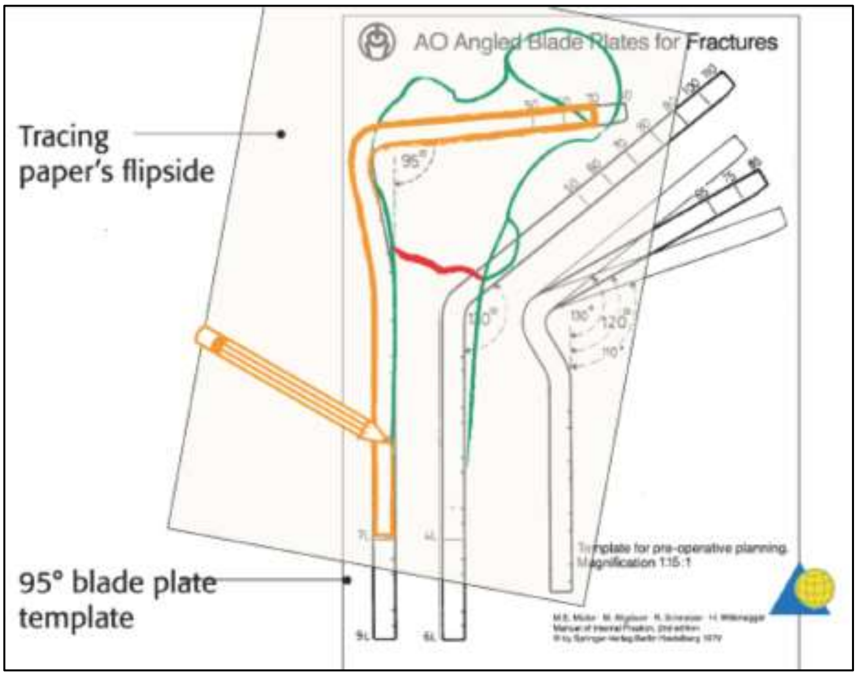

Figure -37: Chosen the appropriate angled blade plate.

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Preparing the blade channel

a. Correct track for the angled blade plate

Before an angled blade plate can be inserted into bone, a channel must be cut with the U-profile seating chisel. The sides of the tip of the seating chisel converge slightly, which facilitates the centering of the chisel within the femoral neck. **(Figure -38).**

In order to insert the 95º angled blade plate correctly into bone, 4degrees of freedom must be controlled:

- the point of entry of the blade into bone,
- parallelism to the anteversion of the femoral neck,
- the angle between the blade and the femoral shaft axis and
- the rotation of the seating chisel about its long axis.

Once the track of the blade is determined on the preoperative plan, the surgeon will know the exact position that the seating chisel should occupy in the bone.

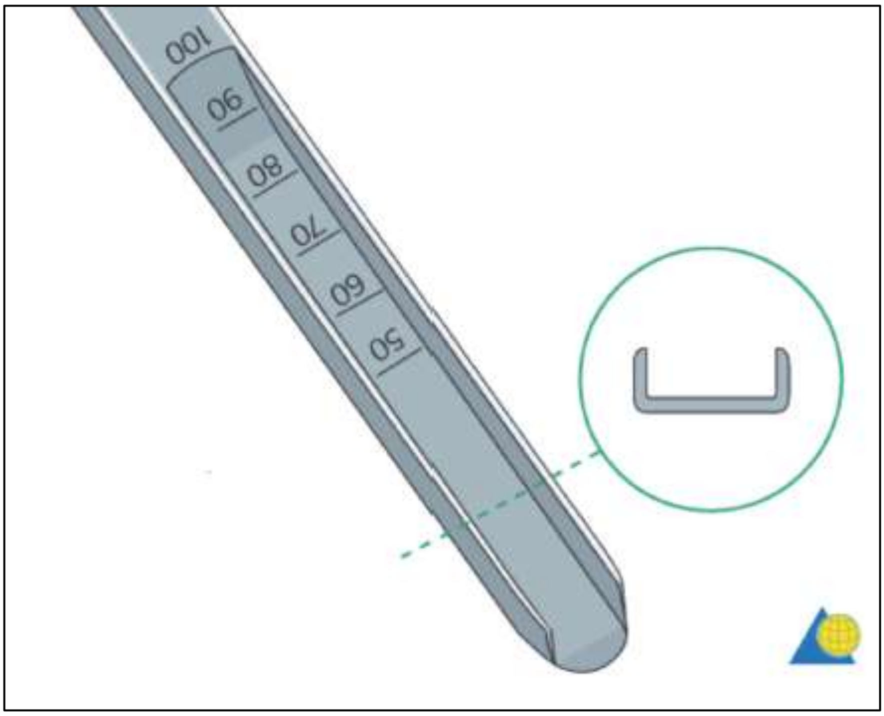

Figure -38: Correct track for the angled blade plate.

b. Parallelism to the anteversion of the femoral neck and the angle between the blade and the femoral shaft axis.

Guide wires are used to mark the plane of anteversion of the femoral neck and also to mark the appropriate inclination of the seating chisel in relation to the long axis of the femur. The surgeon will be guided in the chisel insertion by a definitive guide wire. **(Figure -39).**

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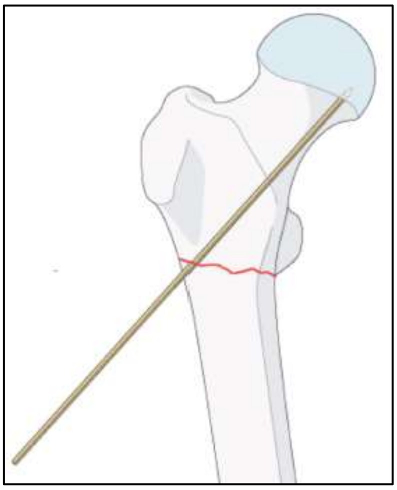

Figure -39: Anteversion guide wires

Firstly, a wire is passed in close contact with the front of the femoral neck and will indicate the axis of the neck in the axial plane. This wire must pass distal to the anterior ridge which runs along the front in the intertrochanteric area, or it may be deflected anteriorly.

The 95º condylar plate guide is then placed along the lateral cortex and a second, definitive guide wire is inserted, parallel in the axial view to the first guide wire and parallel with the upper edge of the condylar plate guide in the AP view. It is drilled into the greater trochanter just above the planned point of entry. The track for the seating chisel will be parallel to this wire. The wire's position should be checked radiologically in both planes, and adjusted accordingly, as necessary. **(Figure -40).**

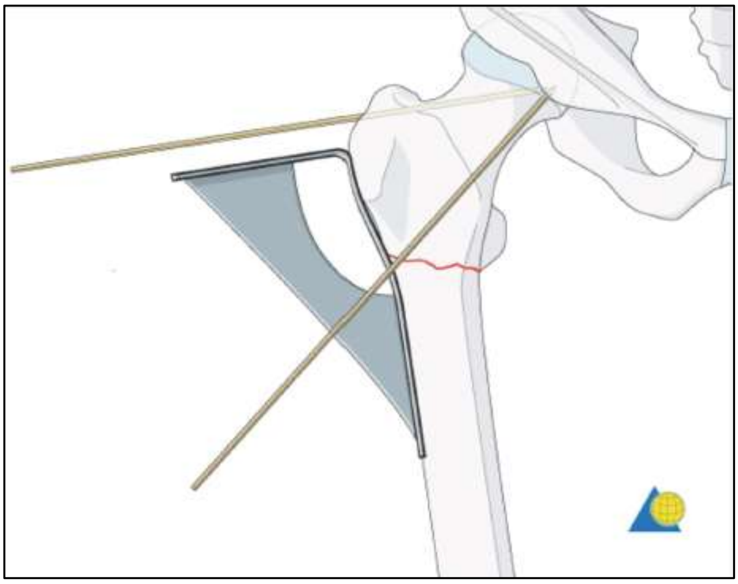

Figure -40: Definitive guide wire

c. Preparing the point of entry

Guided by the measurement made on the preoperative plan, the point of entry on the outer face of the greater trochanter is determined. It is important to remember that, at this level, the posterior edge of the greater trochanter overhangs more than the anterior edge and the center of the point of insertion is at the junction of the anterior one third and middle one third of the outer face of the greater trochanter. **(Figure -41).**

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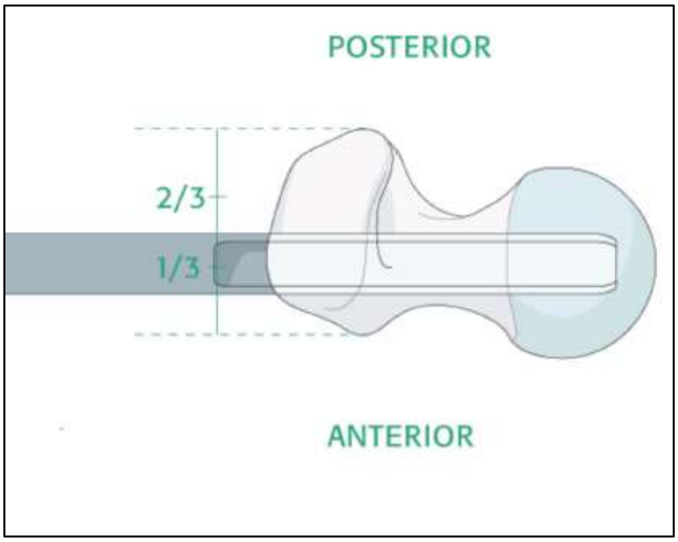

Figure -41: The entry point

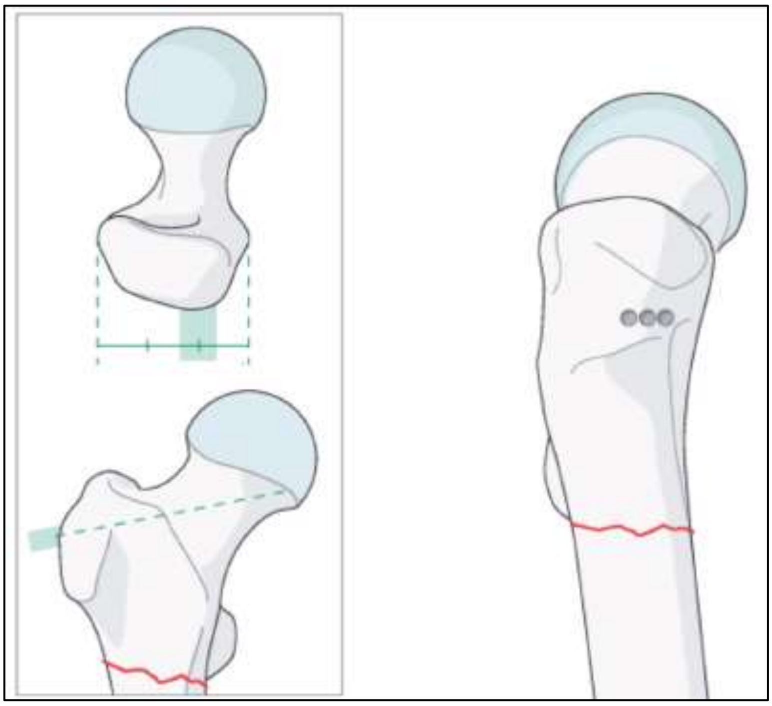

Figure 42: Three 4.5 mm drill holes are made as illustrated.

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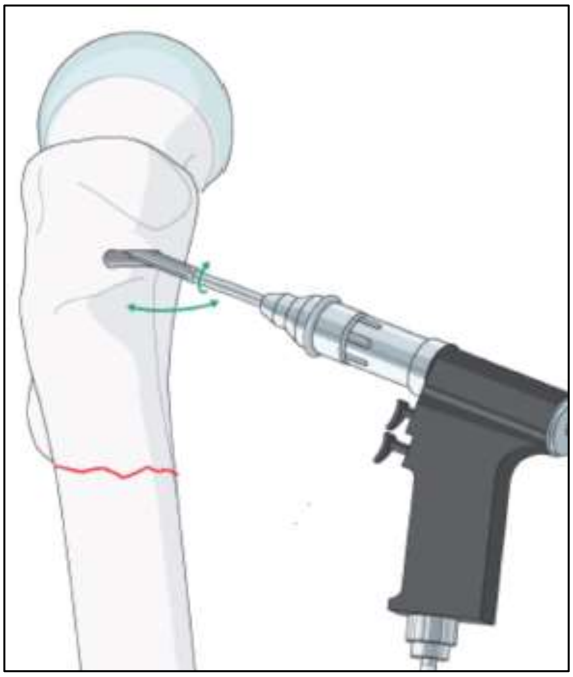

Figure -43: These holes are then enlarged with a router to produce a horizontal slot matching the width and height of the seating chisel.

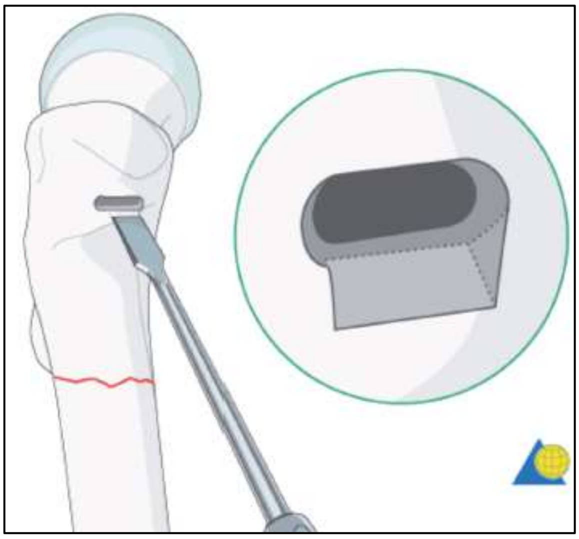

Figure -44: The lower edge of the entry hole should be beveled, using a chisel, to accommodate the curve of the shoulder of the angled blade plate.

d. Preparation of the track for the blade

The seating chisel can now be inserted through the prepared entry slot and parallel in both axial and AP views to the definitive guide wire.This parallelism is judged by frequent visual reference, in both planes,to the advancing seating chisel and the guide wire. Radiology has no part to play in this maneuver. The use of the slotted hammer over the seating chisel aids the control of this track. **(Figure -45).**

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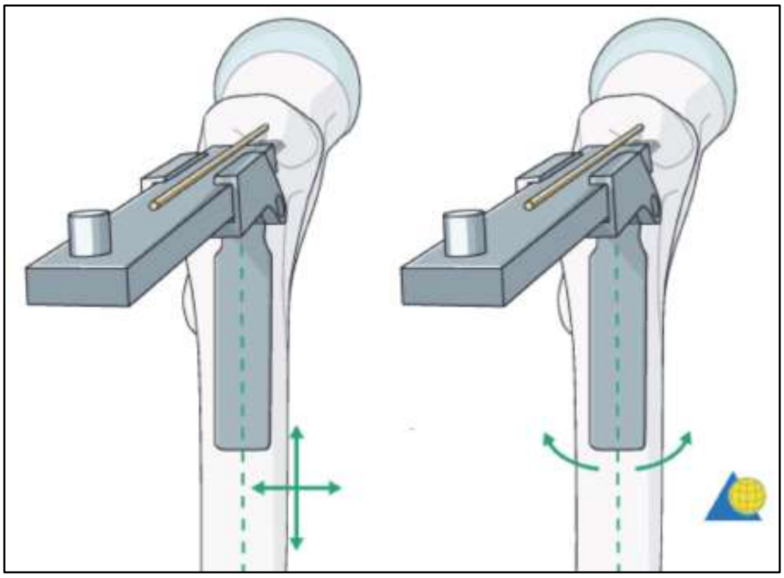

Figure -45: Preparation of the track for the blade

Throughout the insertion of the seating chisel, the parallelism of the tongue of the seating chisel guide to the femoral shaft axis is also carefully maintained.

This is the most demanding and crucial step of the procedure, and the grip on the slotted hammer and the seating chisel guide, as drawn, is crucial. **(Figure -46).**

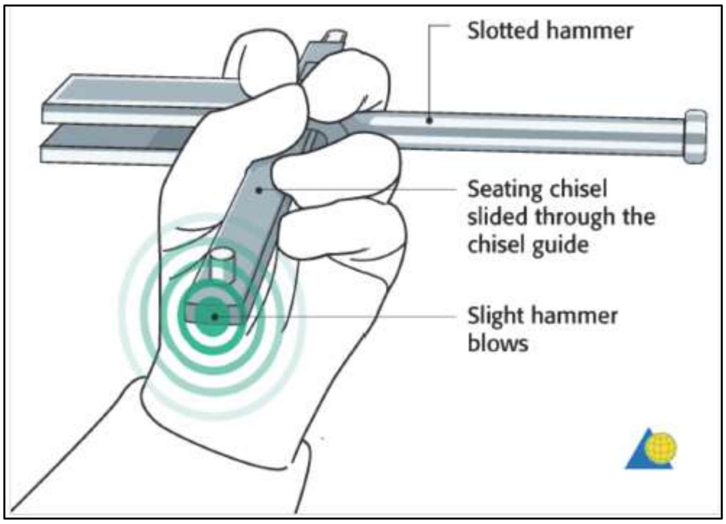

Figure -46: The grip on the slotted hammer

e. Seating chisel insertion depth

Once the seating chisel has been inserted, its position should be checked radiologically. This determines also whether the planned blade length is appropriate. The seating chisel bears markings that indicate the depth of its insertion. **(Figure -47).**

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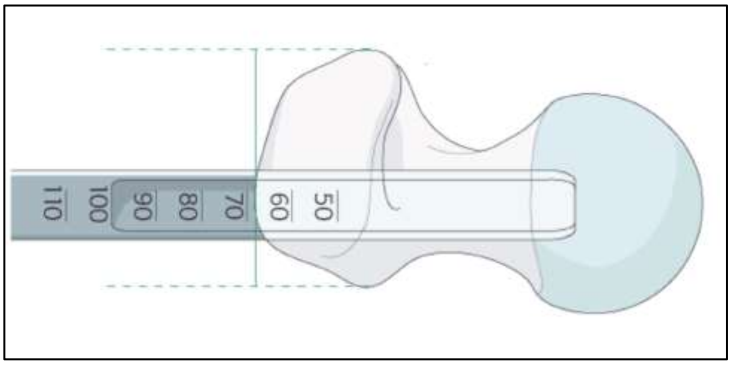

Figure – 47: Seating chisel insertion depth

The seating chisel is then removed by back strokes with the slotted hammer. [Magee, D. J. *et al*., 2011].

Plate insertion

a. Blade insertion

The chosen 95° angled blade plate is then mounted into the plate holder and the blade is pushed by hand into the pre-chiseled track. The blade should pass easily into the precut track and light blows with a hammer should be all that is required to insert it into the femoral neck.

When the plate is about 5 mm from the bone, remove the plate holder and hammer the plate fully home, using the point of the impactor in the indent on the shoulder of the implant. **(Figure -48).**

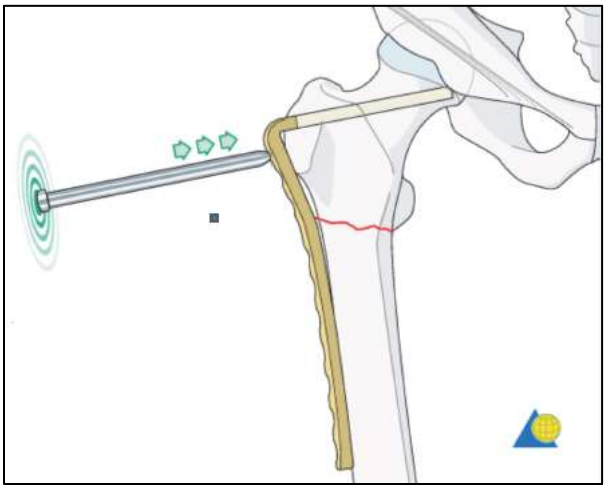

Figure -48: Blade insertion

b. Proximal screw insertion.

The blade should be stabilized with a screw. After the angled blade plate has been inserted into the proximal femur, it is secured with a fully threaded 6.5 mm cancellous screw through the most proximal of the holes of the plate. **(Figure -49).**

The use of a cortical screw at this site would require drilling of the calcar of the femur, with the attendant weakening of this important bony buttress. [Magee, D. J. *et al*., 2011].

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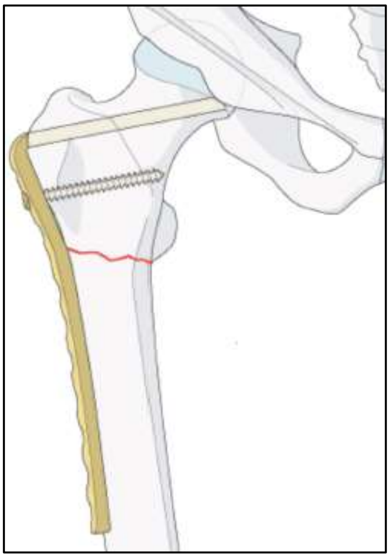

Figure -49: Proximal screw insertion

Reduction and compression of fracture

a. Fracture compression.

Once the angled blade plate is firmly anchored in the proximal fragment,the distal femur is aligned onto the plate and held, if necessary, with a clamp.

In single plane transverse or short oblique fractures, the first screw in the distal fragment should be a load screw, in order to compress the fracture. **(Figure -50).**

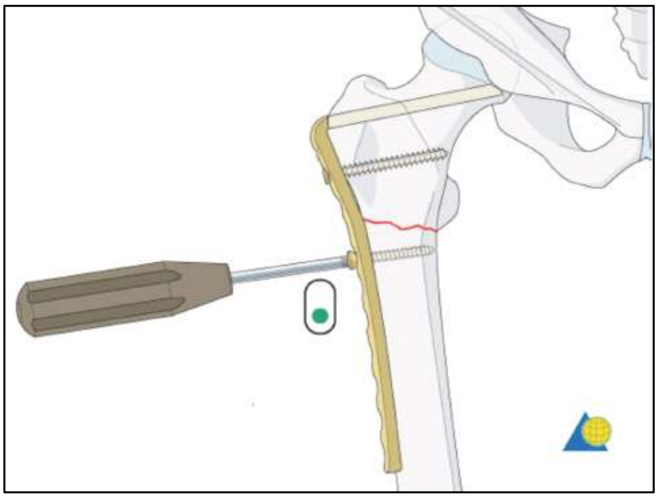

Figure -50: Fracture compression

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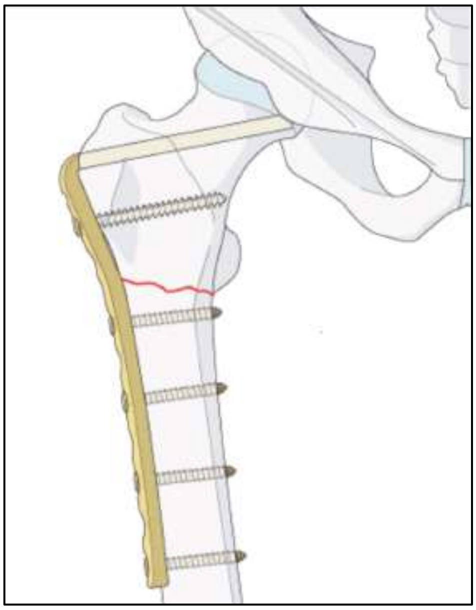

(Figure -51). b. Completion of the fixation,

The remaining, neutral screws are then inserted: at least 8 cortical holds are necessary in the shaft fragment.

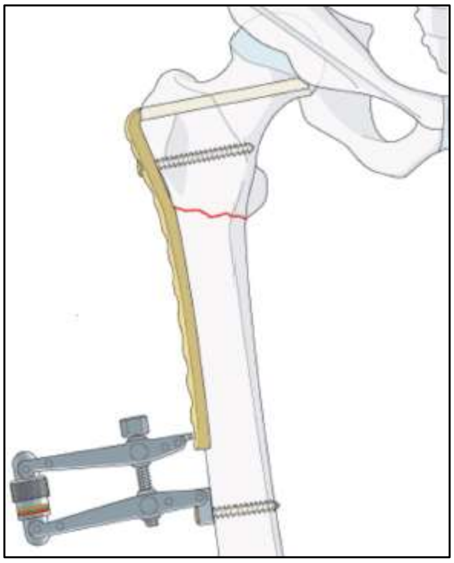

Figure -52: c. Pearl: articulated tension device.

In nonunions, sufficient compression may only be achieved by the use of an external compression device.

Note:-The angled blade-plate devices are strong and can provide very stable fixation, even in poor quality bone. Their correct insertion requires a high degree of surgical discipline and skill. A detailed preoperative plan and a step-by-step tactic are mandatory. Careful adherence to the exact conduct of each step of the procedure is essential for a satisfactory outcome.**[**Magee, D. J. *et al*., 2010**].**

AIM OF STUDY:

To compare the radiographic and clinical results of patients treated with closed reduction and intramedullary nailing to those treated with open reduction and internal fixation using a fixed angle blade plate for the management of subtrochanteric femoral fractures.

PATIENTS AND METHODS

Twenty four patients with subtrochanteric femoral fracture were treated in Al- Imamain Al-Kadhimain Medical City Hospital between October 2011 to September 2014. Twelve patients had been treated with ORIF with 95 angled blade plates were matched to Twelve patients treated with close IM nailing, with regard to gender, age

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decade, and affected side ,depending on the Russell-Taylor classification of the fracture. (**Table 1**).

(Table 1): Characteristics of the 24 patients with closed subtrochanteric femoral fracture

Sex		Affected side		Total	
AGE(in yrs.)	male	Female	Left	right	
20 - 30	4	1	3	2	5
31 - 40	5	1	2	4	6
41 - 50	1	3	2	2	4
51 - 60	1	2	2	1	3
61 -70	1	5	4	2	6
Total	12	12	13	11	24

Fractures were classified according to the system proposed by Russell- Taylor's classification for simplicity and it is the one which is currently mostly used for clinical use.

Fractures with intertrochanteric extensions type II were not included only Type I was included . Demographic details of the patients, mechanism of injury, associated injuries, type of fracture, open or closed injury, time to union, malunion, nonunion, fixation failure and local and systemic complications were recorded. All skeletally mature patients presenting to the hospital with acute closed subtrochanteric femoral fracture.

Informed consent was obtained from each patient and approved the study protocol.

Inclusion criteria:
1. Aged at least 18 years at the time of diagnosis.
2. Closed subtrochanteric femoral fracture.
3. Russell- Taylor's Type I subtrochanteric femoral fracture.

Exclusion criteria:
1. Skeletally immature bone. (Open proximal or distal physes).
2. Russell- Taylor's Type II: Fractures that extend into the piriformis fossa
3. Those with ipsilateral femoral shaft or neck fractures.
4. Patient with peripheral vascular disease.
5. Patient with medical illnesses like diabetes, uremia, cerebral
vascular accident, metabolic disease.
6. Multiply injured patients, patients with head and chest injury.

Patients were randomised to **group l** - open reduction internal fixation with blade plating ORIF-(BP)- or **group ll** closed intramedullary nailing (IMN) treatments. (**Table2**).

Table 2: Characteristics of the 12 matched pairs of patients open reduction internal fixation using 95 º angled blade plate ORIF-(BP)-and closed intramedullary nailing -IMN-.

Group l ORIF –(BP) –				**Group ll – Closed IM nailing**			
Case	**Gender/age (years)**	**Follow-up (months)**	**revision surgery**	**Case**	**Gender/age (years)**	**Follow-up (months)**	**revision surgery**
1A	Female, 67	9	Nonunion	1B	Female, 64	6	Nonunion
2A	Female, 69	7	_	2B	Female, 61	5	_
3A	Female, 53	8	_	3B	Female, 57	4.5	_
4A	Female, 47	6	_	4B	Female, 42	5	_
5A	Female, 39	6.5	Fixation failure	5B	Female, 49	4	_
6A	Female, 66	7	_	6B	Female, 29	4	_

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7A	Male, 61	9	Nonunion	7B	Male, 56	6	_
8A	Male, 32	7	_	8B	Male, 37	4	_
9A	Male, 45	8	_	9B	Male, 38	4	_
10A	Male, 31	7.5	_	10B	Male, 25	4.5	_
11A	Male, 24	8	_	11B	Male, 28	4	_
12A	Male, 39	5	Fixation failure	12B	Male, 21	5	_

The purpose of the study is to measure the revision rate of surgery for both groups.
Revision surgery is due to: Nonunion, Fixation failure, varus deformity and a shortening of 2 cm.

The mechanism of the injury for close acute subtrochanteric femoral fractures included:- one pathological fracture from skeletal metastases of breast adenocarcinoma, 11 were due to motor vehicle injury, 5 fall from height and 7 were due to low energy trauma in osteoporotic patients.

Preoperative planning for all patient include:
1.General assessment.
2.Understanding of the mechanism of injury.
3.Good quality of radiographic imaging.
4.Blood investigation.
5.Prepare across matched of blood.

The **group l** - Place the patient in the supine position on a fracture table.
The surgical approach is through a straight lateral incision made in the skin along an imaginary line joining the greater trochanter with the lateral femoral condyle. At one time the surgical incision extended from a point above the greater trochanter to approximately a hand's breadth below the fracture. Split the fascia lata in line with the skin incision. Split the fascia of the vastus lateralis, and elevate the muscle off the intermuscular septum. Release the origin of the vastus lateralis from the trochanteric ridge. Open reduction, minimizing soft-tissue stripping of fracture fragments, once appropriate alignment has been achieved and internal fixation using a 95º-angled blade plate with or without interfragmentary screws.

The **group ll** - Place the patient in the supine position on a traction table, the supine position is preferred because of the ease of setup and radiographic visualization ,and percutaneous insertion of a IM nail using image intensifier .The foot of the affected limb is placed in a foot holder. The unaffected limb is extended away from the affected limb or flexed and placed in a leg holder. Check the affected limb for length and rotation by comparison to the unaffected limb. Abduct the torso 10°-15° to allow clear access to the intramedullary canal. Rotate the C-Arm to ensure optimal AP and lateral visualization of the entire femur. Small incision beginning approximately 3 cm proximal to greater trochanter and extended proximally. A small incision is deepened through the fascia lata.It splits the abductor muscles approximately 1 to 2 cm immediately above the tip of the greater trochanter and thus exposes its tip. A self-retaining retractor or tissue protection sleeve is put in place, the nail was inserted after reaming. In all patients the static locking mode was used, with 1 proximal and 1-2 distal locking screws.

Radiographs were used to determine the time for union of the fractures.

Union was defined as the absence of pain and instability at the fracture site and presence of bridging callus on the fracture site as seen on anteroposterior and lateral radiographs.[Jay, R. *et al*., 2009]

Delayed union was defined as a fracture that has failed to achieve full bony union by 6 months after the injury or a fracture taking longer to show progression toward healing than would normally be expected
Alignment was determined radiographically.[Jay, R. *et al*., 2009]

Non-union was defined as the absence of bridging callus, sclerotic fracture ends on 2 radiographic views or a fracture that has failed to show progressive evidence of healing over a 4- to 6-month period. In reality, a fracture has lost the potential to progress with healing, it is a nonunion.[Jay, R. *et al*., 2009]

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Fixation failure was defined as migration or failure of the implant, or loss of reduction deemed to require revision surgery.[Jay, R. *et al*., 2009]

As per our protocol, we removed the suture after 14 days.

We allowed the operated cases to stand and walk with non-weight bearing with crutches after 2 to 3 weeks.

After 3 weeks, patient allowed to partial weight bearing, followed by full weight bearing after 12 weeks for IM nailing fixation.

For plate fixation, the weight bearing was delayed; non weight bearing was advised for a period of 6 weeks. Partial weight bearing was advised when the patient could tolerate it without pain with crutches. Full weight bearing was delayed for 4 months.

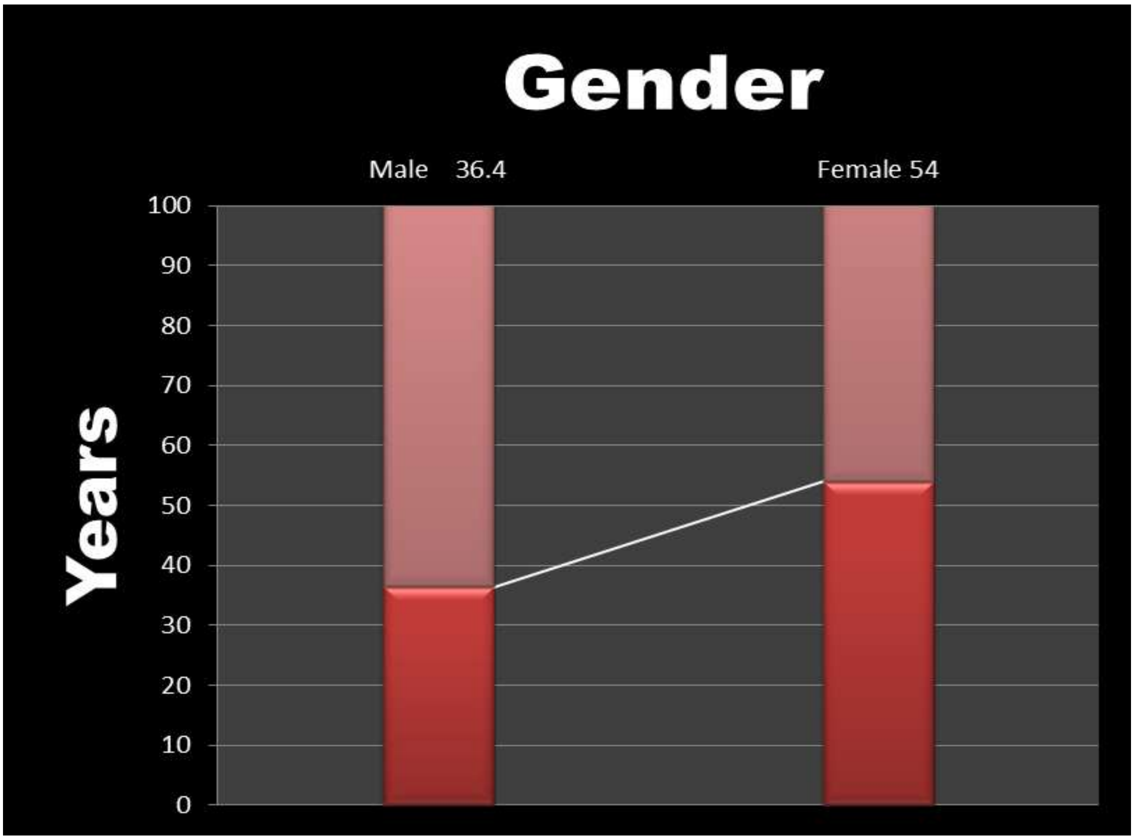
Postoperative radiographs were taken at 3 weeks, 6 weeks, 3 months, 6 months and 9 months.Radiographs were used to determine the time to union of the fractures. Radiographic union was defined as the presence of bridging callus as seen on anteroposterior and lateral radiographs.

For alignment measurement anteroposterior and lateral radiographs were made for both femoral bones, and assessed clinically by recording the longitudinal length of one leg compared with the other, measuring true leg length .To obtain the leg length the patient is supine. The legs should be 15 to 20 cm (4 to 8 inches) apart and parallel to each other, the examiner measures from the anterior superior iliac spine to the lateral or medial malleolus.

A slight difference (1 to 1.5 cm/0.4 to 0.6 inch) in leg length is considered normal; however, this difference still can cause symptoms.[47]. Active range of motion of the hip and the knee were assessed clinically. Strengthening exercises for the quadriceps, hamstrings and the gluteal muscles were done in bed and out of bed under the supervision of a physiotherapist. The range of motion of the hip and knee was examined during the follow-up.

RESULTS

The study population comprised 12 patients (6 male, 6 female) in Group I - BP group - and 12 (6 male, 6 female) patients in Group II- IMN group. The result of distribution of the age, sex and the affected sides in the [**Table-1**] show that the average age of the female patients was 54 years and it was 36.4 years for the males in **graph (1).**



Graph(1): Result of patient’s distribution according to age & gender

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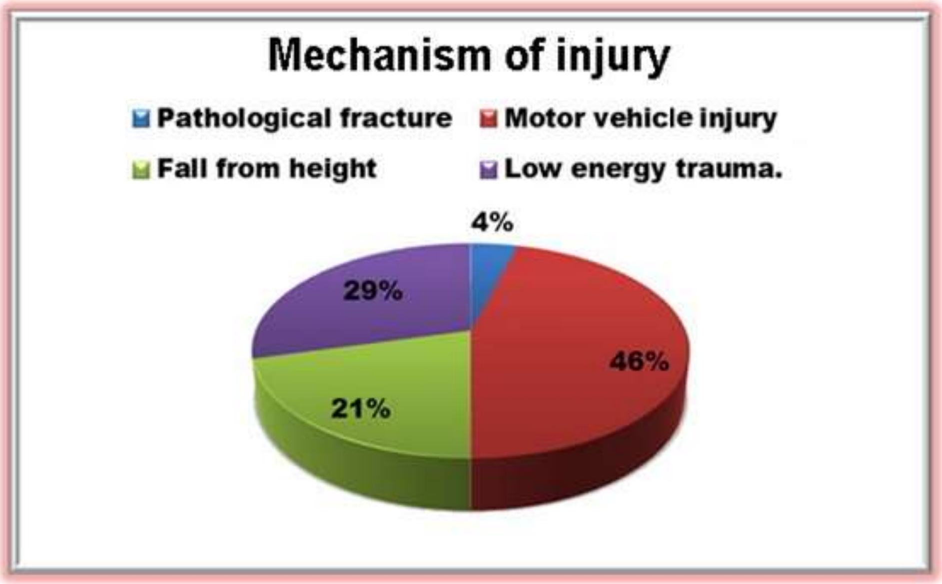
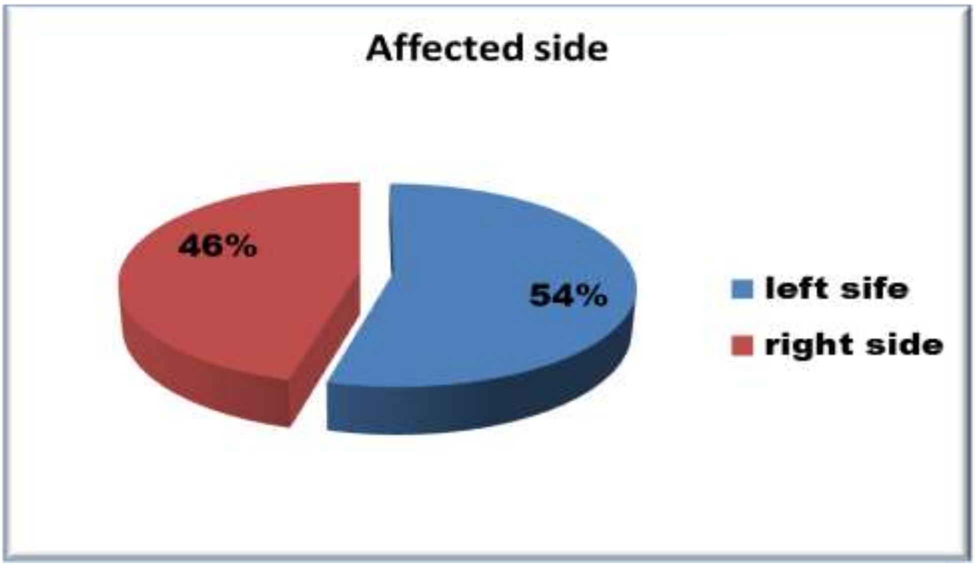
The mean age of Group-I was 47.75(range: 24-69) years and of Group-II was 42.25 (range: 21-64) years. There were no statistical differences between the groups **(p>0.05).**

Result of mechanism of injury and affected side - show that a high-energy traumas like traffic accidents 46 % were the leading cause of injury in both groups (6 patients in Group - I and 5 patients in Group - II). Followed by low energy trauma 29%, fall from height 21% & pathological fracture 4%. **Graph –(2).**



Graph-2: Result of mechanism of injury for closed subtrochanteric fracture.

No significant differences were noted between the 2 groups with respect to affected side **,p>0.05** . **Graph –(3).**



Graph –3: Result of distribution of the affected side.

The median time between admission to orthopedic department and definitive surgery was 4.7 days in Group I and 4.4 days in Group II (p>0.05). The mean duration of operation(inclusive anesthesia) in Group I was 176.8±20.4 min and in Group II was 162.0±20.1 min. There were no statistical differences between groups (p>0.05). [**Table-3**] Patients stayed in the hospital for an average of 10 days (mean: ORIF 9.6 days [range 4–15], IM nailing 8.2 days [range 4 to 12]). The Mean blood transfusion (units) in Group I was 4.3 and in Group II was 2.1 (p>0.05). [**Table-3**]

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Table 3: Result of treatment outcomes

Outcomes	Blade plating group l, n=12	Intramedullary nailing group ll, n=12	p value
The mean age (years)	**47.75**	**42.25**	**p>0.05**
Mean operating time (minutes)	**176.8**	**162.0**	**p>0.05**
Mean duration of hospital stay (days)	**9.6**	**8.2**	**p>0.05**
Mean blood transfusion (units)	**4.3**	**2.1**	**p>0.05**
mean union time (months)	**7.6**	**4.3**	**p<0.05**
No. (%) of Fixation failure	**2 (17%)**	**0 (0%)**	**p<0.05**
No. (%) of revision rate	**4 (33%)**	**1 (8%)**	**p=0.025**
Functional outcome	**Good**	**Excellent**	

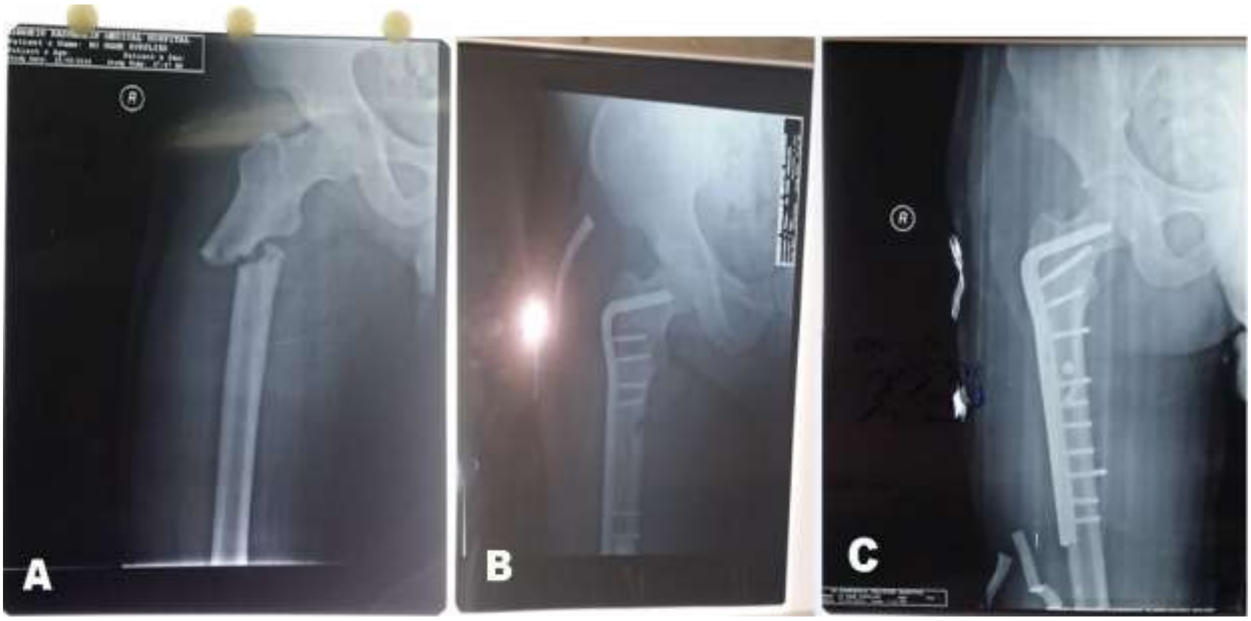

Figure 53: A. Pre-operative ,**B.** postoperative radiograph demonstrate blade plate & screws**, C.** another postoperative radiograph demonstrate blade plate and fragmentary screws.

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Figure 54:- postoperative radiograph demonstrate fracture union after using blade plate and screws.

Four patients in the Group I required revision two for non-union and two of them sustained implant failure and loss of reduction. This was significantly higher than that in the Group Il, in which **one** revisions were deemed necessary by nail exchange with bone graft .(p=0.025, **Table 3**). The mean time to radiographic union was 7.6 months (range 5 - 9 months) for the Group I versus 4.3 months (range 4 - 9 months) for the Group Il. [**Table-3**] One patient with pathological fracture due to skeletal metastasis from breast adenocarcinoma in the IMN group had non-union at 9 months without fixation failure, eventually achieving union after nail exchange with large nail from 11mm to 13mm nail with bone graft. No significant differences were noted between the 2 groups with respect to duration of hospital stay, operating time, receipt of blood transfusions, or mortality –(0% for both groups) . There were no patients in either group who had shortening of >2 cm.

None of the patients had varus/valgus malalignment of >5°.

Each group returned to work after a mean time of 6 months (Group I -ORIF 7.5 versus Group Il-IM nailing 5.3 months;). Anterior hip pain was significantly higher after ORIF than after IM nailing.

Figure 55: preoperative and postoperative radiograph internal fixation with IM nail.

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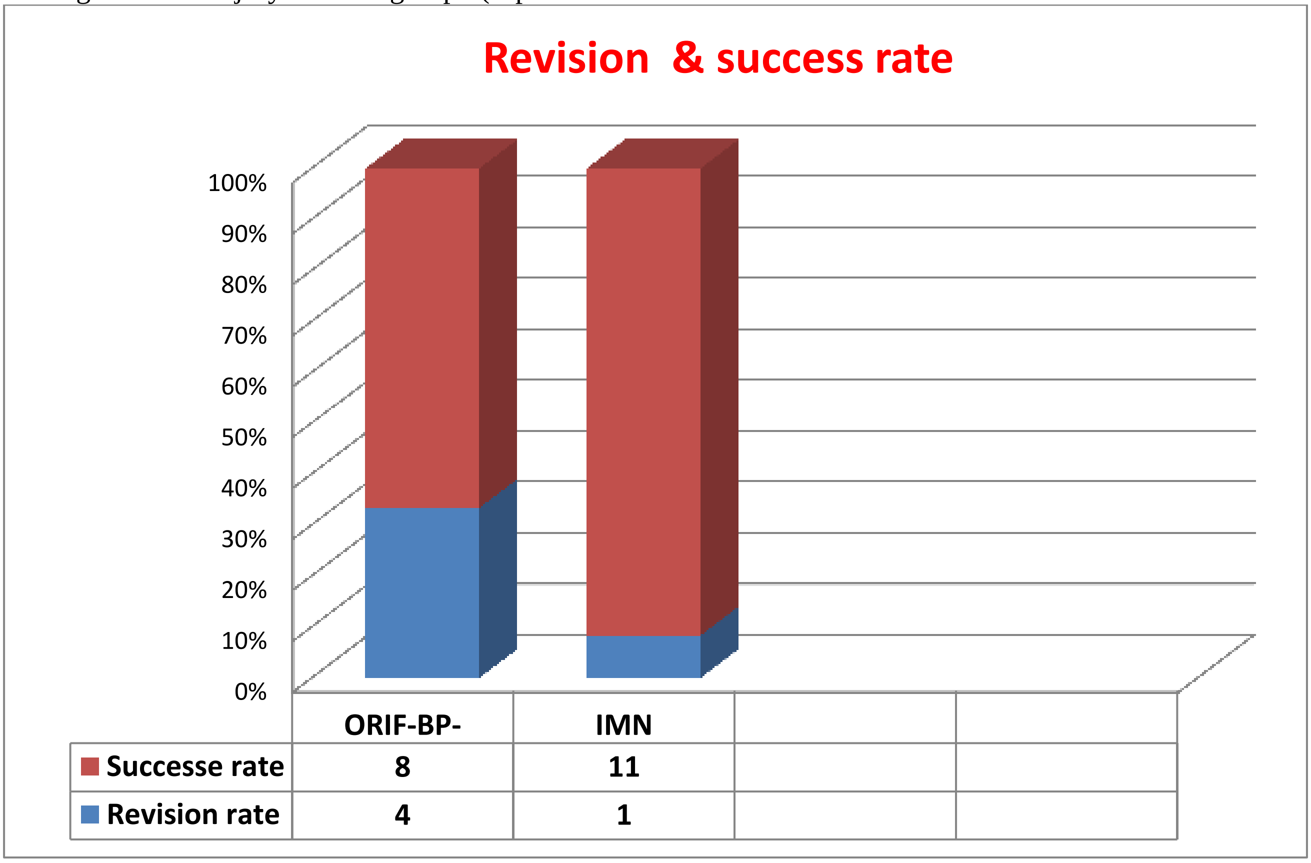
DISCUSSION

A bimodal age distribution is noted where young patients (usually male) mostly present with high-energy injuries, and the elderly (usually female) present with osteoporotic low-energy fractures. **Graph (1)** The average age of the female patients was 54 years and it was 36.4 years for the males. Parker *et al*. reviewed the epidemiology of Subtrochanteric fracture of the femur and showed that it accounted for 3.9% of all the proximal femoral fractures and that the average age was 74 years. It is common in older patients after low energy trauma along with osteoporosis and in younger patients with high energy trauma. [54].

Mechanism of injury - show that a high-energy traumas like traffic accidents 46 % were the leading cause of injury in both groups (6 patients in Group I - BP group and 5 patients in Group II IMN group). Followed by low energy trauma 29%, fall from height 21% & pathological fracture 4%. **Graph –(2).** No significant differences were noted between the 2 groups with respect to affected side **,p>0.05** . **Graph –(3).** Rijal, *et al*., 2007; Show that the mechanism of the injury is fall and direct lateral hip trauma, road traffics accidents, axial loading, fall form height and gunshot injury. [Rijal, K. P. *et al*., 2007]. In this study a higher percentage of revision after ORIF than after IM nailing. **GRAPH(4),** revision in 4 of the 12 patients (33%) treated with ORIF and only 1 of the 12 patients (8%) treated with IM nailing (p=0.025).

A p value of <0.05 (2-tailed) was considered statistically significant.



GRAPH(4): Comparison of the revision rate for the 12 matched pairs of patients.

DM Rahme,IA Harris *et al* show that revision in 8 of the 29 patients (28%) treated with ORIF-BP and 0 of the 29 patients (0%) treated with IM nailing (p=0.025).[53] Also a higher percentage of success after IM nailing than after ORIF . In this study success in 11 of the 12 patients (92%) treated with IM nailing and 8 of the 12 patients (77%) treated with ORIF (p=0.025).in **graph(5&6)**

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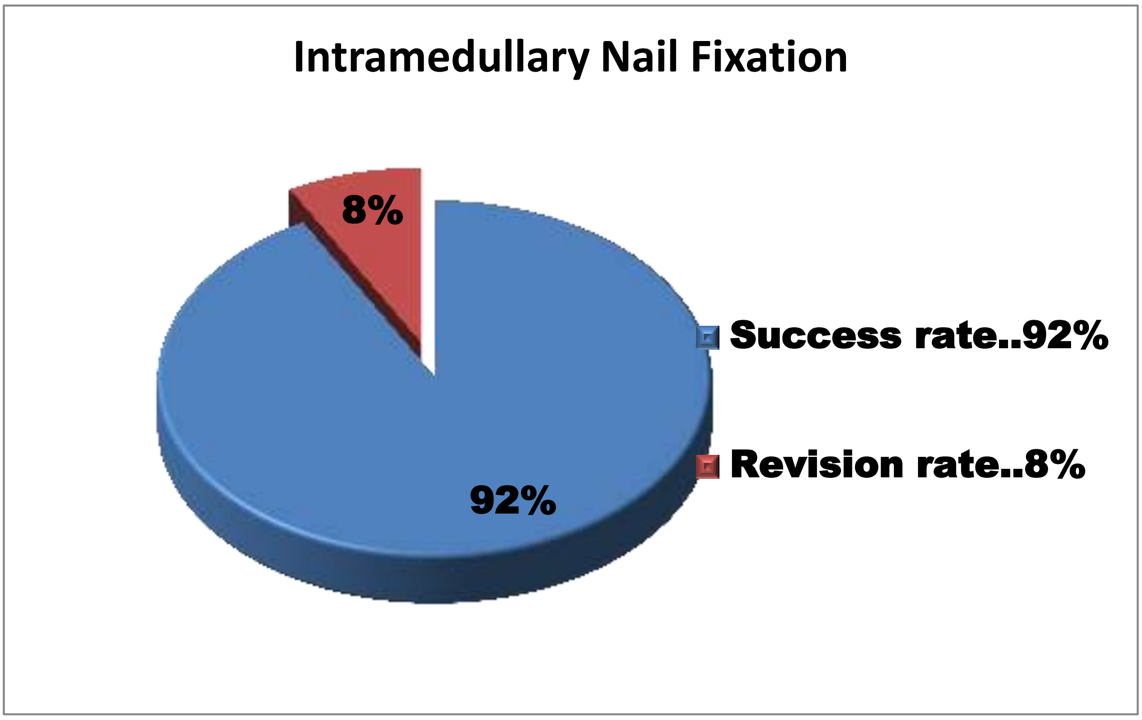
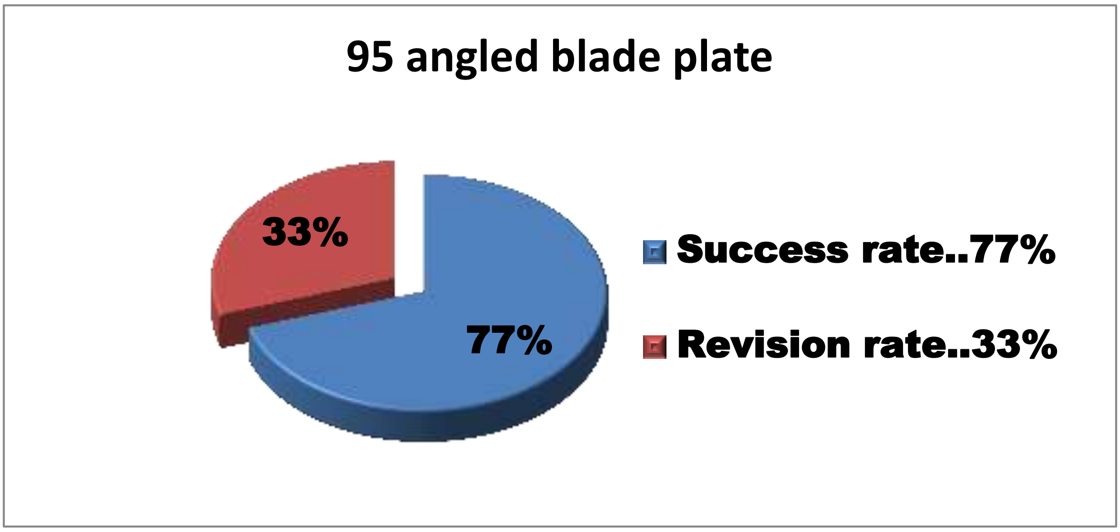


GRAPH-5: Comparison of the success& revision rate for the 12 patients treated with IM nailing .



GRAPH 6: Comparison of the success& revision rate for the 12 patients treated with ORIF-59-angled blade plate

The mean time to radiographic union was 7.6 months (range 5 - 9 months) for the ORIF group versus 4.3 months (range 4 - 9 months) for the IM nailing group. **GRAPH(7)**

A p value of <0.05 (2-tailed) was considered statistically significant. Sadowski, C. *et al*., 2002; radiological assessment show that , the average time of the union for the plate was 5.5 months and it was 3.5 months and for nail.[55].

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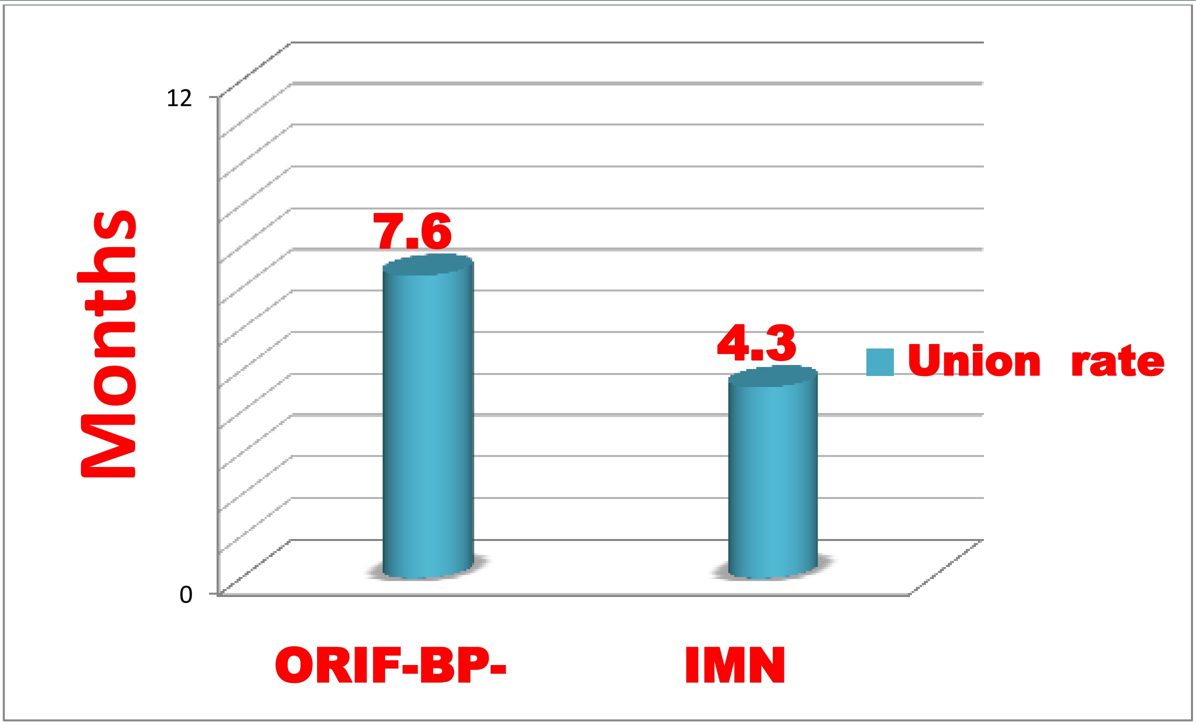

GRAPH 7: Comparison of the union rate for the 12 matched pairs of patients.

Comparison between intramedullary nailing and fixed-angle plating for subtrochanteric femoral fractures has been reported.[48,49]

Taneja *et al* show that the high success rate , a very low revision rate and rabid union with significant advantages of the IMN devices over the blade plate is due to[Taneja, D. K, 2001]:

- Shorter lever arm – so it is biomechanically stronger and the stress on the implant is less.
- Load sharing device instead of load bearing – less stress on the implant.
- Can be introduced without exposing the fracture site –fracture haematoma not disturbed, hence chances of the union are more and faster.
- Transmits weight close to the calcar and has greater mechanical strength.
- Distal locking screw provides length and rotational control and early weight bearing.

Intramedullary interlocking nailing despite being technically simple procedure in expert hands we experienced few difficulties in mastering its technique like difficulties in entry point, distal free hand technique and fractures reduction. The prospective design of this study has some limitations. Selection bias is introduced by the fact that the surgeon decided which operative treatment is to be performed. Some of the bias was eliminated by the matching of patients. To maintain a sufficient number of patients, matching only included gender, age decade, and Russell-Taylor's classification of the fracture. The median time between admission to orthopedic department and definitive surgery was 4 days for both groups only for hemodynamically stable patients without head and chest injury, because according to most authors, early surgery means fixation in the first 24 hours.[Brundage, S. I. *et al*., 2002] However, if other system injury accompanies femur fracture, early surgery may cause pulmonary embolism, adult respiratory distress syndrome or multiple organ failure in hemodynamically unstable patients.[Brundage, S. I. *et al*., 2002] Pape *et al*.,[1993] Jaicks, *et al*.,[1997] and Townsend, *et al*.,[1998] reported that early fixation of femur fractures in patients with head and chest injury increases morbidity and mortality rates.

Surgery is the default pathway of treatment except in the rare situation of high risk of medical complications for surgery.[Sivananthan, S. *et al*., 2012]. In modern trauma care, there is no role of conservative treatment, as was advocated by Delee, *et al*., [1981]. The treatment of Subtrochanteric fractures was mainly focused on ORIF by using various implants with or without bone graft and cerclage wiring [Rijal, K. P. *et al*., 2007].Plating was blamed for extensive surgical exposure, severe soft tissue damage, severe blood loss, non-union and implant failure. Eccentrically, plating usually resulted in fatigue breakage due to a mechanical load shearing effect. [Rijal, K. P. *et*

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al., 2007] High biomechanical stress, poor vascularity and lack of cancellous bone predispose subtrochanteric fractures to non-union, malunion and implant failure. [Sivananthan, S. *et al*., 2012] Despite anatomic reduction, the mode of failure in the group-l was from non-union fracture side or plate breakage (**Figure.56.**), rather than loss of fixation in osteoporotic bones. The strength of blade plates may not be sufficient for such fractures. The dissection needed for BP also devascularises the bone and the surrounding soft tissues, leading to delay in healing.

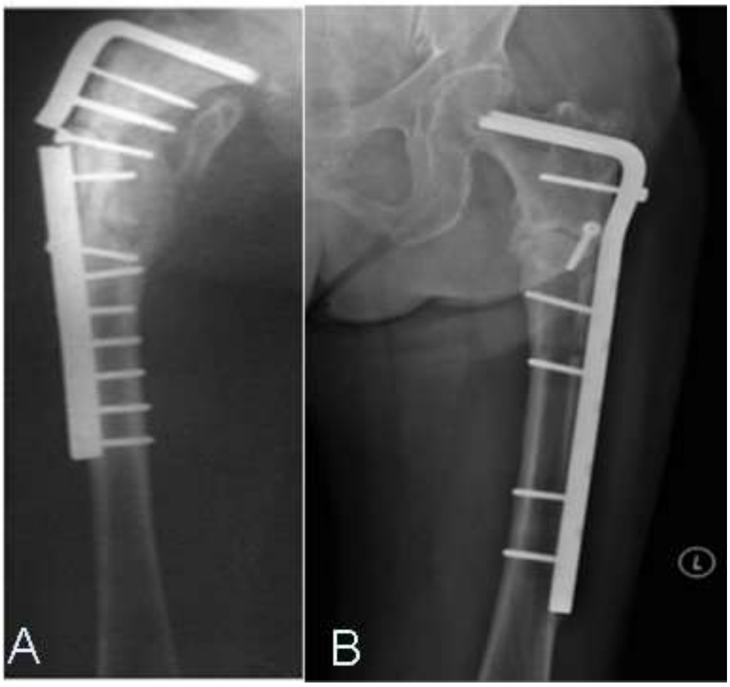

Figure 56: 95° angled blade plate. A. plate failure and B. nonunion of subtrochanteric femoral fracture

The findings in the present study were consistent with the trend towards intramedullary nailing over fixed-angle plating for the treatment of subtrochanteric femoral fractures. Intramedullary nailing had a more biological and mechanical advantage and it was accepted as an implant of choice. Most important for success is the correct entry point; the laterally shifted entry point should be on the top of the greater trochanter in the AP view and in line in the center of the femoral canal in the lateral view. In the present study, the using of Intramedullary interlocking nailing had quite satisfactory results. The overall result of the 95 fixed angle blade plate was not satisfactory because of the longer duration which it took for healing, Nonunion and fixation failure. Intramedullary interlocking nailing, as implants of choice, healed the fractures uneventfully and the walking and squatting abilities were completely restored with the bone union. The interlocking nail is preferred because there is a better control of the rotation and the length can be confirmed by biomechanical and clinical studies. Load sharing devices allow compression at the fracture site, with good results.

Intramedullary interlocking nailing is a reliable implant, leading to good union and less soft tissue damage. It has a biomechanical advantage,but it is a technically demanding operation. Long of the Intramedullary interlocking nail irrespective of the degree of proximal comminution. It is also clear that the overall results of IM nailing are better than those of plate fixation, according to Parker, *et al*., (1997). Intramedullary interlocking nailing still remains one of the optimum methods of fixation of Subtrochanteric fractures. [31]. Complications like infection, and heterotrophic ossification were not encountered in this study. Generally, fixation with intramedullary nails offers better results than extramedullary fixations with plate and screws.[Sivananthan, S. *et al*., 2012]

CONCLUSION

From this study can conclude that :-

1.Intramedullary interlocking nailing gave a better control of the rotation, length particularly in unstable patterns at high risk for shortening and proximal purchase.

2.The load shearing nature of this implant which allowed compression at the fracture site and even in the osteoporotic bone and its location had

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decreased moments as compared to the fixed angle plate will decreased the complication rates reported . So, we recommend the Intramedullary interlocking nail as one of the better methods of fixation than fixed angle plate osteosynthesis.

3.Internal fixation using a fixed angle blade plate for subtrochanteric femoral fractures has higher implant failure and revision rates, compared to closed intramedullary nailing. Despite the introduction of newer designs, better quality of the implant and improvement in the technique, fixation is still a challenge for the orthopaedic surgeons. Search for an ideal implant and an ideal method of fixation in this complex situation is still going on.

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