

**“EVALUATION OF OUT COME OF
INTERTROCHANTERIC FRACTURES OF
FEMUR TREATED WITH DYNAMIC HIP SCREW
WITH LOCKING PLATE”**

By

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DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF
HIGHER EDUCATION AND RESEARCH, KOLAR, KARNATAKA

In partial fulfillment of the requirements for the degree of

**MASTERS OF SURGERY
IN
ORTHOPAEDICS**

Under the Guidance of

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FEMUR TREATED WITH DYNAMIC HIP SCREW WITH
LOCKING PLATE”**

To be submitted to the

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ACKNOWLEDGEMENT

I owe my debt and gratitude to my parents **Shri. J.SIVA PRASAD** and **Smt.J. LAKSHMI RAJESWARI** , along with my brother **J.TRILOK** for their moral support and constant encouragement during the course of the study.

I owe my debt and gratitude to my grandparents late **Shri. M.GANGI SHETTY** and late **Smt. VENKATA SUBBAMA** for their blessing.

With humble gratitude and great respect, I would like to thank my teacher, mentor and guide **Dr. B. SHAIKH NAZEER, M.S.**, Professor, Department Of Orthopaedics, Sri Devaraj Urs Medical College and Research Institute, Kolar, for his able guidance, constant encouragement, immense help and valuable advices which went a long way in moulding and enabling me to complete this work successfully.

I have great pleasure in expressing my deep sense of gratitude to **Dr.ARUN H.S**, Professor and Head, Department Of Orthopaedics, Sri Devaraj Urs Medical College and Research Institute, Kolar. Without his initiative and constant encouragement this study would not have been possible.

I would like to express my sincere thanks to **Dr. SATYARUP, DR.MANO HAR P.V, DR.S.N.PATIL**, Professors, Department Of Orthopaedics, Sri Devaraj Urs Medical College for their valuable support, guidance and encouragement throughout the study.





I would also like to thank **Dr. NAGAKUMAR, DR.PRABHU** Associate professors, Department Of Orthopaedics, Sri Devaraj Urs Medical College for his wholehearted support, constant encouragement and guidance.

I also would like to thank **DR.HARI PRASAD, DR.ANIL KUMAR S.V, DR.MAHESH KUMAR, DR.SRINIVAS, DR.SAGAR, DR.RANAGANATH K.V, DR.PRABHU PATIL, DR.ASHIQ** Assistant professors, all my teachers of Department Of Orthopaedics, Sri Devaraj Urs Medical College, Kolar for their support.

I am thankful to my fellow postgraduates, **especially Dr. AYANAKSHA MALLICK, Dr. VAIBHAV MITTAL, Dr.KARTHIK REDDY, Dr. SACINDRA NAIK, Dr. UTKARSH WAYAL, Dr.PRATHAP U.S and Dr. KESAV MURTHY** , My seniors **Dr .PRANEETH, Dr. NAGARJUN.A, Dr .NAGARJUNA.B, Dr. NITHIN TEJA, Dr. CHARAN.N, Dr. CHAKRADHAR REDDY, DR.RAJYA LAKSHMI, Dr.REHMAN** for having rendered all their co-operation and help to me during my study.

I am also thankful to all my juniors , **especially Dr. HARSHA .M , Dr. RONAK.D ,Dr.ABHIMANYU, Dr.ABHISHEK YADAV ,Dr. SHARATH CHANDRA, Dr.RAM MANOHAR, Dr. ROGER .X, Dr. CECIL FIDO, Dr. SAKTHI K7** , of Department of Orthopaedics , R.L Jalappa Hospital & Research Centre, Tamaka, Kolar for their help

I am also thankful to interns **especially Dr. SINDHURA.J, Dr. RASHMI.R, Dr. SAMBA SIVA RAO.P, Dr. AKSHAY.V.S , Dr. KARTHIK.S, Dr. ASHWINI.G, Dr. USHA BALKRISHNAN** R.L Jalappa Hospital & Research Centre, Tamaka, Kolar for their help.





I am also thankful to all my friends especially **Dr.PRASUNA B.M.S.J , Dr.RADHIKA, Dr.MYTHREYI, Dr.DIVYA, Dr.SIDDARTHMEHTA, Dr.PRASANTH, Dr.RAVINDRA NAIK.B , Dr.PRAVEEN NAIK, Dr.ABHINOV.T, Dr. AMRUTHA MAKAM, Dr. PRINCY, Dr. KAVYA , Dr.LAKSHMI SWAMY ,Dr.NIKILA.D.G, Dr.KEERTHI .M , Dr.VIKAS , Mrs. MADHU MOUNICA** for their moral support and constant encouragement during the course of the study.

I am also thankful to **DEPARTMENT OF ANAESTHESIA & DEPARTMENT OF RADIOLOGY, R..L Jalappa Hospital & Research Centre, Tamaka, Kolar** for their help.

I am also thankful to nursing staff ,OT brothers and supporting staff
PRABHAKAR,ARUN,SURENDRA,NAVEEN,VISWANATH,MURALI,CHIR ANJEEVI,RAMANI,NANJAPPA,AMBRISH

I am extremely grateful to the patients and their families who volunteered to this study, without them this study would just be a dream.

Last but not least I would be failing in my duty if I do not express my gratefulness to the **Almighty**, who helped me to successfully complete this study

Dr. JISHNU JONNALAGADDA



ABSTRACT

Background :

Intertrochanteric fractures of femur account for nearly 50% of fractures around hip. 90% occur in elderly due to trivial fall. Although intertrochanteric fractures unite invariably with conservative treatment, high rate of complications associated with this method make stable reduction and rigid internal fixation and the early mobilization as the method of choice along. Although many devices can achieve rigid fixation, the Dynamic Hip Screw [DHS] is the most commonly used device for intertrochanteric fracture of femur. The most common mode of failure with this device is DHS lag screw cut out of the femoral head and the plate lift off from the femur with the screws being pulled out of the osteoporotic bone. To prevent pulling out of screw, screw toggling, the side plate is modified from non-locking to locking type, which lead to new implant Dynamic hip screw with locking side plate

Materials and Methods:

30 patients (18 male and 12 female) underwent closed reduction and internal fixation with DHS with locking side plate at Department of Orthopaedics, RLJ hospital attached to Sri Devaraj Urs Medical College, Tamaka Kolar during August 2015 To June 2017.

Results:

Excellent results were obtained in 10 cases, good in 16 cases and fair in 4. Most common complications encountered were occasional pain and limp.

Interpretation and conclusion:

The study showed dynamic hip compression screw with locking side plate is a reliable and effective device for the treatment of trochanteric fractures and has slighter edge over dynamic hip screw with regular side plate in terms of early weight bearing , union of fracture, and over all out come.

Dynamic hip screw with locking side provides satisfactory fixation but success is dependent mainly on fracture type, bony architecture, and position of screw, postoperative care and rehabilitation. A telescoping screw offers biomechanical advantage. The principle of sliding allows positive compression at fracture site. Use of locking screw will prevent pulling out of screw and screw toggling. This study showed Dynamic hip screw with locking slide plate to be a versatile, stable, acceptable implant fixation in trochanteric fractures

Key words: Trochanteric fractures; femur; hip fracture; DHS with locking side plate .



LIST OF ABBREVIATIONS

AAOS: American Academy of Orthopaedic Surgery

AD: Anno Domini

AO: Association of Osteosynthesis/ Arbeitsgemeinschaft osteosynthesefragen

AP: Anteroposterior

ASA: American Society of Anesthesiologist

COPD: Chronic Obstructive Pulmonary Disease

DCS: Dynamic Condylar System

DHHS: Dynamic Helical Hip Screw

DHS: Dynamic Hip Screw

DM: Diabetes Mellitus

HTN: Hypertension

K-Wire: Kirschner Wire

PFLCP: Proximal Femoral Locking Compression Plate

PMDO: Primary Medial Displacement Osteotomy

PFN: Proximal Femoral Nail

RTA: Road Traffic Accident

TBP: Trochanteric Buttress Plate

TAD: Tip Apex Distance

TSP: Trochanteric Stabilising Plate

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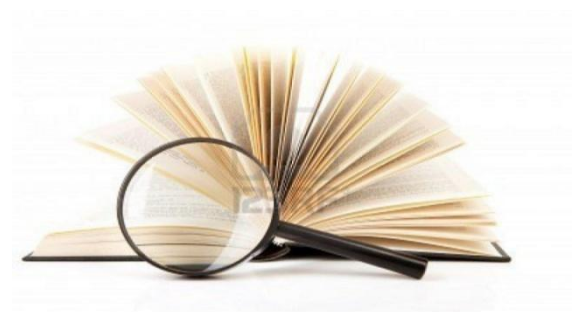
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AIMS AND OBJECTIVES

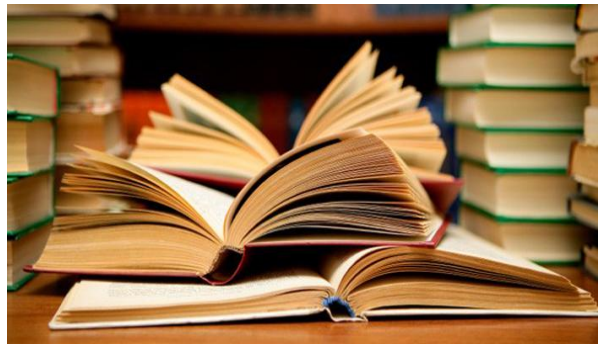


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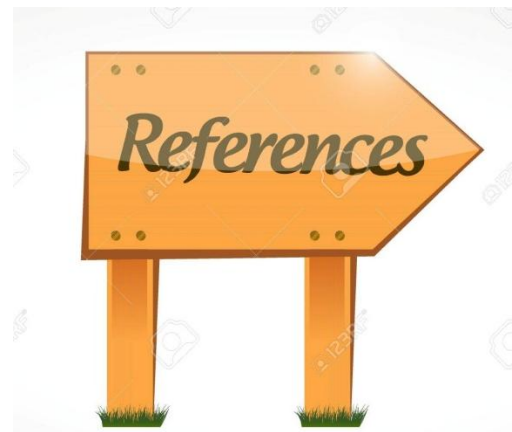
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INTRODUCTION

Intertrochanteric fractures (IT) of femur account for nearly 50% of fractures around hip. It continues to be a major cause of disability leading to reduced quality of life and death in the elderly⁽⁷⁷⁾. They are commonly seen in patients over 50 years of age, mostly due to trivial trauma. Incidence has increased primarily due to increasing lifespan & sedentary life style brought by urbanization. Intertrochanteric fracture of femur can also occurs due to high velocity trauma and fall from height in younger population⁽⁷⁷⁾.

These fractures are more common in females compared to males due to osteoporosis^(1,2).

Trochanteric fractures present a huge threat to life. If they are not treated adequately may cause a considerable change in quality of life and increase mortality or morbidity.

Intertrochanteric fractures represent perhaps the most important public health problem facing the orthopedics surgeon today. Being common in aged patients, would need more care and sort out an effective treatment option available today to reduce morbidity and provide mobility.

More than 280,000 hip fractures occur in the United States every year, and this incidence is expected to double by 2050. These fractures are associated with substantial morbidity and mortality; 30% of elderly patients die within 1 year of fracture⁽⁵³⁾.

In geriatric population, fall is the leading cause of nonfatal injuries and hospital admissions. Proximal femur fractures are divided into three categories:

1. femoral neck
2. intertrochanteric fractures
3. subtrochanteric fractures

Although intertrochanteric fractures unite invariably with conservative treatment because of good blood supply and broad area of contact between two fragments, high rate of complications associated with this method are decubitus ulcer, urinary tract infections, pneumonia, thromboembolic coxa-vara deformity limb length discrepancy makes this method abandoned. . Conservative methods are now indicated under 2 conditions,

- (i) Elderly person with high medical risk for anesthesia and surgery.
- (ii) Non ambulatory patient with minimal discomfort following injury. Rigid Internal fixation and early mobilization has been the standard method of treatment. Intrinsic factors such as osteoporosis and communication are beyond the control of surgeon. Extrinsic factors like choice of reduction of the fracture, the type of implant used and technique of its application are within his control⁽⁷⁸⁾.

If proper precautions are not taken fractures unite in coxa vara deformity resulting in shortening, and limits hip movements.

While rehabilitation interventions to decrease the risk of falls and thus prevent hip fractures are of utmost importance, post-fracture rehabilitation care is

also crucial. A combination of orthopaedic surgery and early postoperative physiotherapy and ambulation is the best approach. The overall goal in the treatment of hip fractures is to return the patient to previous level of function.

Rigid fixation with early mobilization of the patient is the goal of treatment in intertrochanteric fracture of femur. Restoration of mobility in patients with intertrochanteric fracture ultimately depends on strength of surgical construct.

Implants for the fixation of inter-trochanteric fractures can broadly be divided into

1. Extra medullary devices, ex:-DHS, DHS with LockingPlate.
2. Intramedullary devices ex:- PFN(Proximal Femoral Nailing)

Stable IT fractures are commonly treated with DHS with failure rate of less than 6%.

Although many devices can achieve rigid fixation the Dynamic Hip Screw is the most commonly used device for intertrochanteric fracture of femur⁽⁷⁶⁾. The DHS lag screw easily glides within DHS plate barrel for controlled collapse and impaction of fragments leading to uneventful healing and early mobilization⁽⁴⁷⁾.

In osteoporotic bone, normal screws in Dynamic hip screw blade provide less anchorage compared to locking screws. Various kinds of problems are encountered in the fixation of trochanteric fracture by standard compression plate, especially in severe osteoporotic bone. There is increasing incidence of implant failure like lifting off of plate, pulling out of screws, screw toggling, screw breakage and cut-out, failure of lag screw particularly in unstable fractures, resulting in implant failure and mal- or non-union. To prevent pulling out of screw, screw toggling, side plate is

changed to locking type, lead to new implant Dynamic hip screw with Locking plate^(57,85).

The patients with intertrochanteric fractures were treated with dynamic hip screws and locking plate system. This study was undertaken in our hospital to determine the efficacy of the Dynamic Hip Screw with locking plate and complications associated with the procedure in rural population.

AIMS AND OBJECTIVES

1. To study the functional outcome of surgical management of intertrochantric fractures in adults with dynamic hip screw with locking side plate.
2. To study the effectiveness and complications of operative management of these fracture using dynamic hip screw with locking side plate, Analyze advantages and disadvantages of the procedure .
3. Study etiopathogenesis of trochanteric fractures with respect to age, sex, incidence, occupation.
4. Study the failure rates of surgical treatment using DHS with locking side plate and associated morbidity with the procedure.

HISTORICAL ASPECTS

Greece was the center of culture as well as medical development. The basis for the scientific study and practice of medicine arises from 'Corpus Hippocraticum' the remarkable systematically treatise of medicine and surgery written elaborately lengthily by physician of Alexandrian school between 4th century BC and 1st century AD and ascribed to Hippocrates. This book is quite modern and includes use of traction, manipulation and splints.

Shushrutha the great storehouse of Aryan surgery in 5th century AD divided fractures into 12 types and dislocations into 6 types. He has also described the clinical features of fractures. He treated fractures and dislocation with a special splint made of bamboo stick, which was subsequently adopted by British army "patient ratten care" splint.

Egyptians also practiced orthopaedics and have recorded the use of crutches. Their method of treating fractures and is not so different from some recent methods.

The great French surgeon "Ambrose Pare" first described the fracture at the upper end of femur in 1564.

Sir Astley Cooper (1768-1841), the outstanding English surgeon, published his book on management of fractures and dislocations (1825). He classified the fractures at the upper end of femur into Intracapsular, Extra capsular, Fractures through trochanter.

This classification is still valid. He has also recognised the difference in prognosis of intra capsular and extra capsular fractures of neck of femur.

In 1860, Buck introduced adhesive plaster traction in the treatment of fractures.

In 1895, Roentgen discovered X-rays, an event which has resulted in great advances in diagnosis and treatment of fractures.

In 1895, Kocher published a classification of fractures at the upper end of the femur an improvement over Cooper's classification.

The Balkan frame, devised by the Dutch during the Balkan wars in 1903, proved a great value in the treatment of fractures by suspension and traction.

In 1909, Steinmann introduced skeletal traction using Steinmann pin or 'K' wire which form part of conservative treatment of fractures of proximal femur.

Sir Arbuthnot Lane of London reported the internal fixation of fractures with metal plates and screws in 1894 and Albin Lambotte of Belgium also reported this.

In 1949, Boyd and Griffin first classified the intertrochanteric fractures. In the same year E. Mervin Evans classified intertrochanteric fractures as stable and unstable.

REVIEW OF LITERATURE

Before 1930, treatment of trochanteric fractures were basically conservative, using Russell's traction, skeletal traction, counterpoised suspension and well leg traction. None of these approached fractures directly, none provided immediate reduction and rigid fixation of or early ambulation and resumption of normal functions ⁽¹⁾.

In 1930, Jewett introduced Jewett nail to provide immediate stability of fragments.

The introduction of the Triflanged nail by Smith-Peterson (1931) for treatment of fracture neck of femur has resulted in a great reduction of mortality and improvement in the percentage of union^(15,83).

Johansson in 1932 and West Cott in 1934 introduced the cannulated hip nail for more accurate placement in the femoral head. This technique was the precursor for the current techniques of using guide pins for accurate placement of fixation devices in the stabilization of hip fractures ⁽⁸⁰⁾.

In 1934, Austin T Moore began to treat intertrochanteric fractures with open reduction and internal fixation. Initially nailing, bolting-protruding pins were used but with fixation was inadequate .

Lawson Thornton, in the year 1937 developed a plate to be attached to the Smith Peterson nail, called the Thornton plate. This was a breakthrough in the history of operative treatment of trochanteric fractures ⁽¹⁾.

Gerhard Kuntsher in 1940s developed the double nail to treat complex fractures of the hip and femoral shaft ⁽⁸³⁾.

In early 1940s, Austin T Moore published the complications of intertrochanteric fractures such as mal-union, varus deformity, prolonged hospital stay, expensive nursing care and joint stiffness .

He began to use an appliance which held the upper fragment by a blade in the head and lower fragment by a plate on the shaft of femur.

It was made of steel, 8 inches long and angled 135° to correspond to the angle of neck and the shaft of the femur. Milwaukee suggested its used for tproximal femoral osteotomies and named it “blade plate”⁽⁸³⁾.

Britain, in the year 1942, introduced low nail in order to eliminate varus and rotatory deforming forces ⁽⁸³⁾.

In 1947, McLaughlin introduced the adjustable nail plate combination. He used triflanged nail with its lateral end having a slot to which a plate is fixed with a washer and bolt⁽⁶⁾.

In 1949, Mervin Evans devised a classification dividing trochanteric fractures into stable and unstable types. He presented 101 cases treated conservatively and 22 case treated by internal fixation with Capener Neufeld nail plate and suggested that internal fixation of trochanteric fractures has the advantages of early mobility of the patient and lowered mortality⁽⁷⁾.

In the same year, Boyd, Griffin first classified the types of intertrochanteric fractures⁽⁸⁾.

In 1950, Earnest Roll of Germany was the first to use a sliding device for internal fixation of trochanteric fracture

Hafner in 1951 reported trochanteric fractures treated with the 'Low Nail' technique of, Brittain H.A. and described the advantages of the low nail. He preferred internal fixation over other methods⁽⁹⁾.

Pugh and Badgley, in the year 1955, introduced a sliding device with trephine tip in USA. In the same year, Schumpelick et al. described the use of a sliding nail⁽⁷⁾.

In 1957, Clawson studied both stable and unstable fractures fixed internally with a nail plate and found that 41% of the them go into varus and concluded that for the unstable fractures traction was better⁽¹⁰⁾.

In 1960, the USA based 'Richards manufacturing company' produced dynamic compression screw and hence is also known as Richard's screw.

In 1964, Clawson reported the treatment of trochanteric fractures using Sliding Compression Screw and Jewett Nail. In 39 stable fractures treated with sliding screws there was only 5.2% failure rate. In the 26 unstable fractures treated with sliding screws the failure rate was 11.5%. In the fractures stabilized with Jewett

nail plate device, most of which were stable fractures failure rate was about 32%. Mr. Ian McKenzie of the Royal National Orthopaedic Hospital used the Sliding Compression Screw used for trochanteric fractures. Clawson made several modifications and in its current form the device is known as the **Richard's Compression Screw**.⁽¹¹⁾

In 1967, Dimon and Hughston dealing with unstable trochanteric fractures said that if these fractures were nailed conventionally, the nail may penetrate the femoral head and enter the acetabulum, bend or break as the fracture collapses or may cut out through the head and neck as the fracture sets in the varus position. In order to prevent these complications they evolved a new method of fixation termed primary medial displacement osteotomy [PMDO]. In their series complication reduced to 8% contrast to Jewett nail fixation alone⁽¹²⁾.

Holland and Gunn in 1972 reviewed 50 trochanteric fractures treated by Sliding hip screw and confirmed that stable fracture could be satisfactorily fixed with any rigid internal fixation device⁽¹³⁾.

Augusto Sarmiento in 1973 emphasized that the reduction of the medial cortex determines the efficiency of the metallic appliances. Improper reduction of medial cortex resulted in collapse into varus with migration of the nail from the neck. Fractures nailed after accurate reduction of the medial cortex can withstand stresses several times greater than the nail itself. Osteotomy gives maximum stability and in addition would change the angle of inclination of the fracture to a less vertical degree and introduces a valgus attitude to the proximal femur. Sarmiento also

mentions that in some fractures medial comminution is so extensive that osteotomy will not create enough bony contact to ensure stability⁽¹⁴⁾.

Collado in 1973 introduced the condylocephalic nailing method. The condylocephalic nail is a clover leaf intramedullary nail, slightly curved. It is passed upwards into the medullary cavity from the medial condyle of the femur into the proximal fragment of the fractures, which has obvious advantage that, the fracture site is not opened and hence infection is prevented. The procedure is simple and the position of nail is favorable as it is in the long axis of the shaft and corresponds to the direction of mechanical forces acting on the fracture line⁽¹⁵⁾

Sahlstrand T in 1974 reported the results of using the Richards Compression Sliding Hip Screw system, in the treatment of 48 trochanteric fractures. He noted that this system could stabilize the fracture to such an extent that it is possible to mobilize the patient to walking with full weight bearing on the operated leg within a few days. The results were also compared with those previously obtained when Mac Laughlin plate was used, and the advantages were in the form of better fixation, easy rehabilitation, and a shorter length of hospitalstay⁽¹¹⁾.

Malcolm. L Ecker, John J Joyce, Kohl EJ in 1975 treated 104 intertrochanteric fractures in 102 patients with compression screw. They observed that union occurred in 59 of the 62 patients the average healing time being 15 weeks and average time to weight bearing was 14 weeks. This study showed the compression hip screw to be a reliable, versatile and effective device for the treatment of all types of intertrochanteric fractures⁽¹⁶⁾.

Jensen et al. in 1978, reported 80 unstable fractures stabilized with compression screw, and the overall rate of joint penetration and cutting out of the device was 5.3%⁽¹⁷⁾.

Doherty John H, and Lyden John, in 1979, reported 75 patients treated with hip compression screws. They concluded that central placement of the screw in the femoral head with its tip 10-13 mm. from the subchondral bone is ideal and the design of the compression screw allows increased stability and impaction of the bone fragments in an intertrochanteric fracture⁽¹⁸⁾.

Richardson S Laskin, Martin A Gruber, Alan J Zimmerman, in 1979, treated 236 patients with intertrochanteric fractures by compression hip screw. Bony union occurred in 234 patients, non union occurred in 2 patients in whom there was excessive medial displacement of the distal fragment. Other mechanical complications included one case of aseptic necrosis and one case of screw and side plate separation. None of the implants were noted to either break or bend during post operative evaluation

Period. They concluded that rigid fixation with interfragmentary compression using a compression hip screw permitted early mobilization and immediate weight bearing⁽⁵⁾.

Jensen in 1980 modified the existing Evans classification after treating the 234 trochanteric fractures with sliding hip screw. The first class would include the stable 2-fragmentary fractures (Evans Types 1 and 2) , which can be anatomically

reduced in both planes. The second class would contain fractures (Evans Types 3 and 4) in which it is difficult to obtain reduction in one plane and the third class those with difficulty of reduction in all planes⁽¹⁹⁾.

Kyle and Wright in 1980 concluded that the higher the nail plate angle, the easier it is to impact the hip fixation device and thus allow bone impaction and stability at the fracture site. The potential for jamming a sliding hip screw is decreased by maximum engagement of the screw in the barrel⁽²⁰⁾.

Wolfgang in 1982 discussed 317 intertrochanteric fractures, in 302 patients treated by sliding screw plate fixation and argued that an acceptable result may not be obtained due to errors of patient selection, operative technique and postoperative care. Stable reduction was seen to be more important than the fixation device. Medial displacement reduced a number of complications as seen by several others. Mechanical fracture complications occurred in 9% of 142 stable fractures and 19% of 37 unstable fractures. The sliding screw side plate device provided satisfactory results but depends on many factors including reduction, operative technique and postoperative care⁽²¹⁾.

In 1982 Gathercole and Pena fixed 112 trochanteric fractures, with Jewett nail plate in 81 patients and Thorton nail-McLaughlin plate in 31 patients. Penetration of the nail into or through the hip joint was the only complication studied in detail. It occurred in 41 cases: 31 (38 per cent) with the Jewett nails and 10 (33 per cent) in the other group. Both groups are comparable in that the nail plate acts as a single rigid unit and the nail/plate angle varied, but the overall incidence of

migration of the nail was similar. All the 112 cases were reviewed as one group. Penetration was more common in comminuted unstable types of fracture, in those poorly fixed, and in the older patients. Sixteen (14 per cent) well fixed fractures showed penetration. It appears that one important additional reason for penetration in this series was the rigidity of the device and the poor quality of the bone. The incidence of nail penetration in comminuted unstable fractures of the femur might be reduced by using methods of fixation other than rigid nail plate⁽²²⁾.

Harper in 1982 reviewed a consecutive series of 61 unstable intertrochanteric fractures internally stabilized with a compression hip screw utilizing a medial displacement technique. Of these 50 fractures, osseous union occurred in 48. There were two cases of mechanical failure and two deep wound infections. Average limb shortening was 1.8 cm. The mortality rate was 6%.⁽²³⁾.

Moore and Evans in 1983 concluded that patients treated with a Richards device mobilised more quickly and left hospital sooner . Failures of stabilisation were fewer in this group⁽²⁴⁾.

Weiss in 1983 reviewed one hundred sixty two cases of unstable intertrochanteric fractures treated by anatomic reduction and compression hip screw fixation. One hundred twenty four of these patients were followed up for an average of 19.2 months. After compression was applied, 90% of the fractures moved into medial displacement position. Eight percent of the fractures lateral displacement; 2% of the fractures maintained their anatomical alignment After compression was applied, loss of fixation ,with varus angulation of the fractures, occurred in 5

patients, a 4% incidence of failure. One hundred ten patients were bearing full weight an average of three weeks after operation. Fracture healing occurred in average of 18 weeks after operation. Stable reduction accomplished by displacement osteotomy (After Dimon and Hughston), has no advantage over anatomic reduction and fixation by a compression hip screw. The advantages of the latter technique are that weight bearing can be started early, the device can be used for stable and unstable intertrochanteric fractures with identical technique, and fixation is rigid and allows for compression of the fracture site, while maintaining alignment⁽²⁵⁾.

Kulkarni GS, in 1984, reported 140 cases of trochanteric fractures treated with a Modified Richard's Compression screw. The overall failure rate was 6.3%. Early ambulation did not compromise the end results. Complications seen in 6 patients consisted of early infection in 2 patients, late infection in 2 patients, implant penetration in one patient and implant back out of the head in one patient. Six patients had mild pain over the palpable nut. There was non union in one patient⁽²⁶⁾

Moller and Grymer in 1984 showed that the sliding screw-plate is superior to the nail plate in both stable and unstable fractures⁽²⁷⁾.

Brink in 1987 reported low (145°to150°) nail plate fixation (McLaughlin) for stable trochanteric fractures and early weight bearing ambulation. From 1978 to 1982, 52 stable trochanteric fractures in 52 patients were treated by low nail plate fixation. Within a week post operatively, the patient's started full weight bearing ambulation. The functional result was good in 88.2%. Despite the average age of 77.9 years the hospital mortality rate was 1.9%. On the basis of the results they

concluded that low nail plate fixation and early weight bearing of stable fractures can be considered to be reliable⁽²⁸⁾.

Hornby and Evans in 1989 studied all elderly patients with extra-capsular hip fractures over a twelve months period and followed up for six months. Patients were randomised to treatment by AO dynamic hip screw or by traction. Complications specific to the two treatments were low, and general complications, six months mortality and prevalence of pain, leg swelling and unhealed sores, showed no difference between the two modes of treatment. Operative treatment gave better anatomical results and a shorter hospital stay, but significantly more of the patients treated by traction showed loss of independence six months after injury⁽²⁹⁾.

Larsson and Friberg In 1990 reviewed 607 treated trochanteric fractures (563 patients) with a sliding screw technique and followed clinically and Radiologically for one year. Of 351 patients admitted from their homes, 209 (60%) were discharged to their homes after an average of 18 days in the hospital. During the first year another 61 (17%) patients returned home after rehabilitation in a geriatric ward. Of 446 patients walking without support or with one cane before surgery, 360 (80%) had regained the same mobility after one year. The one year mortality rate was 18%, while the ten year rate was 74%. The increase in mortality was influenced by advanced age, admission from long term care institutions, male gender, and ambulatory or non-ambulatory status before surgery. Forty five (7.4%) were re-operated, 17 because of technical complications, three because of infection, and three because of nonunion. No further nonunion occurred. The deep infection rate was nine of 339 (2.7%) before and two of 268 (0.8%) after the introduction of antibiotic prophylaxis⁽³⁰⁾

In 1990, Medoff modified the side plate and designed a modular side plate that allows collapse and impaction along the axis of the femoral shaft, known as the Medoff Sliding Plate⁽³¹⁾.

In 1990, Davis TRC, Sher JL, Horsman A, Simpson M, Porter BB, Checketts RG conducted a study on mechanical failure after internal fixation and concluded internal fixation of unstable intertrochanteric fractures is not always successful. Failure rates of 5% to 10% have been reported with sliding screw devices. Cut out of the implant from the femoral head was the most common cause of mechanical failure⁽³²⁾.

Bridle SH, Patel AD, Bricher M, in 1991, in their study prospectively compared the fixation of 100 intertrochanteric fractures in the elderly patients with random use of either a dynamic hip screw or a new intramedullary device, the Gamma nail. They found no difference in the operating time, blood loss, wound complications, and stay in hospital or the patient's mobility at final review. But in 4 cases, fractures of the femur shaft occurred close to the gamma nail requiring another Major surgery⁽³³⁾.

Martyn J Parker, in 1992 studied the screw position in 25 patients, in who the screws later cutout was compared with position in 200 cases in which there was radiographic evidence of bone union without cutout. They defined cutting out as projection of the screw from the femoral head by more than 1 mm. **The femoral head is divided into superior, central and inferior segments for AP view and anterior, central and posterior segments for lateral view.** The measurement of the

position of the screw allowed statistical evaluation of the results, showing that cutout was more frequent when screws were placed superiorly or posteriorly. The aim should be to place the screw centrally or inferiorly on the AP view and centrally on the lateral view⁽³⁴⁾.

O'Brien PJ, Meek RN, Blachut PA, Sabharwal S, in 1995 compared the fractures treated with DHS and Gamma nail. There was no significant difference between the two groups with respect to intra-operative blood loss, days of hospital stay, time to union and eventual functional outcome. The length of the procedure and fluoroscopy time was longer for the gamma nail group and the DHS was associated with a lower risk of local complications. Hence the DHS is considered to be the implant of choice for intertrochanteric fractures⁽³⁵⁾.

Baumgaertner Michael R et al. in 1995, studied the value of **tip apex index**, which is predicting the failure of fixation of peritrochanteric fractures of the hip in a study of 198 fractures in the AP and Lateral Radiographs. They concluded that the average tip apex distance should be 24 mm for successful fixation of peritrochanteric fractures⁽³⁶⁾.

Baumgartner MR, Curtin SL, Lindskog DM in 1998, assigned 131 patients with trochanteric fractures to treat with either a sliding hip screw or an intramedullary hip screw. In patients with unstable trochanteric fractures, the intramedullary device was associated with 23% less surgical trauma and 41% less blood loss. Intra operative complications occurred exclusively in patients with intramedullary hip screw. There were no differences in the rates of functional recovery between the two fixation groups⁽³⁶⁾.

Watson and Moed in 1998 compared the Medoff sliding plate with a standard compression hip screw in a randomized, prospective study for the fixation of 160 stable and unstable intertrochanteric fractures with an average follow up of 9.5 months (range, 6-26 months). Overall, 91 fractures were treated using the compression hip screw and 69 were treated with the Medoff sliding plate. Stable fractures (46) united without complication in both treatment groups. Unstable fractures (114) had an overall failure rate of 9.6%, 14% (nine patients) with the compression hip screw and 3% (two patients) with the Medoff plate. The time to union for the 114 unstable fractures was not significantly different between the two devices. For all patients, no differences in lengths of hospitalisation return to pre fracture ambulatory status, postoperative living status, or postoperative pain was observed between the two device groups. Use of the Medoff plate for all fracture types was associated with a significantly higher amount of blood loss and operating time ⁽³⁷⁾

Bolhofner BR, Russo PR, Carmen B in 1999, reported the clinical results of the treatment of intertrochanteric fractures in 69 patients treated with a hip screw with a two holed 135° angled side plate.. The average estimated blood loss was 77 cc, and the average surgical time was 31 minutes. Use of the 135° sliding hip screw with a two holed side plate produced satisfactory healing and results in relatively low blood loss and short surgical time without the loss of fixation ⁽³⁸⁾.

Olsson and Ceder in 2001 compared 54 patients treated by a Medoff sliding plate, with 60 stabilised by a compression hip screw in a prospective randomized study of, the management of intertrochanteric femoral fractures. Four months after

the operation femoral shortening was determined from radiographs of both femora. In unstable fractures the mean femoral shortening was 15 mm with the Medoff sliding plate and 11 mm with the compression hip screw. A subgroup in which shortening was classified as large, comprising one-third of the patients in each group, had a similar extent of shortening, but more medialisation of the femoral shaft occurred in the compression hip screw (26%) than in the Medoff sliding plate (12%) group. Five postoperative failures of fixation occurred with the compression hip screw and none with the Medoff sliding plate. The marginally greater femoral shortening seen with the Medoff sliding plate compared with the compression hip screw appeared to be justified by the improved control of impaction of the fracture. Biaxial dynamisation in unstable intertrochanteric fractures is a safe principle of treatment, which minimizes the rate of postoperative failure of fixation⁽³⁹⁾.

In 2001 Chang-Hwan Han Jin-Il Park Jin-Young Kim after studying 178 fractures found 49 cases which showed radiographic failures. Two were stable fractures and 47 unstable fractures (Evans' classification). Unstable fractures with osteoporosis had a failure rate of more than 50%. In such cases DHS should not be the first choice for treatment. When Evans classification was compared with the other methods, it was found to be the most accurate for predicting a failure of fixation. Osteoporotic and unstable fractures using Singh's and Evans' classification had a high rate of collapse (53%). Although Singh's classification for osteoporosis has a greater observer variation and less diagnostic accuracy than dual energy X-ray absorptiometry⁽⁴⁰⁾.

Harrington and Nihal in 2002 reported a randomised, prospective study comparing a standard sliding hip screw and the intramedullary hip screw for the treatment of unstable intertrochanteric fractures in the elderly. In 102, 52 patients were treated with a compression hip screw, and 50 had intramedullary fixation with an intramedullary hip screw. The mean duration of operation and fluoroscopy screening time was significantly greater for insertion of the intramedullary hip screw. There was no difference between the groups with regard to transfusion requirements or time to mobilise after surgery. There were 2 technical complications in the compression hip screw group and 3 in the intramedullary hip screw group. There was no significant difference between the two groups in radiological or functional outcome at 12 months. It remains to be shown whether the theoretical advantages of intramedullary fixation of extra-capsular hip fractures bring a significant improvement in eventual outcome⁽⁴¹⁾.

Verhofstad MH, Van der Werken C in the year 2004, conducted a retrospective study comparing the use of DHS and a short [two-holed] side plate in stable per-trochanteric femur fracture. They concluded that fixation of stable pertrochanteric femur fractures with a two-hole DHS is safe. The traditional use of a four-hole DHS plate for this indication is therefore ‘over treatment’ since it is more invasive⁽⁴²⁾.

Lindskog DM, Baumgaertner MR, in the year 2004 conducted a study on unstable intertrochanteric hip fractures in the elderly and opined that for stable intertrochanteric hip fractures consistently good results have been achieved with compression hip screw fixation. However, with more unstable fracture patterns,

problems with compression hip screw fixation, such as excessive fracture collapse and implant cutout, increase. For these fractures, adding a trochanteric stabilizing plate or using an axial compression hip screw or intramedullary hip screw is warranted⁽⁴³⁾.

Klinger HM, Baums MH, Eckert M, Neugebauer R, conducted a study in 2005 comparing the results obtained using two osteosynthesis systems developed for the surgical treatment of unstable fractures of the trochanteric region of the femur: the Proximal Femoral nail [PFN] and the dynamic hip screw with trochanteric buttress plate. They treated 173 patients with unstable trochanteric fractures [type 31 A-2 and A-3 according to AO Classification]; at an average follow-up of 17 months the radiological and clinical outcome according to the score of “Merle d’ Aubigne” was analyzed in 61% of all patients. They observed that in case of PFN 17.2% revisions were necessary and in the case of DHS with Trochanteric Buttress Plate [TBP] 21.6% revisions were necessary.

A shorter operation time and a considerable shorter inpatient stay were common with PFN. Full weight bearing was immediately after the osteosynthesis was possible for 98% of the PFN patients and 81% of DHS/TBP patients. The DHS/TBP osteosynthesis in instable trochanteric fractures is associated with a higher incidence of complications. Therefore they recommend treating unstable fractures of the trochanteric region with the PFN⁽⁴⁴⁾.

In the year 2006 Sanjay Agarwal, Abhijeet Bhagawat, Amit Kohli, treated intertrochanteric fractures with both long and short barrel dynamic hip screws and

the results show that short barrel side plates have given better sliding than long barrel in Indian population who had short femoral neck length⁽⁴⁵⁾.

In 2006 Babubalkar stated Eighty fresh trochanteric fractures were subjected to internal fixation, 50 with the DHS and 30 with the DCS. Satisfactory fixation was achieved in 93.3% of the DCS group and 92% of the DHS group. Union was seen at 12 weeks and 16 weeks depending on the quality of reduction and fixation.. He concluded Although there were no significant difference in the number of good reductions and the time to bony union between the 2 groups, as regards handling and complication, the DCS was found a more versatile implant compared to the DHS. In 2006 G. S. Kulkarni, Rajiv Limaye, Milind Kulkarni, Sunil Kulkarni had concluded that Dynamic hip screw is still the gold standard for majority of trochanteric fractures but according their modified classification type 1 being stable, type 2 unstable, type 3 being shattered lateral wall, which may require implant other than DHS like intramedullary device or arthroplasty⁽⁴⁶⁾.

In 2007 Yih-Shiunn Lee, Hui-Ling Huang, Ting-Ying Lo & Chien-Rae Huang concluded that Minimally invasive Dynamic Hip Screw or Conventional Dynamic Hip Screw have similar functional results except that the mini-invasive technique as opposed to conventional technique has smaller wound size, lower pain level, and lower blood loss. Hospital stay and total analgesic use are decreased with a benefit to the patient and reduction in hospital cost⁽⁴⁷⁾.

In November 2008, Gupta RK, Kapil Sahgwan, Pradeep Kamboj, Sarabjeet S Punia, Pankaj Waleeha used Salvati and Wilson scoring system for functional

assessment after treating unstable trochanteric fractures with lateral wall reconstruction using Trochanteric Stabilising Plate (TSP) in combination with a dynamic hip screw (DHS)⁽⁴⁸⁾.

In 2008, Jewelle DP, found the mean number of cycles to failure for the locking plate construct was 2.6 times greater than for the standard screw construct and concluded, A dynamic hip screw with fixed angle locking screws would reduce the risk of DHS failure. A locking screw DHS would be particularly useful in patients with osteoporotic bone, and in patients with less stable fracture configurations.⁽⁸⁵⁾

In 2009 George J. Haidukewych has reviewed various studies and suggested ten tips for intertrochanteric fracture management 1: Use the Tip-to-Apex Distance, 2: “No Lateral Wall, No Hip Screw”, 3: Know the Unstable Intertrochanteric Fracture Patterns, and Nail Them, 4: Beware of the Anterior Bow of the Femoral Shaft, 5: When Using a Trochanteric Entry Nail, Start Slightly Medial to the Exact Tip of the Greater Trochanter, 6: Do Not Ream an Unreduced Fracture, 7: Be Cautious About the Nail Insertion Trajectory, and Do Not Use a Hammer to Seat the Nail, 8: Avoid Varus Angulation of the Proximal Fragment—Use the Relationship Between the Tip of the Trochanter and the Center of the Femoral Head, 9: When Nailing, Lock the Nail Distally if the Fracture Is Axially or Rotationally Unstable, 10: Avoid Fracture Distraction When Nailing⁽⁵⁰⁾.

In 2010 Chin-chuan Wu, Ching- lung Tai from Taiwan studied the effect of lag screw positions in trochanteric fractures using sliding hip screw concluded that

When a lag screw is placed in the inferior part of the femoral head in the frontal plane, a torque develops between the resultant force and the lag screw head. The femoral head rotates upwards and laterally, and the lag screw displaces downwards and medially. The distance between the lag screw and the superio-lateral edge of the femoral head increases, thus decreasing the possibility of cut-out⁽⁵¹⁾.

In 2011 Setiobudi T, Ng YH, Lim CT, Liang S, Lee K, Das De S studied One hundred and thirty-six patients were analysed. 61 stable and 78 unstable fractures for 30 months. The rates of local complications were not significantly different between the 2 groups. The incidence of malunion and excessive impaction were significantly higher in the unstable group. The ambulatory status at one year post-surgery was not significantly different between the 2 groups. Concluded, DHS fixation provides comparable postoperative outcomes in unstable IT fractures with relatively low rates of complications. Although it was associated with a higher incidence of malunion and excessive impaction in the unstable fracture group, there was no difference in functional status at one-year compared to the stable group⁽⁵²⁾.

Ranjeetesh Kumar, R.N. Singh, B.N. Singh in after doing Comparative prospective study of proximal femoral nail and dynamic hip screw in treatment of intertrochanteric fracture femur in 2012 came to a conclusion the dynamic hip screw is still the implant of choice in the stable types of intertrochanteric fractures. In the more unstable types of fracture the intra medullary hip screw has distinct advantages over the plate and should be the preferred implant for fixation.⁽⁵³⁾

In 2012 Gupta et al studied 60 patients (AO type 31-A2.1 in eight, A2.2 in 29, A2.3 in 17 patients, and 31-A3.1 in five, A3.2 in three, and A3.3 in two patients and

PMMA augmentation of DHS was performed in all cases by injecting PMMA cement into the femoral head with a custom made gun designed. Fracture united in all patients and the average time to union was 13.8 weeks (range 12 - 16 weeks). no incidence of varus collapse or superior screw cut out was observed in any of the patients in spite of weight bearing ambulation from the early postoperative period. They concluded Cement augmentation of DHS appears to be an effective method of preventing osteoporosis related complications of fracture fixation in the trochanteric fractures⁽⁵⁴⁾. In 2013 Ram Chander Siwach et al. studied Radiological and functional outcome in unstable, osteoporotic trochanteric fractures stabilized with dynamic helical hip system (DHHS) which show that the use of a DHHS for stabilization of unstable, osteoporotic per-trochanteric fractures in the elderly patients was associated with reliable rates of union and functional outcome and decreased incidence of screw cut-out and side plate pullout as compared to standard DHS⁽⁵⁵⁾.

In 2013 Kjell Matre et al. did a study of treating trochanteric fractures with Trigen Intertan Intramedullary Nail Versus Sliding Hip Screw. In conclusion, they found similar results regarding pain, function, complications, and reoperation rates at one year in this randomized controlled trial comparing the INTERTAN nail and the sliding hip screw for the treatment of intertrochanteric and sub-trochanteric fractures⁽⁵⁶⁾.

In 2014, Barwar. N et al studied 50 patients randomly allocated for fixation with a standard DHS (group A) and locking DHS (Combi plate, group B) and concluded locking DHS allows sound bone healing and is not associated with any major complications⁽⁵⁷⁾.

In 2015 Chehade MJ¹, Carbone T, Awward D, Taylor A, Wildenauer C, Ramasamy B, McGee M. studied 743 patients coculded fracture instability influences early mortality after surgical fixation of trochanteric hip fracture. The Austofix double lag screw device had suboptimal results⁽⁵⁸⁾.

In 2017 Prabhat A,gaba S, Das S, Singh R, Kumar A, Yadav G studied 26 cases of IT fractures and concluded Both DHS and PFLCP(proximal femoral locking compression plate) are good choices for stable intertrochanteric fractures, and both lead to excellent functional outcomes, but non-union might be more common with PFLCP⁽⁵⁹⁾.

ANATOMY

Anatomy of proximal end of femur^(3,4)

The proximal femur is formed by head, neck, greater and lesser trochanter.

The head articulates with the acetabulum to form hip joint.

a. Hip joint

This is the most perfect example of ball and socket joint. This synovial, multi-axial ball and socket type of joint is formed by the cup shaped acetabulum of innominate bone with the hemispherical head of the femur.

The range of movements this joint permits is less than that of shoulder joint, but the strength and stability are much greater. These features arise from

- The depth of the acetabulum, which is increased by the labrum acetabulare
- The strength of the ligaments and the surrounding muscles
- Length of neck of femur.

b. Head of the femur

This is entirely intra capsular and is encircled immediately lateral to its greatest diameter by the acetabular labrum. It is more than half a sphere. It is directed upwards, medially and slightly forwards to articulate with the acetabulum. Its surface is smooth, but a little below and behind its center is small roughened pit or fovea. The fovea affords attachment to the ligament of the head of the femur. The inferomedial part of the anterior surface of the head is related to the femoral artery, from which the psoas tendon and the articular capsule separate it.

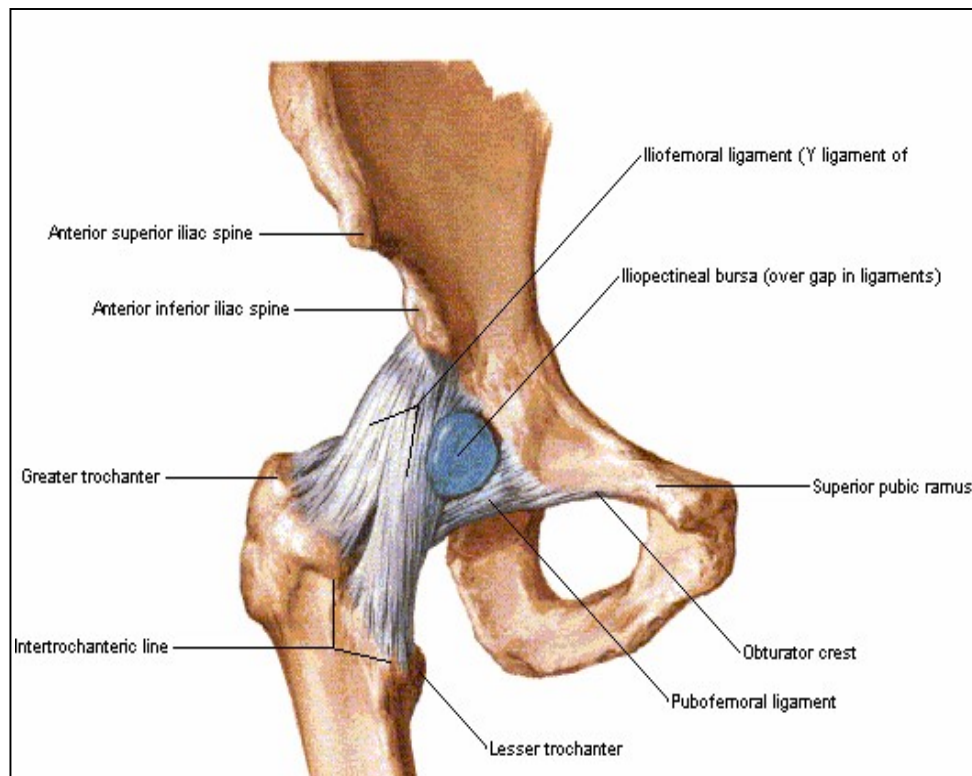


Figure 1: Hip joint (anterior view)

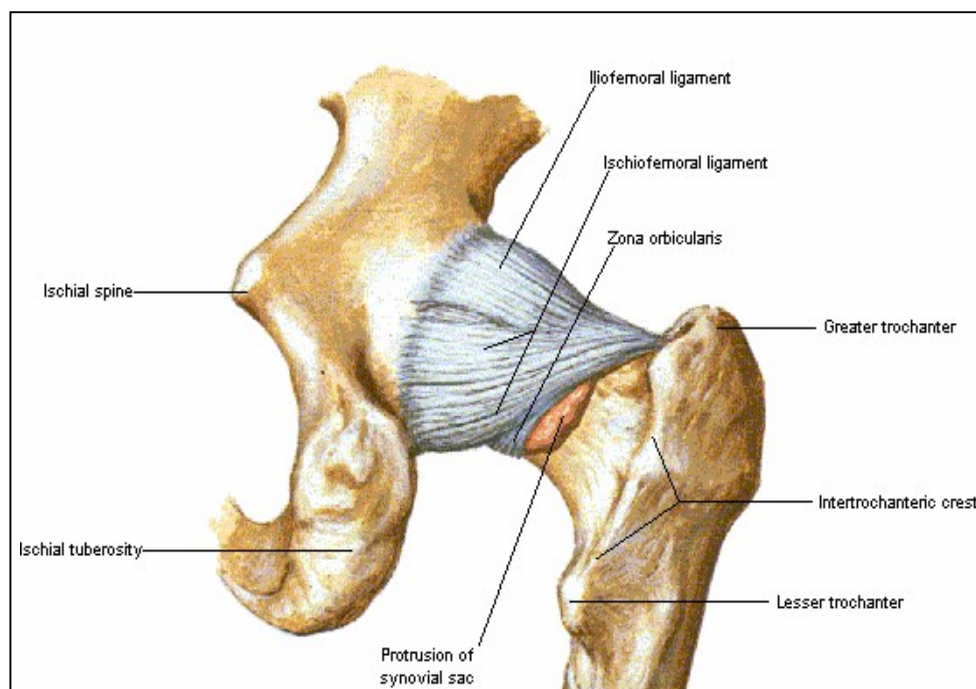


Figure 2: Hip joint (posterior view)

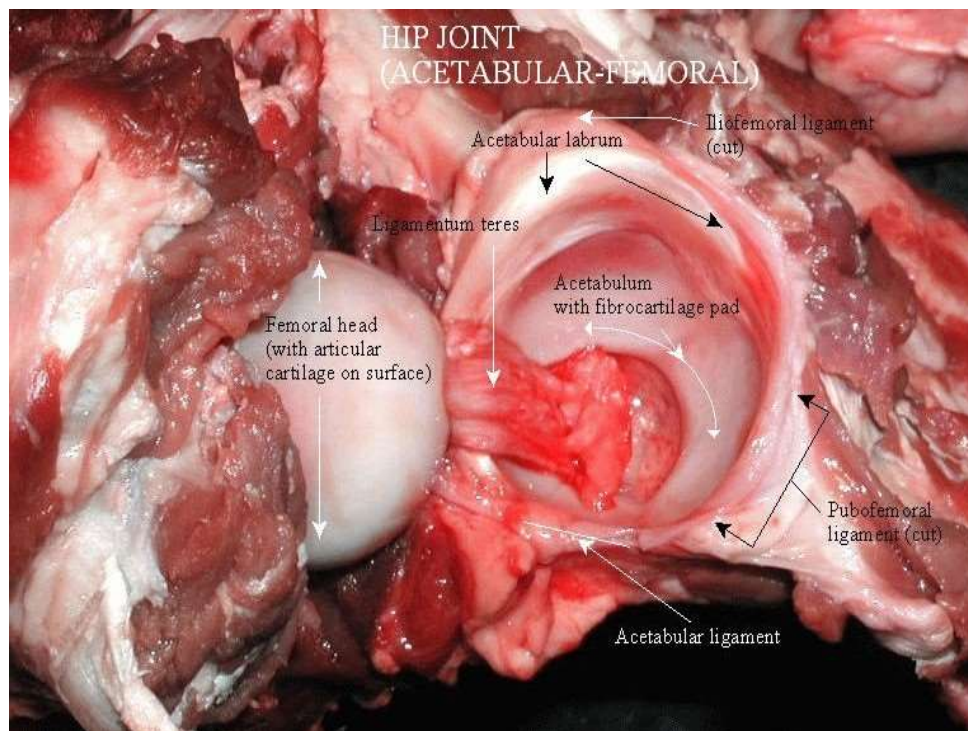


Figure 3: Hip joint (opened) (lateral view)

c. Neck

It is about 5 cm long and forms an angle of about 125° to 140° with the shaft of the femur. This arrangement facilitates the movements of the hip joint and enables the lower limbs to swing clear of the pelvis. The anterior surface of the neck is flattened and its junction with the shaft is marked by prominent rough ridge, termed the intertrochanteric line. The posterior surface is convex backwards and its transverse axis is marked by intertrochanteric crest at the junction with the shaft. The anterior surface of the neck is entirely intra capsular and on this surface the capsular ligament extends laterally to the intertrochanteric line. On the posterior surface, the capsular ligament does not reach the intertrochanteric crest. Only a little more than the medial half of the neck lies within the capsule. The neck of the femur does not lie in the same plane as the shaft, but is carried forwards as it passes upwards and medially.

On this account the transverse axis of the head of the femur makes an angle with the transverse axis of the lower end of the bone, and this is known as the angle of femoral torsion.

d. Greater Trochanter

The greater trochanter is a large quadrilateral projection at the upper part of the junction of the neck with the shaft. Its postero-superior surface projects upwards and medially so as to overhang the adjoining part of the posterior surface of the neck. In this situation its medial surface presents a roughened depressed area, the trochanteric fossa. The upper border of the trochanter lies one hand breadth below the tubercle of the iliac crest and is on a level with the centre of the head of femur. The anterior surface of the trochanter bears a roughened impression. Its lateral surface is divided into two areas by an oblique, flattened strip, wider above than below, which runs downwards and forwards across it. The greater trochanter provides insertion for most of the muscles of the gluteal region. The gluteus minimus is inserted into the rough impression on its anterior surface, the gluteus medius into the oblique flattened strip, which runs downward and forwards across the lateral surface. -The area in front of this insertion is separated from the tendon by the trochanteric bursa of the gluteus medius. The deep fibres of the gluteus maximus cover the area behind the insertion and part of the trochanteric bursa of that muscle may be interposed. The upper border of the trochanter gives insertion to the piriformis and its medial surface to the common tendon of the obturator internus and two gemelli. The trochanteric fossa receives the insertion of the obturator internus.

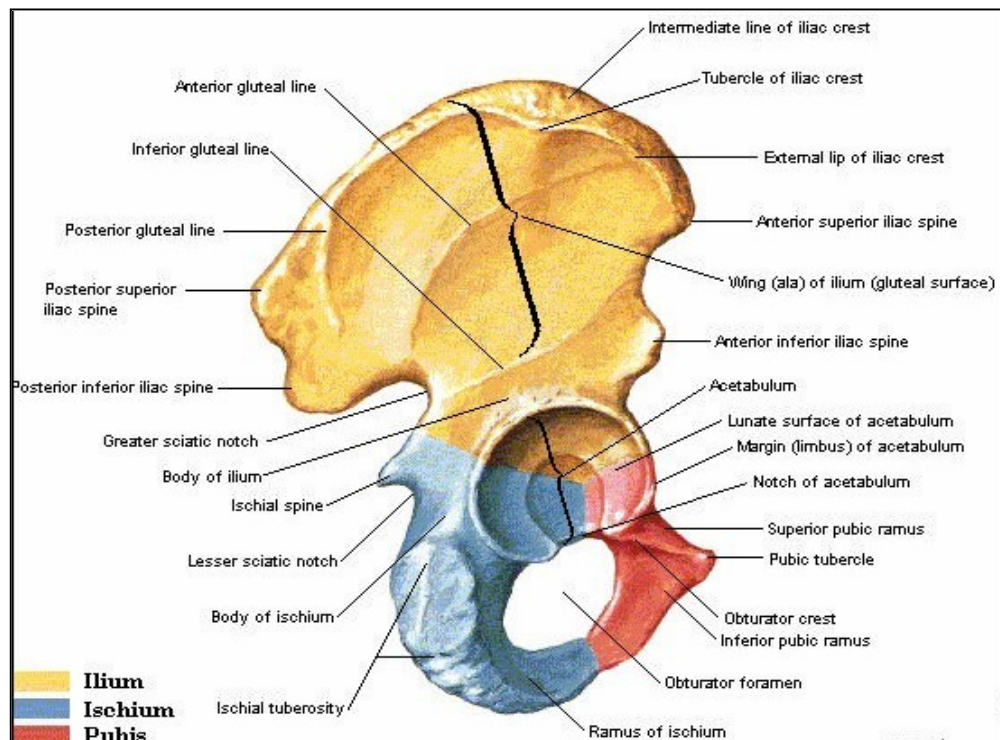


Figure 4: Coxal bone (lateral view)

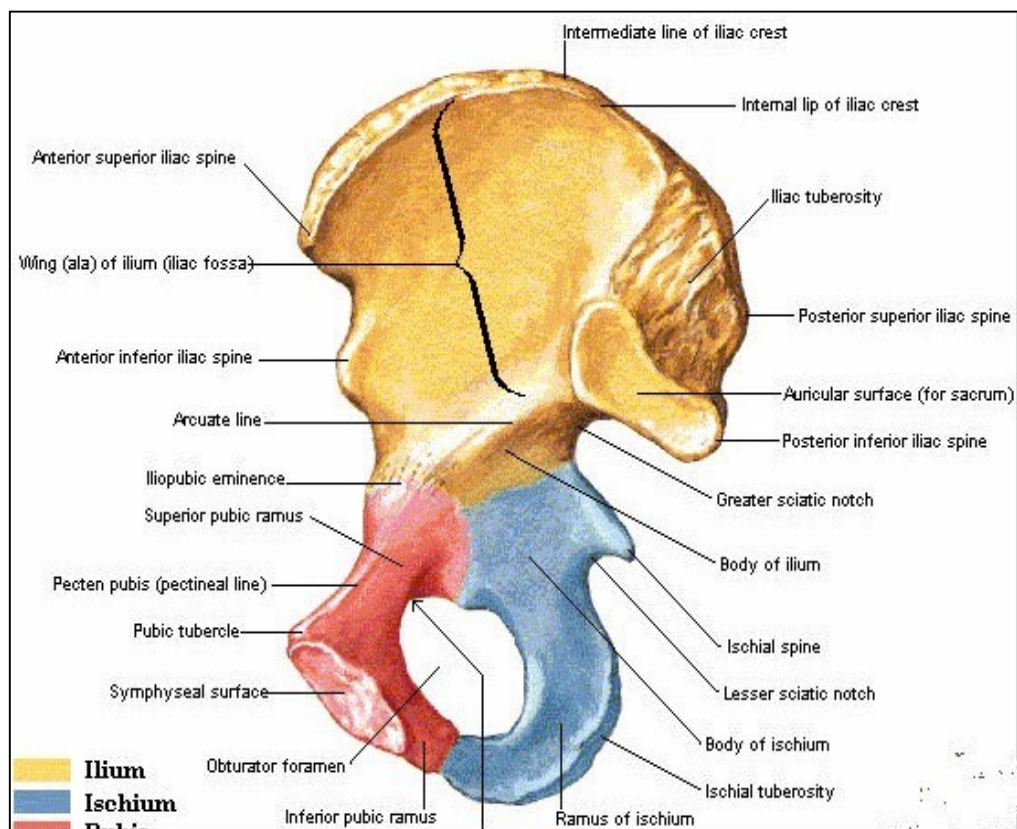


Figure 5: Coxal bone (medial view)

e. Lesser Trochanter

The lesser trochanter is a conical eminence, which projects medially and backwards from the shaft as its junction with the lower and posterior part of the neck. Its summit and anterior surface are roughened but its posterior surface, which lies at the lower end of the intertrochanteric crest, is smooth. It is placed too deeply to be felt in the living. The psoas major is attached to the lesser trochanter at its summit and on the medial part of its anterior surface. The base of the trochanter is expanded and its medial and anterior surface has the iliacus attached to it, extending downwards for a short distance behind the spiral line. The upper fibres of the adductor magnus play over the posterior surface of the lesser trochanter and a bursa is sometimes interposed between them.

f. Intertrochanteric line

The intertrochanteric line marks the junction of the anterior surface of the neck with the shaft of the femur. It is a prominent roughened ridge, which commences in a tubercle at the upper and medial part of the anterior surface of the greater trochanter and runs downwards and medially. It reaches the lower border of the neck at a level with the lesser trochanter but in front of it. It often presents a second tubercle near its lower end below and is continuous with the spiral line. The inter-trochanteric line marks the lateral limit of the capsular ligament of the hip joint, its upper part receives the attachment of the upper band of the iliofemoral ligament. Its lower part receives the lower band of the same ligament. The highest fibres of the vastus lateralis arise from the upper end of the line and the highest of the fibres of the vastus medialis from its lower end.

g. Intertrochanteric crest

This marks the junction of the posterior surface of the neck with the shaft of the femur. It is a smooth rounded ridge, which commences at the postero-superior angle of the greater trochanter and runs downwards and medially to terminate at the lesser trochanter. A little above its middle it presents a low rounded elevation, the quadrate tubercle. The intertrochanteric crest above the quadrate tubercle is covered by the gluteus maximus below the tubercle it is separated from that muscle by the quadratus femoris and the upper border of the adductor magnus.

h. Acetabulum

This is approximately a hemispherical cavity on the lateral aspect of the innominate bone about its centre, and is directed laterally, downwards and forwards. The sides of the cup present an articular lunate surface, which is widest superiorly, in this situation the weight of the trunk is transmitted to the femur in the erect position. The formation of acetabulum is by the three bones, the pubis forms the upper and anterior fifth of the articular surface, the ischium, the floor of the acetabular fossa from the lower and posterior two fifth of the articular surface, the ilium forms the remainder of the articular surface.

i. The fibrous capsule

This is a strong and dense covering and is attached above to the margin of the acetabulum. It surrounds the neck of femur, and is attached in front of the trochanteric line above, to the base of the neck behind, to the neck above the trochanteric crest, below to the lower part of the neck close to the lesser trochanter. From its attachment to the front of the femoral neck many of the fibres are reflected upwards along the neck as longitudinal bands, termed retinaculae, which contain blood vessels supplying the head and neck of the bone.

j. The ligaments

1. Iliofemoral ligament (Ligament of Bigelow)

This ligament lies on the front of the joint. It is the thickest and most powerful part of the articular capsule. Proximally, it is attached to the inferior part of the anterior inferior iliac spine and to the surface of the ilium immediately lateral to the spine. Distally it widens to be attached to the intertrochanteric line of femur. It is thicker at the sides than in the middle. This gives the ligament the appearance of the inverted Y. The iliofemoral ligament is more than 0.5 cm thick. It is the strongest ligament in the body (its only rival being the interosseous, sacroiliac ligament). A stress varying from 250-750 lb is required to rupture it. Thus it is rarely torn in dislocation of the hip joint and the surgeon may use it as a stay in levering the head of the femur back into the acetabulum.

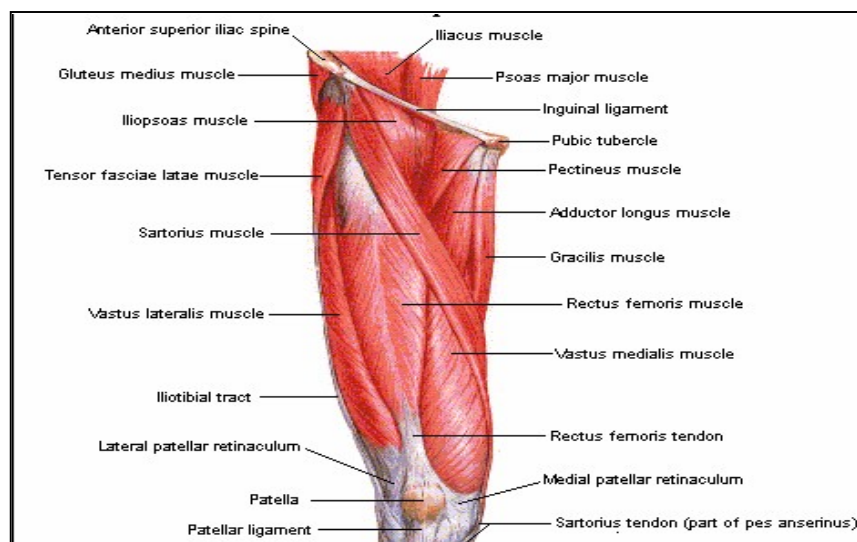


Figure 6: Muscles of thigh (anterior view – superficial dissection)

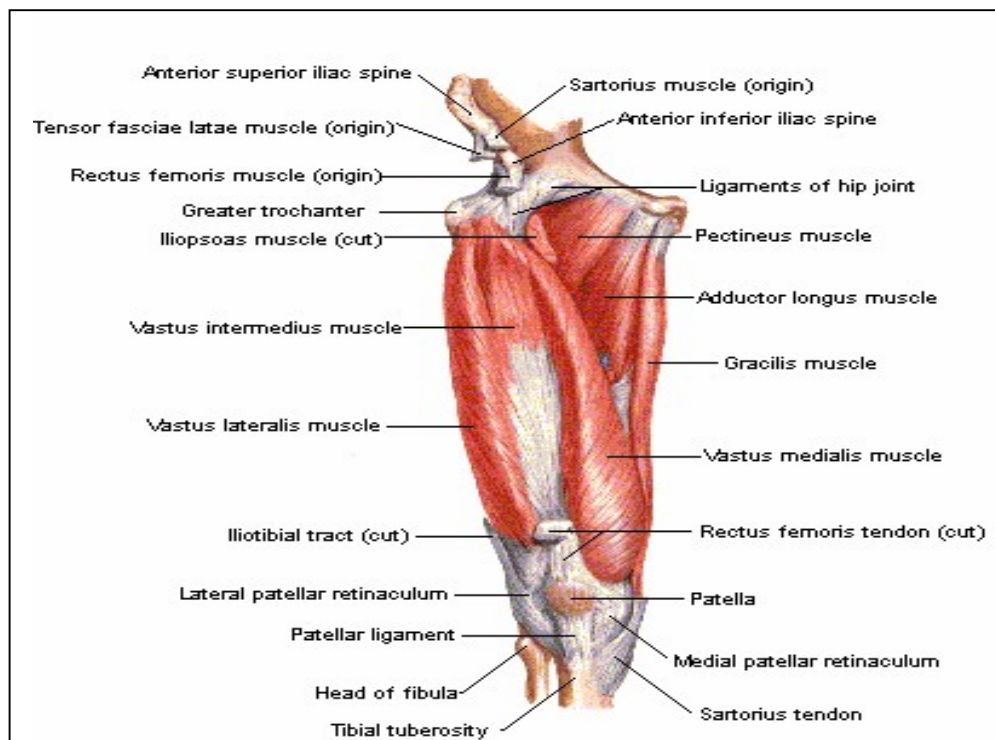


Figure 7: Muscles of thigh (anterior view – deeper dissection)

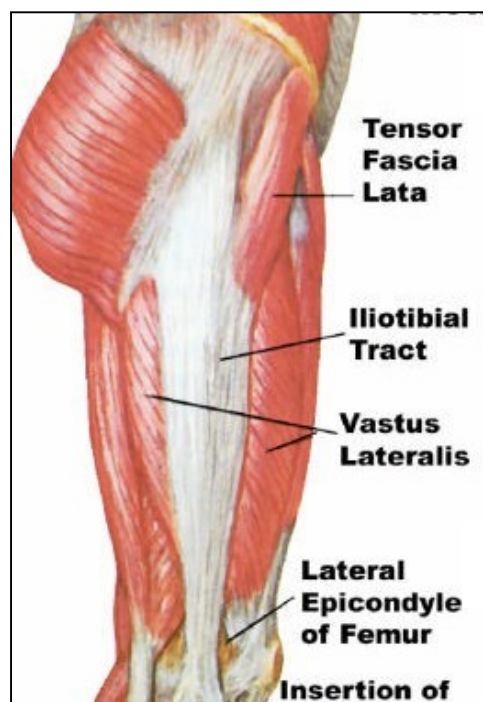


Figure 8: Lateral aspect of thigh

In erect posture, a vertical line through the centre of gravity of the body falls slightly behind a line, joining the centres of the two hip joints. The tendency of the body to fall backwards on the hip joints is resisted by the iliofemoral ligaments, which maintain the erect posture without muscular activity at these joints.

2. Pubofemoral ligament

This ligament is triangular in shape with its base attached to the superior ramus of the pubis, iliopectineal eminence and its apex attached below to the lower part of the intertrochanteric line. This ligament limits extension and abduction.

k. Ischiofemoral ligament

It is a spiral shaped ligament attached to the body of ischium near acetabular margin. The fibres of the ligament pass upwards and laterally and are attached to the greater trochanter. This ligament limits extension.

l. Transverse acetabular ligament

It is formed by the acetabular labrum and is attached to the edge of either side of labrum inferiorly as it bridges the acetabular notch. The ligament converts the notch into a tunnel through which the blood vessels and nerves enter the joint.

2. Ligamentum teres or ligament of the head of the femur

This is relatively weak band of connective tissue surrounded by synovial membrane. Its narrow cylindrical end is implanted into the pit on the head of the femur. Its broad flattened end is attached to the transverse ligament and the adjacent margins of the acetabular fossa.⁽⁶⁰⁾

Vascular anatomy of the proximal end of femur^(61,62,63)

The arterial supply to the proximal femur has been studied very extensively. Crock described the arteries of the proximal end of the femur and divided them into three groups, based on three planes. These are:

- a. Extra capsular arterial ring located at the base of the femoral neck.
- b. Ascending cervical branches of the extra capsular ring on the surface of femoral neck.
- c. The arteries of the round ligament.

The extra capsular arterial ring is formed posteriorly by a large branch of the medial femoral circumflex artery and anteriorly by branches of the lateral femoral circumflex artery. The superior and inferior gluteal arteries also have minor contribution to this ring.

Ascending cervical branches arises from the extra-capsular arterial ring. Anteriorly they penetrate the capsule of the hip joint at intertrochanteric line and posteriorly, they pass beneath the orbicular fibres of the capsule. The ascending cervical branches pass upward under the synovial reflections and fibrous prolongations of the capsule towards the articular cartilage that demarcates the femoral head from its neck. These arteries are known as retinacular arteries as described by Weitbrecht.

As the ascending cervical arteries traverse the superficial surface of the neck of the femur, they send many small branches into the metaphysis of the femoral neck. Additional blood supply to the metaphysis arises from the extra capsular arterial ring and may include anastomoses with intramedullary branches of superior

nutrient artery system, branches of the ascending cervical arteries and the subsynovial intra-articular ring.

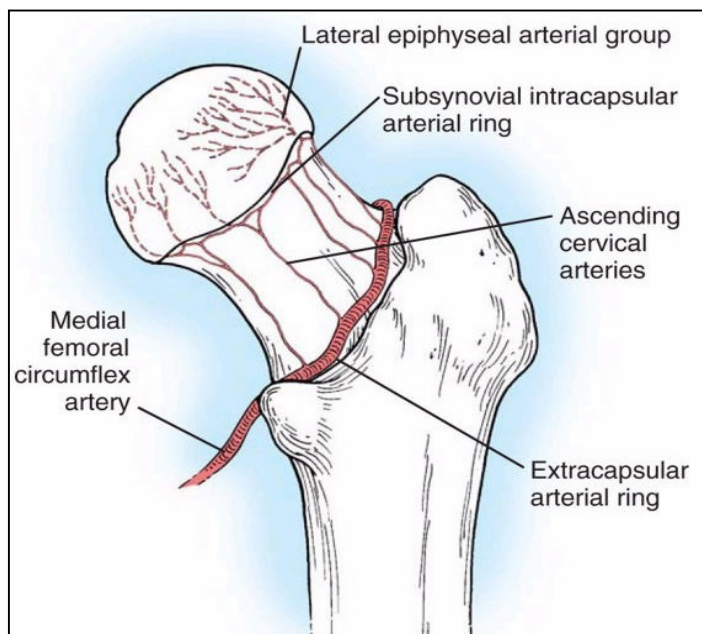


Figure 9: Vascular anatomy of the proximal end of femur

The artery of the ligamentum teres is a branch of the obturator or the medial femoral circumflex artery. The function and the presence of this artery have been variably reported in the literature. Wertheimer and Lopes found that only one-third of patients studied had a large artery of the ligamentum teres that supplied a substantial portion of the femoral head blood supply.

Howe et al. described the ascending branches of lateral femoral circumflex artery lateral to the iliopsoas muscle to reach the femur at the inter-trochanteric line.

The lateral femoral circumflex artery also supplies two or three trochanteric branches to the anterior and lateral surfaces of the greater trochanter, which pierce the posterior surface of the trochanter along with the branches from the first perforating artery.

The medial femoral circumflex artery as it passes around the femur proximal to the lesser trochanter gives off two or three branches to lesser trochanter as it runs between the trochanters. Its branches also supplies to the posterior surface of the base of the neck and as it passes more laterally it gives off two or three branches into the upper surface of the neck near its junction with the greater trochanter.

Ossification of femur

The femur ossifies from one primary and four secondary centres. The primary centre for the shaft appears in the seventh week of intra-uterine life. The secondary centres appear, one for the lower end at the end of ninth month in intrauterine life, one for the greater trochanter during the fourth year and one for the lesser trochanter during twelfth year.

There are three epiphysis at the upper end and one epiphysis at the lower end. The upper epiphysis (lesser trochanter, greater trochanter and head, in that order) fuses with the shaft at about 18 years. The lower epiphysis fuses by the twentieth year.

ANATOMY OF BONY TRABECULAE OF PROXIMAL END OF FEMUR

Trabecular pattern of proximal femur^(3,4,60)

In 1838, Ward first described the inter-trabecular system of the femoral head. The orientation is along the lines of stress (Wolff's law) and thicker lines come from the calcar and rise superiorly into the weight bearing dome of the femoral head.

These are five groups of trabeculae

- a. Principle compressive group
- b. Principle tensile group
- c. Secondary compressive group
- d. Secondary tensile group
- e. Greater trochanter group

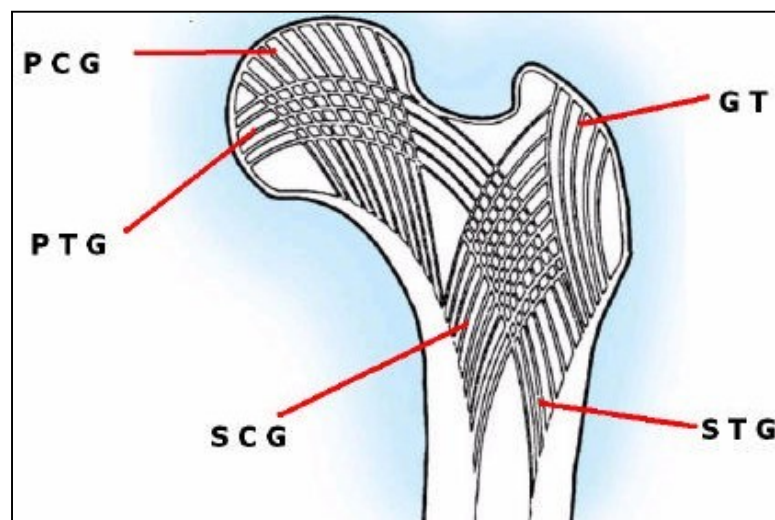


Figure 10: Trabecular pattern of proximal femur

1. Principle Compressive Group [P C G]
2. Principle Tensile Group [P T G]
3. Secondary Compressive Group [S C G]

4. Secondary Tensile Group [S T G]

5. Greater Trochanter Group [G T]

Harty and Griffin described the calcar femorale a dense vertical plate of condensed bone extending from the postero- medial portion of the femoral shaft under the lesser trochanter and radiating lateral to the greater trochanter, reinforcing the femoral neck postero- inferiorly.

The calcar femorale is thickest medially and gradually thins as it passes laterally.

Movements of the hip joint and muscles producing the movements

- a Flexion:** It ranges from 80-90° with extension of knee, and from 120-130° with flexion of knee. Psoas major and iliacus are the major contributors and minor contribution is by rectus femoris, sartorius, pectineus and adductor longus in the early flexion from full extension.
- b Extension (10° to 15°):** Gluteus maxim us and hamstrings are active when the thigh is extended against resistance.
- c Abduction (45°):** Gluteus medius and gluteus minimus are the major contributors and sartorius, tensor fascia latae and piriformis are the minor contributors.
- d Adduction (40°):** Adductor fibres of adductor magnus, adductor longus and adductor brevis are the main adductors and the pectinius, gracilis are the minor adductors.
- e Medial rotation (30°):** Anterior fibres of gluteus minimus, medius and tensor fascia latae are major medial rotators and minor contribution is by adductors.

- f Lateral rotation (40°):** Quadratus femoris, obturator internus, obturator externus, superior gemelli and inferior gemelli are the major contributors and the minor contribution is by gluteus maximus, sartorius and piriformis.
- g Circumduction:** It is a combination of the above movements.

The extensor muscles are more powerful than the flexor group of muscles and that the lateral rotators are more powerful than the medial rotators.

BIOMCHANICS OF HIP JOINT ^(64,84)

The ball and socket configuration of hip joint allows movements about all the three axes of flexion-extension, abduction-adduction and internal-external rotation. The most frequent motion that is required for walking is from 30° flexion to 10° extension accompanied by about 8° of pelvic rotation.

The forces applied to the hip joint are normally quite large and much more than the body weight. These forces may be static or dynamic.

The term static force refers to the application of external loads or forces so that they are balanced out and the joint is not subjected to acceleration.

Dynamic forces on the other hand refer to unbalanced loads or forces associated with acceleration or deceleration in this case of lower extremity. The forces include both gravity and forces generated by muscle activity.

The forces on the hip joint result from stabilising the centre of gravity of the body during stance and locomotion. The centre of gravity of the body is located just

anterior to the second sacral vertebra. The horizontal distance from the centre of gravity of the body to the centre of the hip joint is 8.5 to 10 cms. Vertically the centre of gravity is about 3 cm above the hip joint axis and during stance centre of gravity is in the same frontal plane as the common hip joint axis.

Locomotion

During stance phase of normal level walking, the body is balanced on the head of the weight bearing femur. In order to smooth out the gait the supported side of the pelvis drops approximately 4° from the horizontal which shifts the centre of gravity towards the weight bearing side to bring the centre of balance very nearly over the foot with the next step, the weight of the body is shifted to the opposite foot; the centre of gravity being moved towards the weight bearing side and unsupported side of pelvis drops again slightly. The total movement of the body and centre of gravity is 4-4.5 cms. The alternating shift of weight bearing during walking is accomplished smoothly and rhythmically with the least expenditure of energy. Each hip in turn is required to support the body weight eccentrically which subjects the femoral head to large forces.

Static Forces on Hip Joint

During normal standing on both feet, the hips take equal share of the body weight is above it (0.31 BW). In single leg stance the weight of the unsupported lower limb is added to that of the body weight and the centre of gravity is displaced to the opposite side. To maintain equilibrium over the fulcrum (head), the abductor muscles must impose an equal and opposite moment about the hip. Thus $W \times a = W \times b$, where 'a' is the moment arm of the partial body weight 'W' about the centre of hip

and 'b' is the moment arm of the estimated mean line of action of abductors about the hip centre. This gives the abductor muscle for ($W = 0.81$).

$$\underline{M} = \frac{W_{xa}}{b}$$

$$\underline{M} = \frac{0.81 \times 110}{47}$$

$$M = 1.9 \text{ BW}$$

The 'moment arm' is the perpendicular distance of the line of action of force from the pivot point at the centre of the hip. The calculated abductor force $M=1.9$ BW is the minimum possible, since it neglects the effects of antagonistic muscle actions that maintain posture.

The downward actions of gravity acting on the body and the abductors pulling as the ilium must be opposed by equal and opposite reaction force of the femoral head pressing upwards into the acetabulum. The hip joint reaction force can be found graphically since the free part of the body (body weight minus supporting lower limb) can be assumed to have only three forces acting on it (W, M, H) a force vector triangle can be drawn to scale with the lengths of the side of triangle proportional to the magnitudes of the forces and with the correct diagrams taken from the radiographs. If the magnitude of M and W are known, H can be easily obtained. $H = 2.64 \text{ BW}$, acting at 21° to the vertical. Abductor muscles act 30° to vertical.

This analysis is considered only for the components acting about an anteroposterior axis. On considering flexion, extension and internal-external rotation forces, true joint reaction forces are predicted to be 6.00 BW .

The ratio of the two lever arms is important in the generation of the total force acting on the hip joint. The shorter the horizontal distance from the centre of gravity of the body to the hip joint, less muscle force is required of abductors to balance it. If an individual leans the trunk directly over the weight bearing hip, the medial lever arm is reduced to zero so that no muscle force is necessary in the abductor tensor muscles (as in Trendelenberg's gait), and joint force is reduced to body weight (minus supporting limb = 0.81 BW). If the centre of gravity is moved away from the weight bearing hip abductor force is more, hence the hip joint reaction force.

The reaction force through the head of femur is transmitted 165° - 170° from the vertical irrespective of the position of pelvis. The significance of this observation is that the weight of the body is not borne vertically but at an angle that coincides with the direction of the medial trabeculae of femoral head.

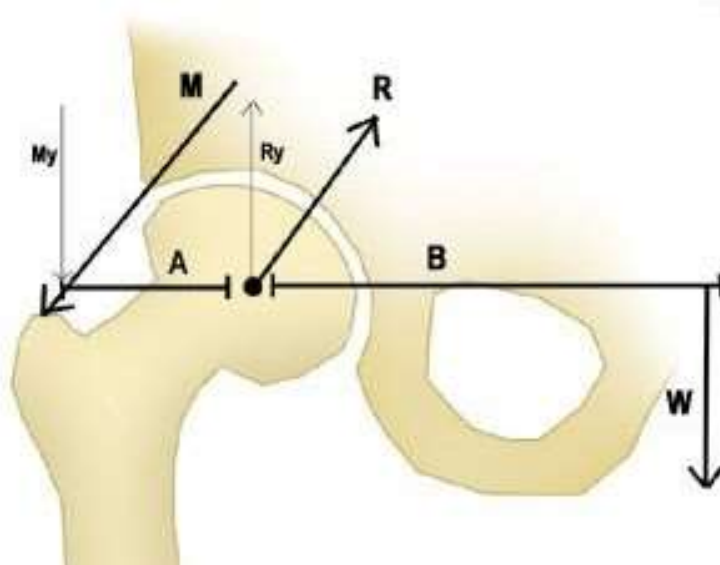


Figure 11: Biomechanics of Hip

Dynamic Forces on Hip Joint

During normal walking, the forces imposed on the hip joint are greater than standing stationary on one leg. These dynamic forces are upto 50% more than static forces. In 1918, Grunewald stated that as a result of muscle contraction the force on the hip joint may reach 400 kgs. Pauwels in 1935, stated that maximal total force during level walking to be 5-6 times bodyweight.

The dynamic forces at the hip joint are derived from the forces of ground, reaction, gravity, acceleration and deceleration and muscles. Paul JP et al. (1967) have calculated these forces to be 4.00 BW after heel strike and 7 BW before toe-off. The vertical and horizontal dynamic loads acting on the neck set up a torsion load on the proximal femoral shaft.

Femoral Neck Stresses

With a normal neck-shaft angle of 125° , the neck of the femur is approximately 50° from the vertical. This means that the joint force approximately 20° from the vertical in coronal plane, imposes a bending load on the neck of femur. Analysing this force in the form of axial and transverse components, the axial components, induces an axial compressive stress throughout the cross section of the femoral neck. The transverse component acting through the centre of head, tends to shear the neck or displace the head transversely and also imposes a moment on the femoral neck. This bending moment causes tensile stresses on the inferior aspect. The tensile stresses are partly offset by the axial compressive stress, but the resultant obtained by superimposing the stress fields arising from the axial and transverse forces is a small tensile stress and a large compressive stress. Radiographs show arrays of trabeculae oriented to these loads.

Intra-vital measurements of hip joint forces

1. When a person stands on one leg the force on the hip joint is 2-6 times the body weight.
2. During slow walking the maximum force is approximately 1.6 times the body weight.
3. If the walking speed is increased (1.4 mts/sec) the force is increased to 3.3 times the body weight in the stance phase and 1.2 times the body weight in swing phase.
4. During running, the force is increased upto five times the body weight during the support phase and upto three times the body weight during swing phase.
5. When crutches are used the joint forces are reduced to only 0.3 times the body weight.

TROCHANTERIC FRACTURES ^(1,2,65)

Definition

Trochanteric fracture is defined as the fracture in which the main plane of bony separation passes the tip of the greater trochanter obliquely downwards, inwards to or through the lesser trochanter. Trochanteric fractures occur in the area just distal to the capsule of the hip joint, and above the area of isthmus of the medullary canal.

Mechanism of Injury

90% of intertrochanteric fractures in the elderly result from a simple fall. The tendency to fall increases with patient age and is exacerbated by several factors, including poor vision, decreased reflexes, vascular disease, and coexisting musculoskeletal pathology like osteoporosis. Laboratory research indicates that the fall of an elderly individual from an erect position typically generates at least 16 times the energy necessary to fracture the proximal femur. Although these data suggest that such falls should cause fracture almost every time they occur, only 5% to 10% of falls in older white women result in any fracture, and less than 2% in a hip fracture. The fact that overwhelming majority of falls do not result in a hip fracture implies that the mechanics of the fall are important in determining whether a fracture will occur.

In younger individuals fracture results from high energy trauma such as motor vehicle accident or fall from height.

According to Cummings, four factors contribute to determining whether a particular fall results in a fracture of the hip

- a) The fall must be oriented such that person lands on or near the hip
- b) Protective reflexes must be inadequate to reduce the energy of the fall below a certain critical threshold.
- c) Local shock absorbers [e.g. Muscles and fat around the hip] must be inadequate
- d) Bone strength at the hip must be insufficient.

1. BIOMECHANICS OF TROCHANTERIC FRACTURE^(1,2)

Trochanteric fractures primarily involve cortical and compact cancellous bone. Because of the complex stress configuration in this region and its non-homogenous osseous structure and geometry, fractures occur along the path of least resistance through the proximal femur. The amount of energy absorbed by the bone determines whether the fracture is a simple [two-part] fracture or is characterized by a more extensively comminuted pattern.

Bone is stronger in compression than in tension. Cyclic or repetitive loading of bone at loads lower than its tensile strength can cause a fatigue fracture. Each load causes microscopic damage to the osseous structure, essentially forming microscopic cracks that can coalesce into a single macroscopic crack, which in turn functions as a stress riser. Failure can thus occur if healing of these microfractures does not take place. In repetitive loading, the fatigue process is affected by the frequency of loading as well as the magnitude of the load and the number of repetitions.

Muscle forces play major role in the biomechanics of the hip joint. During gait or stance, bending moments are applied to the femoral neck by the weight of the body, resulting in tensile stress and strain on the superior cortex. The contraction of gluteus medius generates an axial compressive stress and strain in the femoral neck that acts as a counterbalance to the tensile stress and strain. When the gluteus medius is fatigued, unopposed tensile stress arises in the femoral neck. Stress fractures are usually sustained as a result of continuous strenuous physical activity that causes the muscles gradually to fatigue and lose their ability to contract and neutralize the stress on the bone.

DEFORMITY

The amount of clinical deformity in patients with trochanteric fracture reflects the degree of fracture displacement. The deformity in intertrochanteric fractures is determined by the direction of the forces responsible for the fracture and by the pull of the muscle attachments.

The proximal fragment lies in full external rotation, if the short external rotators remain attached to the proximal fragment. If the fracture is proximal to the attachment of the short external rotators, the distal fragment shows external rotation. Hamstrings and gluteus maximus having greater mechanical advantage over rectus femoris, produce an angulation in the sagittal plane with its apex pointing anteriorly.

The lesser trochanter is separated by compression –extension type of injury. The coxa vara is produced by the gluteus medius and minimus tilting the proximal fragment and the pull of the adductors on the distal fragment.

RADIOGRAPHY

The diagnosis of trochanteric fracture should always be confirmed by a radiograph. Standard radiographic views of the hip includes –

- Anteroposterior [AP] view of the pelvis including both the hip joints.
- Anteroposterior [AP] view of the involved proximal femur.

The AP view of the pelvis allows comparison of the involved side with the contralateral side and can help to identify non-displaced and impacted fractures.

The AP view of the involved hip should be taken in 10° to 15° of internal rotation. This offsets the anteversion of the femoral neck and provides a true AP view of the proximal femur.

When a fracture is suspected but is not apparent on standard radiographs, other useful investigations are –

- ☐ Technetium Bone Scan, for the bone scan to be positive in an elderly patient with a trochanteric fracture, it usually requires two or three days.
- ☐ Computerized Tomography [CT] scan employing fine cuts of 3 mm.
- ☐ Magnetic Resonance Imaging [MRI] scans which will reveal fracture within 24 hours of injury.

CLASSIFICATION OF TROCHANTERIC FRACTURES^(1,2,79,81)

In trochanteric fractures, the classification should allow the surgeon to predict the stability of the fracture, since stability is the key to selection of treatment as well as prognosis.

Boyd HB, Griffin LL in 1949, classified fractures in the peritrochanteric area of the femur into four types.

Their classification included all fractures from the extracapsular part of the neck to point 5 cm distal to the lesser trochanter.

In the same year Evans EM presented a simpler classification dividing the fractures into stable and unstable groups.

Over the past 50 years, much has been published on the different methods for the fixation of trochanteric fractures. In order to appreciate the results, one needs to understand the fracture patterns involved. Many classification systems have been devised; however, since each has had a different object, none has been unanimously adopted by the orthopaedic community. Some of the systems proposed have confined themselves to a simple anatomical description of the patterns observed. Other, more recent, systems were designed to provide prognostic information on the prospect of achieving and maintaining reduction of the different types of fractures.

BOYD AND GRIFFIN CLASSIFICATION

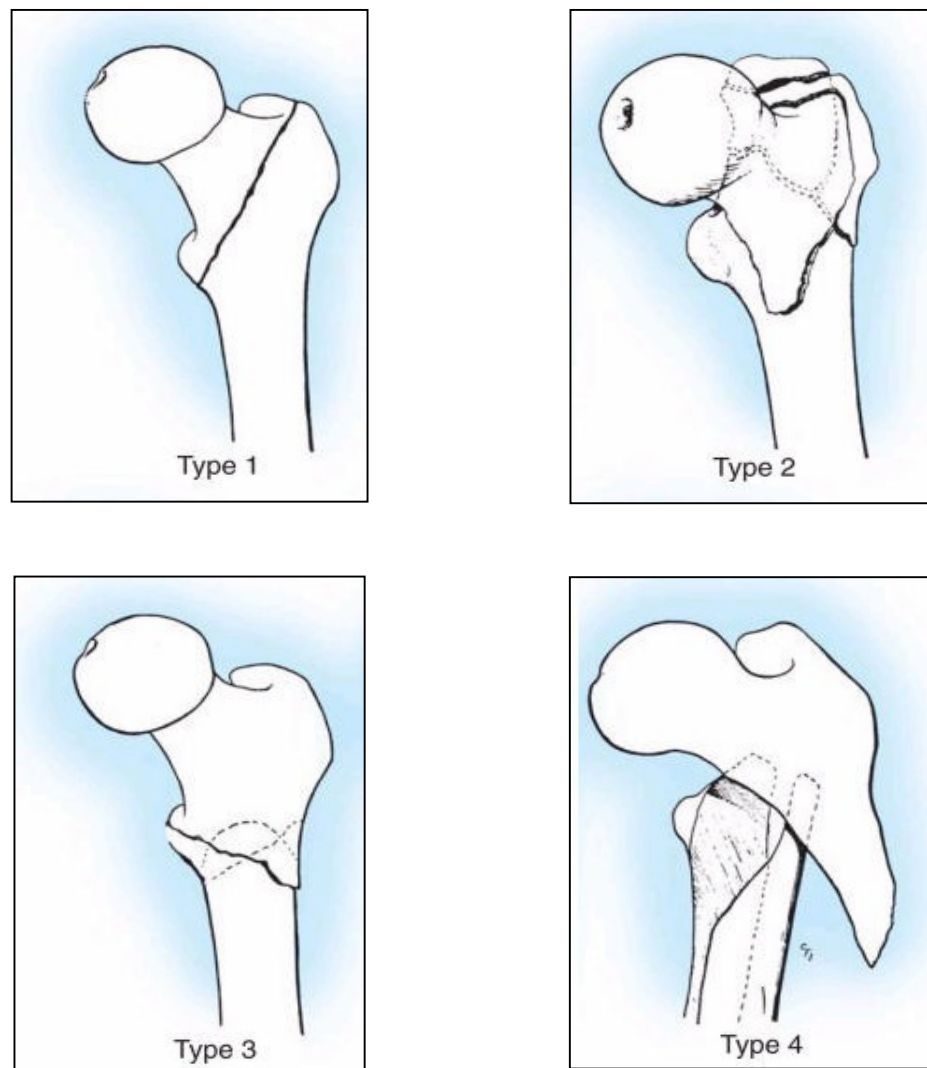


Figure 12: Boyd and Griffin Classification

- Type 1: Fractures that extend along the intertrochanteric line from the greater to the lesser trochanter.
- Type 2: Comminuted fractures, the main fracture being along the intertrochanteric line but with multiple fractures in the cortex. Is a deceptive fracture in which an anteroposterior linear intertrochanteric fracture occurs as in type 1, but with an additional fracture in the coronal plane, which can be seen on the lateral roentgenogram.

- Type 3: Fractures that are basically subtrochanteric with atleast one fracture passing across the proximal end of the shaft just distal to or at the lesser trochanter. Varying degrees of comminution are associated.
- Type 4: Fracture of the trochanteric region and the proximal shaft, with fracture in at least two planes⁽⁶⁶⁾.

Evans EM (1949) devised a classification system that had the twin merits of reproducibility and ease of use. It has been widely used in the English-speaking countries. In this system, fractures of the trochanteric region are subdivided into five types.

1. Type I: Undisplaced 2-fragment fracture
2. Type II: Displaced 2- fragment fracture
3. Type III: 3-fragment fracture without posterolateral support
4. Type IV: 3-fragment fracture without medial support
5. Type V: 4-fragment fracture without posterolateral and medial support

Reverse oblique

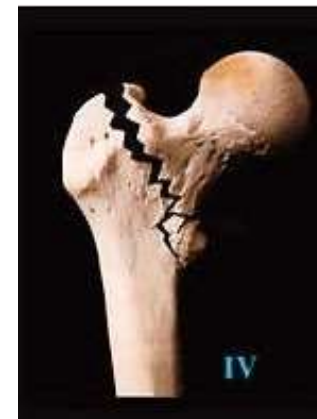
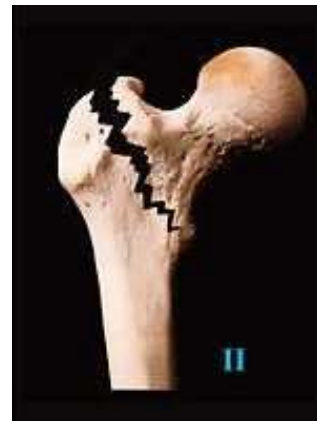
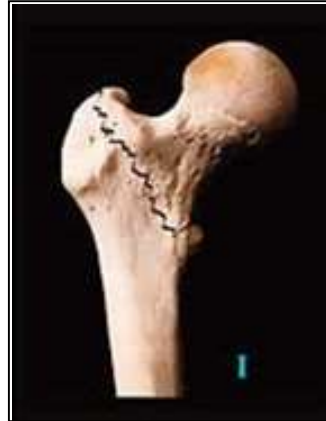


Figure 13: Evans classification

Ramadier (1956)⁽⁶⁷⁾ established a grading system that came to be widely used in France. He described four basic patterns, under four main headings, as a function of the fracture line recognised

1. Cervico-trochanteric fractures
2. Simple pertrochanteric fractures
3. Complex pertrochanteric fractures
4. Pertrochanteric fractures with valgus displacement
5. Pertrochanteric fractures with an intertrochanteric fracture line
6. Trochantero-diaphyseal fractures
7. Subtrochanteric fractures

Decoulx and Lavarde's (1969)⁽⁶⁷⁾ enhanced the above system by the addition of a further pattern that had previously been described by Ehalt and their classification include four patterns:

1. Cervico- trochanteric fractures
2. Pertrochanteric fractures
3. Subtrochanteric fractures
4. Subtrochantero- diaphyseal fractures

Briot (1980)⁽⁶⁷⁾ tried to simplify the Ramadier system and to introduce biochemical concepts. He merged the cervico-trochanteric and the pertrochanteric fractures. According to him;

1. Evans' reversed obliquityfracture
2. "Basque roof" fractures
3. Boyd's "steeple" fracture
4. Fractures with an additional fracture line ascending to the intertrochanteric line
5. Fractures with additional fracture lines radiating through the greater trochanter.

Ender HG (1970), in his description of a technique for condylocephalic nailing, gave a fracture grading system based upon the fracture mechanism. According to him;

Trochanteric eversion fractures

1. Simple fractures
2. Fractures with a posterior fragment
3. Fractures with lateral and proximal displacement

Trochanteric inversion fractures

4. with a pointed proximal fragment spike
5. with a rounded proximal fragment beak
6. Intertrochanteric fractures

Subtrochanteric fractures

- 7 and 7a Transverse or reversed obliquity fractures
- 8 and 8a Spiral fractures

The AO classification, proposed by Muller et al. in 1980-1987, attempts to be descriptive and to provide prognostic information, in the light of what can be done with present-day fixation techniques. According them;

A1: Simple (2-fragment) pertrochanteric area fractures⁽⁸¹⁾

- A1.1 Fractures along the intertrochanteric line
- A1.2 Fractures through the greater trochanter
- A1.3 Fractures below the lesser trochanter

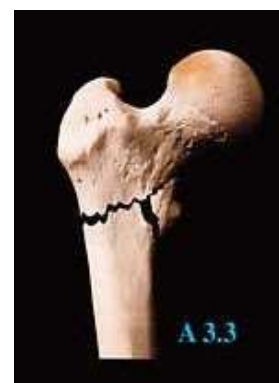
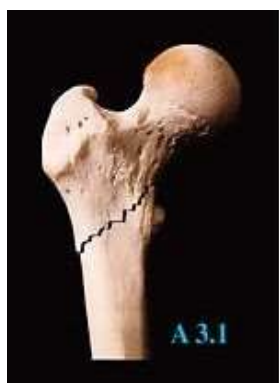
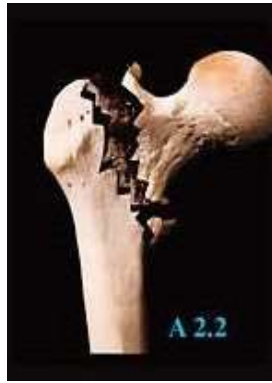
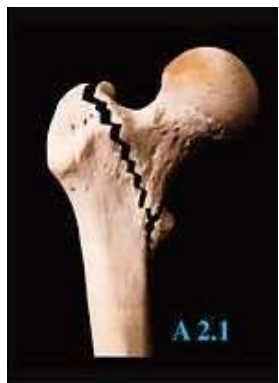
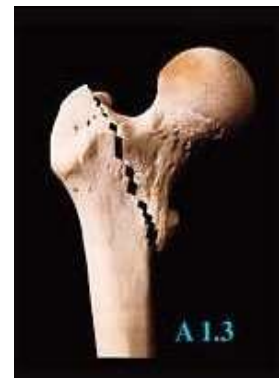
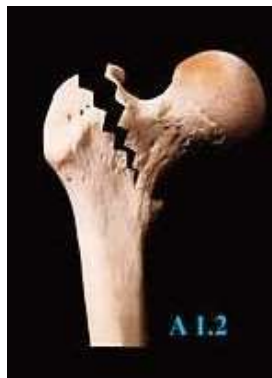


Figure 14: AO Classification

A2: Multifragmentary pertrochanteric fractures

A2.1 With one intermediate fragment (lesser trochanter detachment)

A2.2 With 2 intermediate fragments

A2.3 With more than 2 intermediate fragments

A3: Intertrochanteric fractures

A3.1 Simple, oblique

A3.2 Simple, transverse

A3.3 With a medial fragment

Ottolenghiin (1964) distinguished between intradigital fractures, whose fracture line is medial to the digital fossa of the greater trochanter, and extradigital fractures.

MANAGEMENT OF TROCHANTERIC FRACTURES^(1,79)

The goal of treatment of patients with intertrochanteric hip fractures should be the early mobilization of the patient, with a prompt return to the prefracture level of functioning. For displaced fractures, this goal is rarely, if ever, achieved without surgical intervention.

Trochanteric fractures can be managed in two ways –

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

CONSERVATIVE MANAGEMENT^(1,2)

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.

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

For management of an intertrochanteric fracture by skeletal traction, a metal pin or wire is driven through 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 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.

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, Sonstegard have listed the variable that determine the strength of the fracture fragment, implant assemble.

The variables are: bone quality, Fracture geometry, Reduction, Implant design and 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 stable reduced and internally fixed intertrochanteric fracture⁽⁶⁸⁾.

SURGICAL TECHNIQUES

1. Plate and Screw Devices⁽⁸³⁾

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 to 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 breakage or pulling out of the screw from the femoral shaft.

These experiences led to the modification of the fracture site rather than the implants by femoral osteotomies. 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 by Richard Manufacturing Company and Ian McKenzie of the Royal National Orthopaedic Hospital developed the Sliding Compression Screw used. Clawson made several modifications and in its current form the device is known as the Richards compression Screw, with the following solution:

- Screw threads on the hip nail – to improve purchase in the porous 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.

Kulkarni GS has modified the Richard's Hip Screw called the Miraj Screw, to make the procedure simpler and biomechanically sounder. The following modifications have been made in the standard device:

1. The lag screw is longer, while its proximal end has coarse threads as in the standard device; its distal end is also threaded. The compression is applied by a nut, which passes over the distal end instead of the nut entering the distal end. This makes the procedure simpler.
2. The distal shaft thread junction is made tapering to prevent the distal end of the barrel getting stuck.
3. The key and slot mechanism in the screw and barrel of the standard device, which prevent rotational movement of the fragment, has been eliminated.

In unstable trochanteric fractures in patients with severely osteoporotic bone some authors have suggested the use of PolyMethyl Methacrylate [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.

Nilesh B and Sharma modified side plate with locking plate for osteoporotic bones. In osteoporotic bone, normal screws in DHS blade provide less anchorage compared to locking screws. Various kinds of problems are encountered in the fixation of trochanteric fracture by standard compression plate, especially in severe osteoporotic bone. There is increasing incidence of implant failure like lifting off of plate, pulling out of screws, screw toggling, screw breakage and cut-out failure of lag screw particularly in porotic bone in unstable fractures, resulting in implant failure and mal- or non-union. To overcome these problems a locking plate and screw system has been developed. The locking compression plate is the combination of two completely different anchorage technologies in one implant called DHS Combi plate (57, 85).

2. Intramedullary Devices⁽⁸³⁾

Intramedullary fixation of the intertrochanteric fractures from the medial side began with Lezius in 1950, who inserted the nail at the junction of 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 complication such as; Rotational deformity, Supracondylar femur fracture, proximal migration of the nails through the femoral head and back out of the nail with resultant knee pain and knee stiffness.

Other intramedullary devices such as the Gamma Nail, Intramedullary 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 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 screw.

The Russell Taylor Reconstruction Nail has been recommended for use in unstable intertrochanteric fractures or in fractures with reverse obliquity or subtrochanteric extension⁽⁶⁹⁾.

3. Prosthetic Replacement^(2,75)

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 et al. are:

- I. Symptomatic ipsilateral degenerative hip disease, where a total hip replacement is ideal.
- II. 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 a 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.

4. External Fixators ⁽⁷⁰⁾

The application of external fixators in the management of intertrochanteric fractures is simple, safe and economical. It was the method of choice in high risk geriatric patients.

Two or three 6.5 mm 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 4.5 mm 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

DYNAMIC HIP SCREW WITH LOCKING SIDE PLATE⁽⁸³⁾

The Dynamic Hip Screw and locking Barrel Plate assemble remains the implant of choice for most intertrochanteric fractures.

Biomechanics of the Dynamic Hip Screw:

In a 1935 study, Pauwels concluded that the forces acting on the hip in a single limb stance amount to approximately three times the body weight applied at an angle of 159 degrees to the vertical plane. This same force acts on any hip fixation device that is placed across the fracture site.

The optimal angle between the barrel and the side plate of a hip compression screw has been the subject of controversy.

Many authors have argued that 150 degrees plates are preferable because the angle of the lag screw more closely parallels the compressive forces within the femoral neck. Theoretically, this should lead to less bending of the screw within the barrel of the side plate and less chance of failure of the implant from bending.

The use of a 150° side plate often resulted in

- Unacceptable high placement of the lag screw in the relatively weak bone of the antero-superior part of the femoral head.
- As it necessarily enters the shaft below the fracture in thick cortical bone, the angle of entry has to be exact, since the bone at the entry hole is too thick to permit crushing to correct minor errors of angle insertion.

There is no difference in fracture impaction between 135° and 150° plates.

For these reasons a 135° side plate is used in most fractures.

The major force acting in a trochanteric fracture is the joint force through the femoral head. This force has two components –

- I. The force parallel to the fracture line causes sliding of the fracture surfaces, and inferior displacement and varus angulation of the femoral head.
- II. The force perpendicular to the fracture drives the fracture surfaces together, causing friction and mechanical interlocking.

Therefore the aim of fixation of trochanteric fracture is to use the perpendicular component to drive the surfaces together and gain stability. This is the basic principle of the Dynamic hip screw.

In using the dynamic hip screw, it is important to ensure that the screw can slide in the barrel of the side plate. When this occurs the screw is protected from bending as it is supported by the fracture surfaces. Two basic principles enhance the ability of the screw to slide in the barrel –

- I. Within the clinical constraints of the fracture geometry, the higher angle device will allow less resistance to sliding because the screw axis is more closely aligned to the direction of the joint force.
- II. The screw should be engaged as deeply as possible within the barrel. For the same force acting at the femoral head end of the screw, the internal force between the barrel and the screw, which keeps it from bending downward, is greater when the length of screw in the barrel is smaller.

To balance the moment caused by the force acting at the femoral head end of the screw [this moment is equal to the force acting perpendicular to the screw multiplied by the distance to the proximal edge of the barrel], the internal force [for the balancing moment, which is equal to the force acting between the screw and the barrel multiplied by the distance of this force from the proximal edge of the barrel] must be larger, if its moment arm is smaller. If this force is larger, the frictional force between the screw and barrel increases, and greater resistance to sliding results.

To ensure impaction, the barrel threaded portion of the hip screw device must cross the fracture site. There must also be enough room for the implant to collapse before the screw impinges on the barrel because, when such impingement occurs, the device acts as a fixed angle plate. Jamming, or failure of the hip screw to slide, also results in the implant's functioning as a fixed angle plate.

Failure of the lag screw to telescope can also occur as the result of impingement of the sleeve of the side plate on the base of the proximal fragment.

Hybrid fixation is the fixation of the fracture with one material with two or more fixation devices. The Dynamic Hip Screw is the most commonly used hybrid device, which combines an intramedullary device [the lag screw] with an extramedullary device [the side plate]. Pulling out of screw, screw toggling, plate loosening are common with oval hole barrel plate, whereas combi hole barrel plate (locking side plate) can be locked with locking, it reduces pulling out of screw, screw toggling and plate loosening⁽⁵⁷⁾.

The Dynamic Hip Screw may be applied with static compression during surgery and with dynamic compression and gliding after resumption of physiologic loading. This combination of effects is desirable in intertrochanteric fractures in porous bone and stands as an ideal indication for hybrid fixation. In high subtrochanteric osteotomy, the same device can be placed to function as a compression plate having dynamic tension band properties.

Parts of the Dynamic Hip Screw with locking side plate

The Dynamic Hip Screw with locking side plate has three parts:

1. The Lag Screw

It is available in variable lengths. Its proximal tip is blunt and has broad threads at the proximal end, which is threaded into the femoral head. The diameter of the threaded part is 12.5 mm, and the length of the threaded part is 22 mm. The pitch of the thread is 3 mm. The diameter of the shaft of the lag screw is 8 mm. The inner surface of the distal end of the shaft is threaded for the application of the compression screw.

2. The Side Plate with a Barrel

It is available in various lengths. The barrel for the lag screw to slide through it is set at an angle [120 to 150 degrees] to the plate. The side plate has combi-hole slots for fixation to the shaft of the femur.

3. The Compression Screw

It is 19 mm in length, and is screwed into the distal end of the lag screw after the side plate is fixed.

Ideal Dynamic Hip Screw:

1. Position of the Lag Screw

The ideal location for the placement of the lag screw in the femoral head has been the subject of much controversy.

Mulholland, Gunn in a retrospective study, found that central placement of the lag screw on the anteroposterior and lateral X-rays with deep penetration of the head was optimum.



Figure 15: DHS locking plate and Locking screws

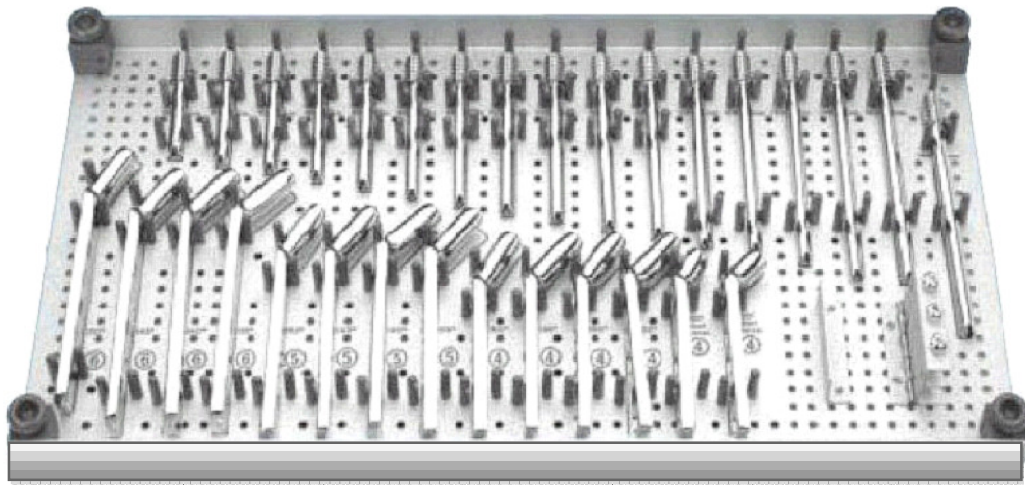
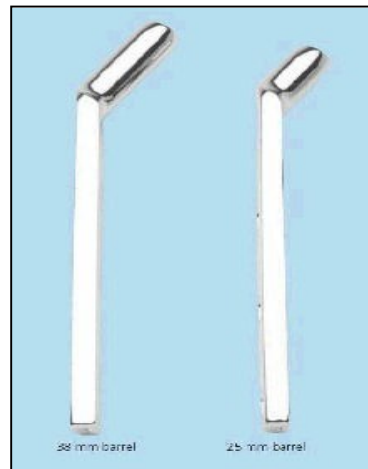


Figure 16: Implant box



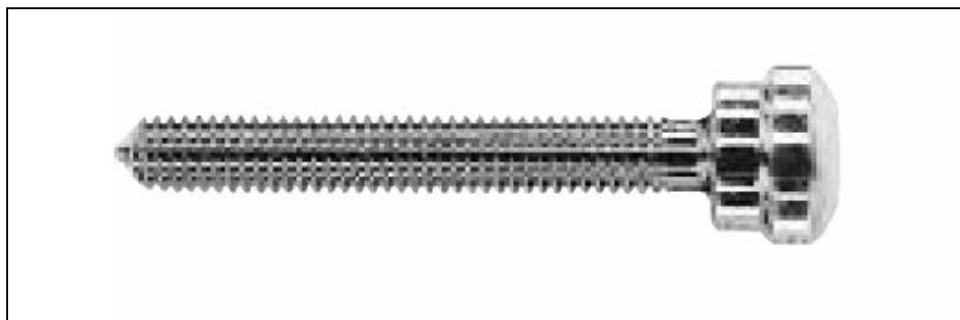
Figure 17: Implants and instruments



Barrel plate



Screws



Compression screw

Figure 18: Implant and instruments

Kaufer recommended placing the screw in the posteroinferior quadrant of the head on the lateral X-ray and low on the Calcar on the anteroposterior X-ray so that the nail would have to “Plow Through” a maximum amount of bone before cutting out of the femoral head.

Although the optimal position of a compression screw within the head and neck is controversial, there is uniformity of the agreement that it should be central or inferior and posterior, anterior and superior aspects of the femoral head should be avoided, owing to the increased risk of the implant cutting out.

2. Depth of the Lag Screw

Kaufer recommends placing the lag screw within 2 cm of the subchondral bone for maximum purchase.

3. Angle of the Barrel Side Plate

The optimal angle between the barrel and the side plate is controversial. 150° plates are preferable because the angle of the lag screw more closely parallels the compressive forces within the femoral neck. The 135° devices are easily placed and because their clinical results are similar to those of the 150° plates. Hence the 135° barrel plates are ideal.

4. Length of the Barrel

The barrels are available in two sizes:

- The standard barrel [38 mm]
- The short barrel [25 mm]

The longer barrel maximizes the amount of screw barrel engagement and minimizes the likelihood of the lag screw “jamming” within the plate barrel.

A short barrel plate is indicated for specific clinical situations, including:

- ☐ Cases in which the standard barrel may not provide sufficient glide for the lag screw; i.e., a long impaction distance is expected.
- ☐ A medial displacement osteotomy.
- ☐ Unusually small femurs.

A short barrel is also used if a lag screw less than 85 mm has been inserted, because if sliding does occur, it is less likely to use up the sliding capacity of the device, resulting in contact of the lag screw and the plate barrel.

Optimal sliding results when the tip of the screw shaft is within 1 cm or less of the barrel plate junction.

5. Shape of the Lag Screw and Barrel

A “Keyed” sliding hip screw system is ideal.

In a keyed system, the lag screw is captured within the plate barrel such that the screw can slide along the barrel but cannot rotate. This mechanism theoretically maximizes rotational stability of the femoral head and neck compared to a non keyed system in which the lag screw can rotate within the plate barrel.

6. Length and type of the Plate

For majority of fractures a 4 holed combi plate is adequate. A 5 -6 holed plate is suggested for those fractures with a subtrochanteric extension.

It is essential to have minimum of four screws distal to the fracture line. The plate should fit the shaft without stress and is attached to it with atleast four screws, engaging eight cortices.

7. Length of the Screw

The lag screw length is determined by measurement at the time of fixation. If a screw of excessive length is used, it will protrude. A lag screw 5 mm less than the measured length will allow 5 mm of compression.

8. The Compression Screw

The need for a compression screw is determined by direct visualization of the lag screw within the plate barrel. A compression screw is inserted if there is risk of postoperative screw-barrel disengagement.

Tip Apex Distance^(1,36,50):

The tip-apex distance is defined as the sum of the distance from the tip of the lag screw to the apex of the femoral head, as measured on an antero-posterior radiograph and that distance as measured on a lateral radiograph after correction has been made for magnification.

The Tip Apex Distance if less than 25 mm has shown least implant failure and if more than 25mm has shown more implant failure. The reason behind this less Tip Apex distance having good results and better hold is, the area of the femoral head from 25 mm to the apex of head has both the both the primary tensile trabeculae and primary compressive trabeculae crossing each other and forming a mesh of cancellous bone.

If the lag screw is fitted in this area it will have a best hold and the probability of screw cut out, implant failure is very less.

The calculation of Tip Apex Distance:

FORMULA FOR CALCULATION OF TIP APEX DISTANCE⁽³⁶⁾

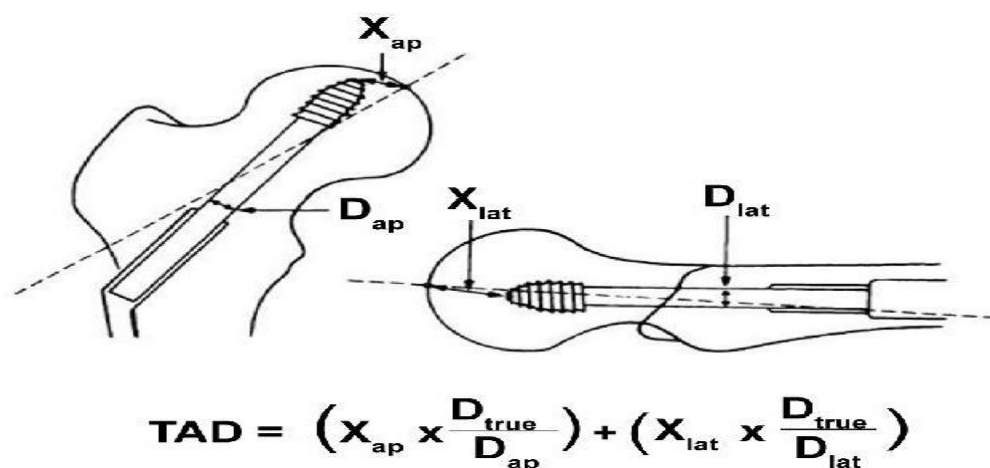


Figure 19:TAD Calculation formula

REDUCTION OF TROCHANTERIC FRACTURES

A stable reduction of an intertrochanteric fracture requires providing medial and posterior cortical contact between the major proximal and distal fragments in order to resist varus and posterior displacing forces.

The restoration of normal anatomy is the ideal goal, but unfortunately anatomical reduction of a comminuted intertrochanteric fracture is difficult to achieve. Therefore, a non-anatomical but stable reduction is indicated in those fractures in which an anatomical stable reduction cannot be obtained.

With the use of dynamic implants that allow for controlled, post – operative axial impaction, absolute anatomic reduction of trochanteric intermediate fragments to achieve mechanical stability is not necessary.

METHODS OF REDUCTION

Intertrochanteric fractures can be reduced by closed or open means.

CLOSED REDUCTION:

- ☐ Stable Fractures
- ☐ Unstable Fractures

Stable fractures: In fractures patterns without posteromedial comminution [type I stable intertrochanteric fractures], anatomic fracture reduction restores the ability of the bone to transmit compressive loads across the medial cortex. Anatomic reduction of the fracture fragments can usually be achieved. Reduction simply requires adequate longitudinal traction to overcome shortening caused from unopposed muscle action and bleeding into the proximal thigh, mild abduction to correct any residual varus, and slight internal rotation to “Screw Home” the distal fragment.

Unstable Fractures: Although there is almost universal agreement that anatomic reduction is best for stable fractures, there have been numerous opinions regarding the preferred reduction for unstable fractures. Most investigators recommend attempted anatomic reduction of the unstable intertrochanteric fracture. In practice, because it is rare for the posteromedial lesser trochanter fragment and the lateral

greater trochanter fragment to reduce spontaneously and formal exposure and fixation of these fragments exact too much of a biologic cost to be beneficial, absolute anatomic reconstruction is rarely attempted. Instead, the goal is to reestablish an anatomic relation between the head and neck fragment and the shaft fragment, both axially and translationally, in the AP and lateral planes. Fixation of these fragments with a fatigue resistant sliding hip screw allows for a controlled impaction of the fracture surfaces with out loss of axial or translational alignment as the fracture is loaded during the postoperative period. Clinical support for this method of reduction exists in various reports.

Before the development of devices that could collapse during postoperative fracture settling, surgeons had to achieve complete fracture stability during the operation. Lacking this, the incidence of fatigue failure of the implant or joint perforation [if the fracture collapsed on a fixed – length implant] was high. Methods to achieve stable medial cortical opposition include nonanatomic neck-shaft valgus alignment and high angled fixation, with or without osteotomy.

Elective Osteotomy to Femoral Shaft to Achieve Stability

Dimon and Hughston's Medial Displacement Osteotomy

In 1967, Dimon and Hughston reported that four part fractures with a posterior or medial gap after an unstable reduction collapsed into varus. This collapse resulted in implant failure. The addition of the medial displacement osteotomy reduced the incidence of failure⁽¹²⁾.

Naiman et.al. added that, oblique intertrochanteric fractures with a thin greater trochanteric component and intertrochanteric fractures in which the greater

trochanter is fractured during nail insertion along with four part intertrochantric fractures are indications for medial displacement osteotomy⁽⁷¹⁾.

The addition of sliding hip screw has altered the use and indications for medial displacement osteotomy.

Chang et al. reported that an anatomic reduction of a four part intertrochantric fracture internally fixed with a sliding compression screw provides significantly higher compression across the Calcar region and lower tensile strength on the plate than fractures treated by medial displacement osteotomy.

Medial displacement osteotomy has resulted in limitation of range of hip and knee motion, shortening of 1 cm to 2.5 cm and limp.

The failure of fixation after medial displacement osteotomy varies from 10% to 30%.

Sarmiento's Valgus Osteotomy

In 1973, Augusto Sarmiento introduced a valgus osteotomy for the unstable intertrochantric fracture in an effort to gain medial cortical stability. This technique changes the fracture plane from vertical to near horizontal and creates contact between the medial and posterior cortex of the proximal and distal fragments.

The advantage of this valgus osteotomy is that valgus realignment of the proximal fragment makes up for the loss of length at the osteotomy site so that the limb remains equal⁽⁷²⁾.

Sarmiento has pointed two possible errors in the technique of valgus osteotomy. They are:

- If the osteotomy is made too transverse, it places the head in an exaggerated valgus position. This may result in the leg's being too long or in the hip's being unstable. To avoid this, the medial displacement of the osteotomy should exit 1 cm below the fracture surface medially to compensate for the increased length caused by the valgus osteotomy.
- Creation of an external rotation deformity after nailing. This can be prevented by attaching the shaft to the proximal fragment in slight internal rotation.

Sarmiento also mentions that in some fractures medial comminution is so extensive that osteotomy will not create enough bony contact to ensure stability.

Augmentation with Polymethylmethacrylate

The use of polymethylmethacrylate to augment medial stability has been recommended in comminuted intertrochanteric fractures.

The addition of polymethylmethacrylate increases the magnitude of the operation and may introduce complications of non-union and delayed union.

OPERATIVE PROCEDURE

Anaesthesia

The patients are taken up for surgery under General Anaesthesia, Spinal or Epidural Anaesthesia.

Patient Positioning⁽⁸²⁾

The patients are positioned supine on the fracture table with a radiolucent padded counter traction post placed between the patient's legs.

The uninjured leg is held in wide abduction by a boot attached to one of the leg extensions of the fracture table.

The injured leg is held in slight abduction, by a boot attached to other leg extension of the fracture table

The C-arm image intensifier is positioned between the patient's legs and the adequacy of both the antero-posterior and true lateral views are verified, before surgical preparation.

Reduction Technique

Closed reduction of fracture by manipulation is performed.

After the anesthetized patient is positioned on the fracture table, and the extremity is secured in the traction foot piece, traction is exerted longitudinally on the slightly abducted injured leg until reduction is achieved.

The degree of rotation required for rotation is variable, depending on the degree of comminution. In non comminuted fractures without displacement, the limb was fixed in neutral or slightly internal rotation. In comminuted fractures. 15-20° of external rotation is required to close the defect posterolaterally.

Reduction is checked in the antero-posterior and lateral views in an image intensifier, paying special attention to the posterior and medial cortical contact. If reduction is not achieved by closed manipulation Open anatomical reduction is done.

Draping

The skin over the hip is scrubbed with betadine scrub, for 10 minutes and painted with betadine and spirit. The lateral aspect of the hip is squared off from the iliac crest to the distal thigh, with towels and drapes. A plastic transparent, adherent, isolation drape is directly applied to the skin at the proposed incision site.

Exposure ⁽⁸²⁾

Approach to proximal femur Watson –Jones lateral approach , incision made from the greater trochanter extending distally .The length of incision depends on length of implant used.

The dissection is deepened in the line of incision down to the fascia lata. The fascia lata is incised and retracted. The vastus lateralis muscle and its origin from the inferior border of the greater trochanter is viewed.

Vastus lateralis is divided at its origin from the greater trochanter transversely, down to the posterolateral surface of femur. Then the muscle and its fascia divided longitudinally with cautery beginning on the posterolateral surface, 0.5 cm from its attachment to the linea aspera.

Guide Pin Insertion

The level of insertion of the pin is approximately 2 cms below the vastus lateralis ridge. It is the level of entry of a 135° angle plate. If a higher angle side plate is used, the entrance is moved 5 mm distally for each 5° increase in barrel angle.

A fixed angle guide is placed midway between the anterior and posterior cortex of the femur on the lateral cortex. The guide pin with 3.2 mm is aimed towards the apex of the femoral head, confirming the central placement of the pin on both anteroposterior and lateral views; the guide pin is passed to within 10 mm of the joint. The guide pin is advanced to an additional 5 mm into the subchondral bone to avoid guide pin pullout while reaming.

Reaming the Femur

The cannulated reamer is set to the length of the lag screw measured. The reamer is slid over the guide pin, and femur is reamed coaxial to the guide pin, under c-arm control.

The reaming is stopped when the short barrel notch indicator on the barrel reamer reaches the lateral cortex.

Tapping of Femoral Head

Tapping is done to avoid excessive torque on the insertion wrench and to minimize risk of inadvertent malrotation of the femoral head fragment during final seating of the screw.

Insertion of Lag Screw

The appropriate lag screw is placed over the guide pin and introduced into the reamed hole. The lag screw is advanced into the femoral head to the predetermined level and its position is verified with image intensification in both planes.

Then the side plate is advanced onto the lag screw shaft, lag screw retaining rod is unscrewed and the insertion wrench is removed from the back of the lag screw. Then the guide pin is removed.

Attachment of the Side Plate

The plate is secured to the shaft of femur with a plate clamp. With a 3.2 mm drill, holes are drilled into the lateral cortex, through the holes of the side plate. The holes are tapped with a 4.5 mm tap or self tapping 4mm or 5 mm locking screws used. The appropriate screw length is measured with a depth gauge. The screws are inserted using a screwdriver.

Compression of the Fracture

Compression is obtained using the barrel compression instrument. The 19 mm compression screw is threaded into the distal end of the lag screw shaft. The traction of the leg is released and compression screw is tightened to compress the fracture. The position of the lag screw, side plate and fracture compression is confirmed by image intensification in both anteroposterior and lateral views.

Closure of the Wound

Fascia lata and subcutaneous tissue is sutured with, over a suction drain. Skin is sutured with non absorbable suture material. Sterile dressing is put after removing the plastic isolation drape.

COMPLICATIONS

The complications following the surgical management of intertrochanteric fractures are:

General Complications^(79,80)

As a result of prolonged immobilization of the elderly patients, following the fracture and surgery, they may develop some general complications.

These include:

- Thromboembolism
- Pneumonia
- Urinary tract infection
- Cerebrovascular accidents
- Deep vein thrombosis [DVT]

Local Complications

As a result of surgery there may be certain complications locally at the operative site. These include:

- Hemorrhage
- Wound infection

Mechanical and Technical Failures: These include –

- ☐ Varus Displacement
- ☐ Nail Penetration
- ☐ Rotational Deformity
- ☐ Nonunion
- ☐ Aseptic Necrosis
- ☐ Stress Fracture

METHODOLOGY

The cases for the study were collected from patients who were admitted to admitted to RLJ hospital attached to Sri Devaraj Urs Medical College, Department of Orthopedics, Tamaka Kolar, diagnosed with inter trochanteric fractures. 30 such cases were selected between August 2015 To June 2017, patients and their relatives were explained the condition of the patient. Informed consent obtained and all details of the patients were collected in a preformed proforma.

Patients were admitted to the ward, detailed history taken with particular emphasis on mode of injury and medical illness. Cardiovascular and respiratory system evaluation done and upper tibial skeletal traction applied prior to surgery.

Following discharge, regular Clinical evaluation and radiological evaluation was done in outpatient department at 6 weeks, 3 , 6 months for all cases on follow up. Parker's mobility scoring system was used for evaluation. Need for readmission was also considered if required. In case physiotherapy was needed, patients were referred accordingly on OPD basis.

Study design: Prospective observational study.

Sample size: A sample size of 30 was selected.

METHOD OF COLLECTION OF DATA

- The cases at follow up were analysed both clinically and radiologically
- By interview,
- By follow up at intervals 1,2,3,4 and 6 months postoperatively

STATISTICAL METHODS APPLIED

Data is analysed using the statistical program for social sciences(SPSS) software. Evaluation of the functional outcome done by Parker mobility score. Comparison of complications was done using the chi-square test. A probability value(p value)<0.005 will be considered statistically significant

INCLUSION CRITERIA:

- ☐ Patients diagnosed with IT fractures of Femur.
- ☐ Patients more than 40 years of age.
- ☐ Closed type of fractures .

EXCLUSION CRITERIA

- ☐ Pathological fractures.
- ☐ Peri prosthetic fractures.
- ☐ Open type of fractures
- ☐ Old malunited or non union IT fractures.
- ☐ Not willing for treatment.
- ☐ Medically unfit for surgery.
- ☐ Compound fractures associated with vascular injuries, ipsilateral shaft fractures and pelvic fractures.
- ☐ Trochanter fractures associated with neck of femur/head of femur/ shaft of femur /dislocation of hip/knee

PROCEDURE OF THE STUDY

Pre operative

Patients admitted with trochanteric fractures were examined and X-rays of hip in antero posterior and lateral views obtained. Skin traction with appropriate weights applied and in old cases and where surgery delayed because of other medical causes upper tibial skeletal traction with minimum 5-6 kgs applied over Bohler Brawn splint.

Oral and parenteral NSAIDs used in most cases to relieve pain.

Routine blood investigations like, Complete blood count, urine routine, bleeding and clotting time, blood urea, serum creatinine, random blood sugar, serology for HIV, Hbsag, Anti HCV Electro cardiograph (ECG), chest X-rays were obtained routinely, physician opinion regarding fitness was obtained and Echocardiography obtained as per cardiologist opinion if need be.

Patient was advised to perform both static and dynamic quadriceps exercises. Pre anesthetic evaluation was done for all cases and American society of Anesthesiologist (A.S.A) grading system used prior to surgery. Parenteral 3rd generation cephalosporin were administered 1 hour prior to surgery.

Clipping of hair outside OT and scrubbing done in OT.

OPERATIVE PROCEDURE

1. Type of anesthesia

- i) General anesthesia
- ii) Spinal anesthesia
- iii) Epidural anesthesia
- iv) Combined spinal and epidural

2. Surgery

Position: Patient was positioned in supine position on a fracture table and closed reduction was done and reduction checked using C-arm in both AP and Lateral views.

3. Exposure

- Draping was done adequately from xiphisternum up to foot. Lateral approach to proximal shaft and trochanteric region used. Incision was made over proximal femur laterally beginning from the middle of the greater trochanter extending distally. The length of incision depends on length of implant used. Incision was deepened down to fascia lata, with a scalpel in the distal part of the wound and was split proximally with scissors. In proximal part of the wound fascia lata divided posterior to the tensor fascia lata muscle.
- By retracting, vastus laterals muscle and its origin from the inferior border of the greater trochanter. Exposed vastus laterals is then divided near linea aspera.
- The vastus laterals muscle retracted posteriorly and then perforating branches of profunda femoris identified and ligated.
- After dividing muscle along the femur for required distance, it is elevated with a periosteal elevator and lateral and anterolateral surfaces of femoral shaft exposed.

4. Guide pin insertion

- ❖ Point of insertion: lateral aspect of femoral shaft midway between anterior and posterior cortices approximately 2 cms below the flare of greater trochanter (i.e. vatus lateralis ridge).
- ❖ An entry point was made.
- ❖ Using fixed/dynamic angle guide measuring 130/135/140 degree, guide pin mounted on a T handle inserted till the resistance is felt.

Reaming of femur

A triple reamer with the reamer set 5 mm shorter than the length of guide pin used in osteoporotic bone else reamed to the length of guide pin.

Tapping of femoral head

Tapping of femoral head done in patients with good bone quality but avoided in osteoporotics.

Insertion of lag screw

Using a lag screw introducer, screw introduced and checked on image intensifier.

Attachment of plate

Barrel plate is selected based on the neck shaft angle. 130°/135°/140° barrel plate was secured to femoral shaft and fixed with 4 or 5 mm locking screws and 4.5 mm cortical screws.

Application of compression screw

Compression screw is then inserted into the distal end of lag screw and tightened to compress the fracture after release of the traction. Final position is conformed, joint movement checked passively (for short movements). Wound washed thoroughly and closed in layers and sterile dressing applied over a suction drain in required cases.

Postoperative

Patient was initially observed in the recovery room later shifted to ward.

Adequate analgesics, I.V antibiotics given up to 48 hours post operatively.

Post OP check X-rays obtained. Oral antibiotics were continued after discharge if infection was found.

Drain was not used, wound inspected at 2nd post op day. Staple or suture removal done on 10th day.

Patient was made to sit up on bed and Static quadriceps exercises started from 2nd day. Patient reviewed regularly after discharge at OPDs for a period of 3 to 6 months.

Partial weight bearing allowed from second week and full weight bearing from sixth week with walkers.

Cases included in the study were followed up regularly.

Clinical evaluation was done assessment for pain, swelling, infection and mobility, deformity, wound status, limb length, walking ability determined on follow up. Parker's mobility scoring system was used for evaluation.

Radiographic assessment was done at each visit as Tip apex distance ,
Migration of screw, Cutting out of screw , . Implant failure

Table -1 Parkers mobility score for Assessment of mobility ^{(34,37,57).}

Score is the total 9 , Excellent 8-9,Good 6-7,Fair 5 or less than 5

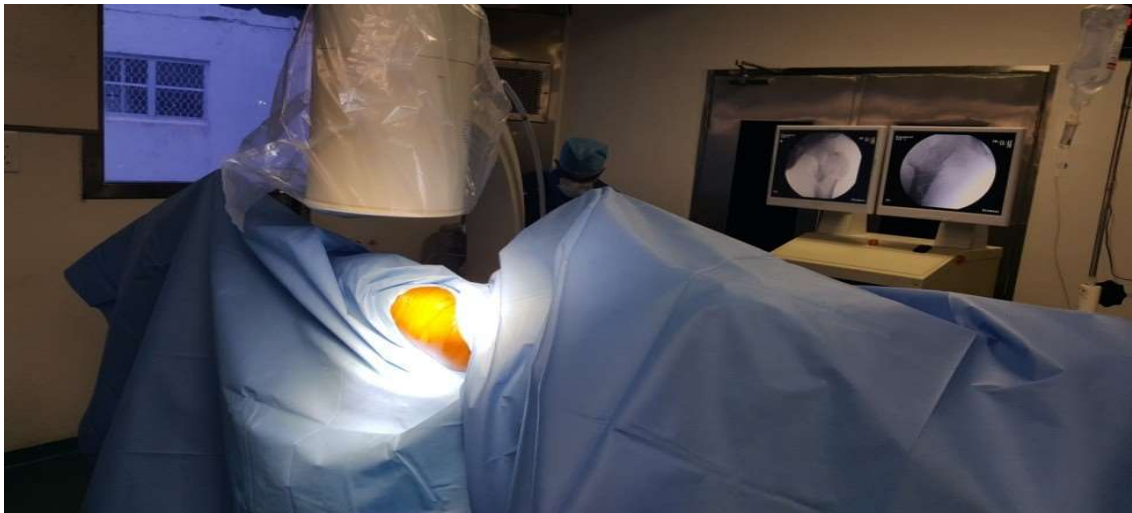
Mobility	No difficulty	With an aid	With help from another person	Not at all
Able to get about the house	3	2	1	0
Able to get out of the house	3	2	1	0
Able to go shopping	3	2	1	0

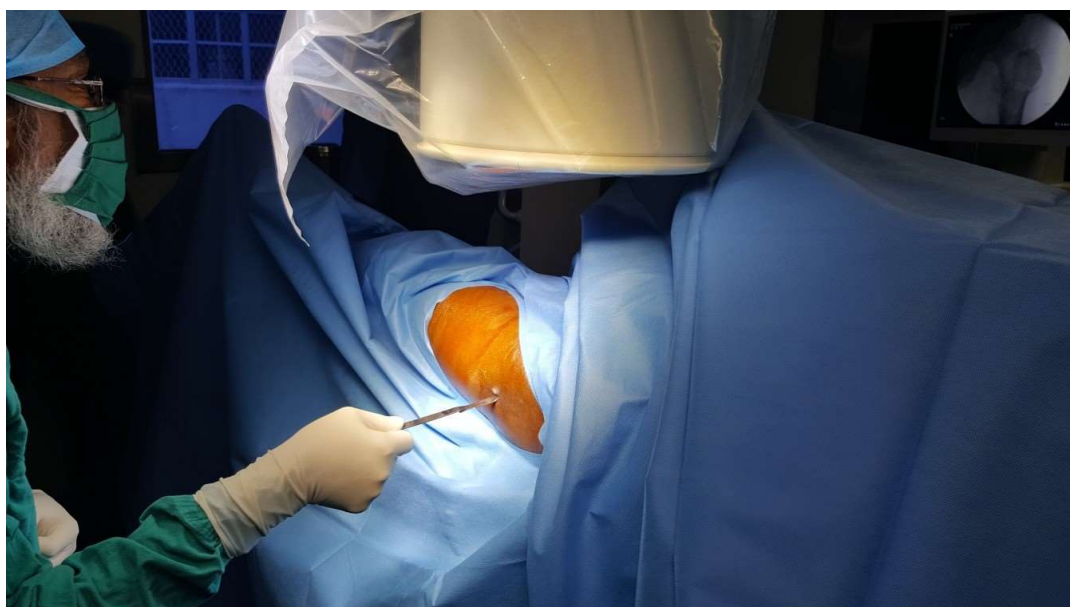
FIGURE 20: PROCEDURE PICTURES

ON FRACTURE TABLE & PAINTING AFTER REDUCTION

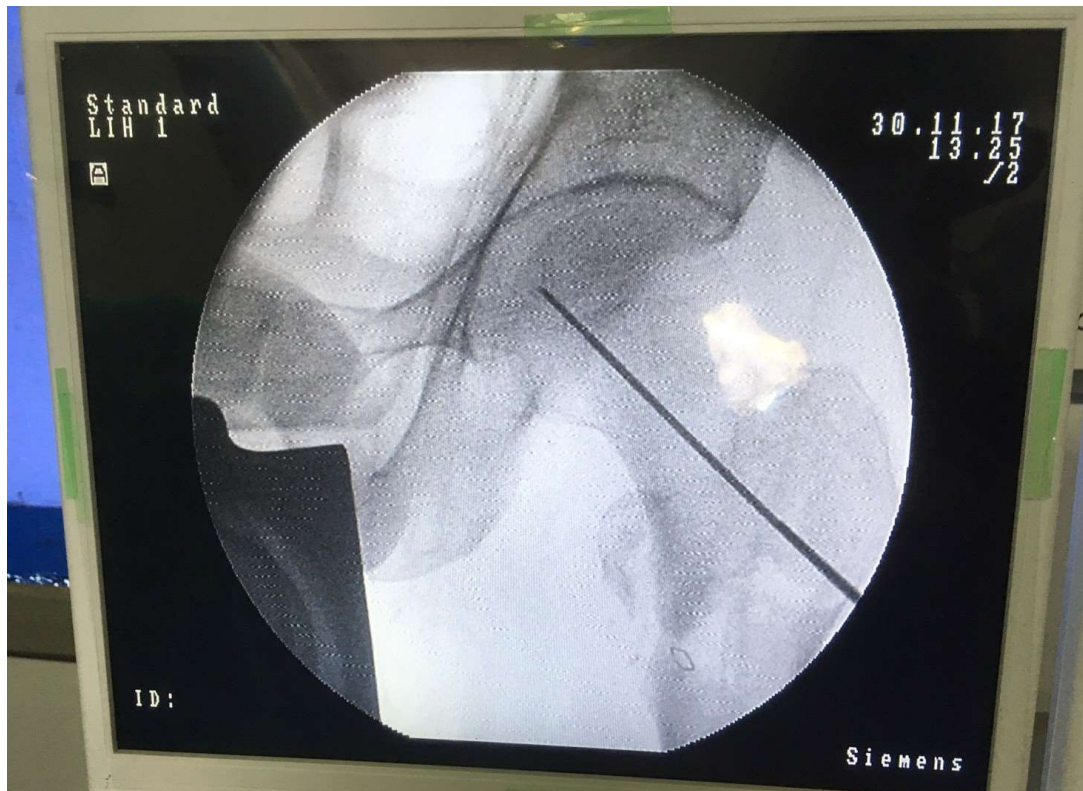


LIMB DRAPED C-ARM COVERED





INCISION PICTURES

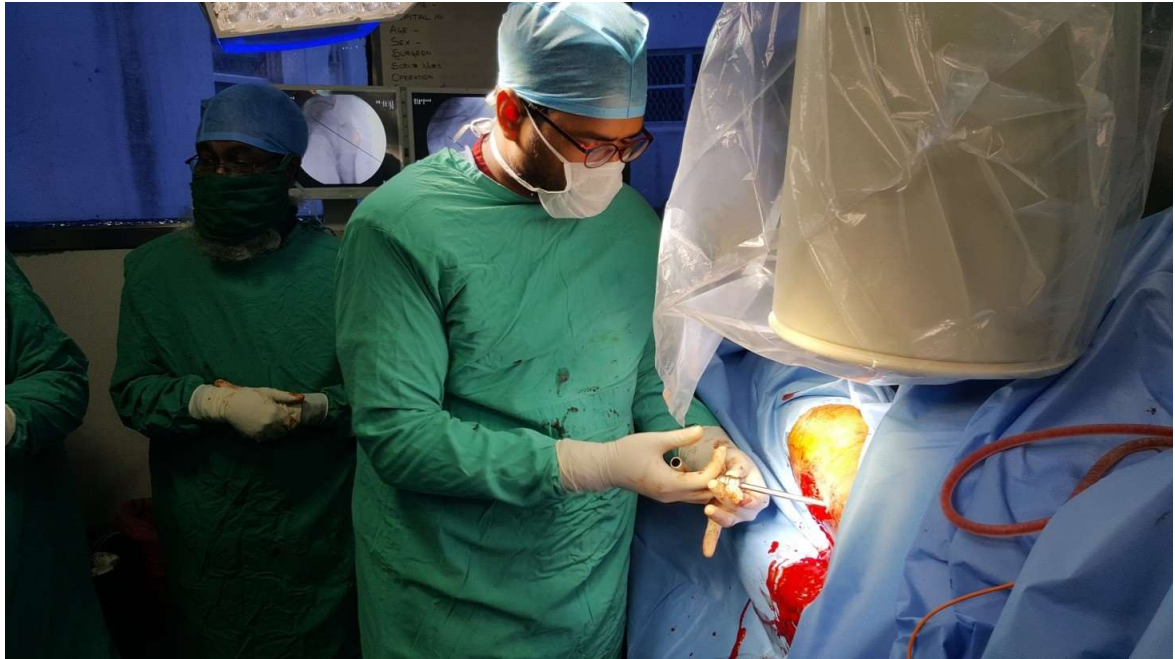


GUIDE WIRE INSERTION PICTURES



TRIPLE REAMING





LAG SCREW INSERTION

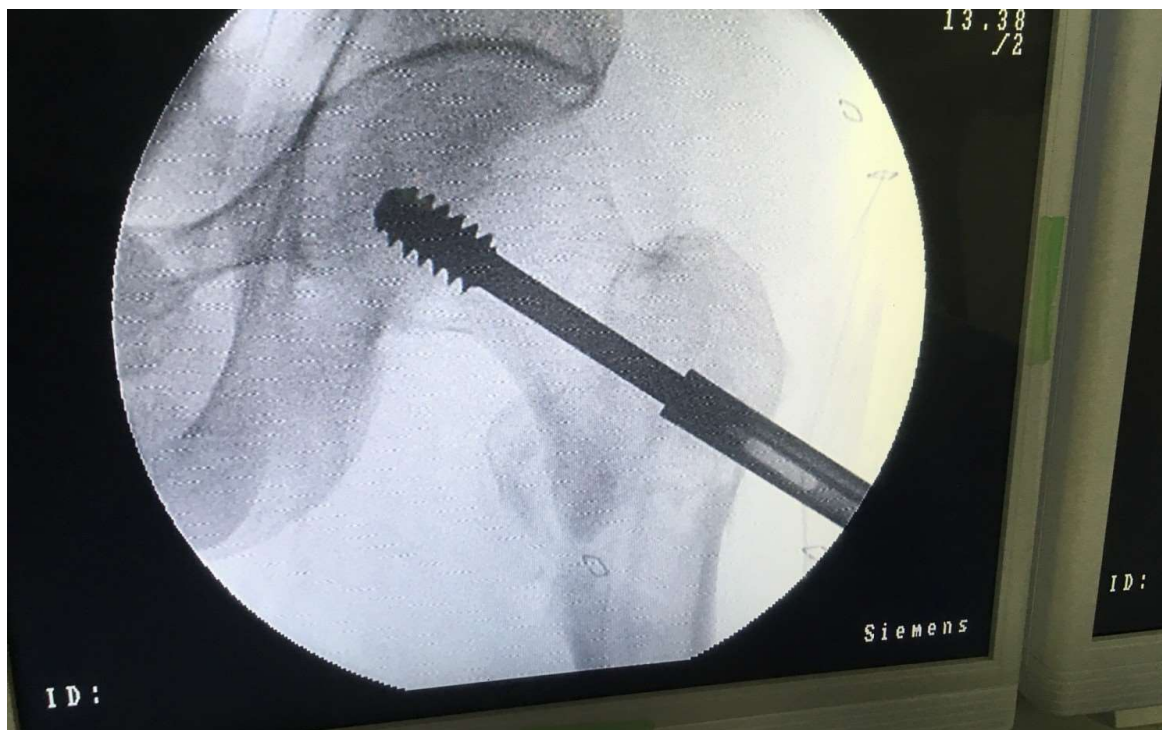
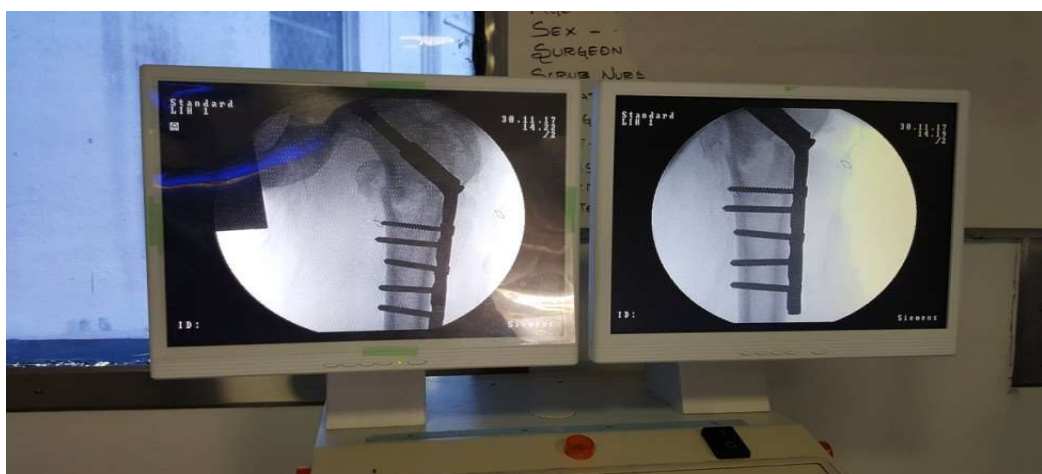
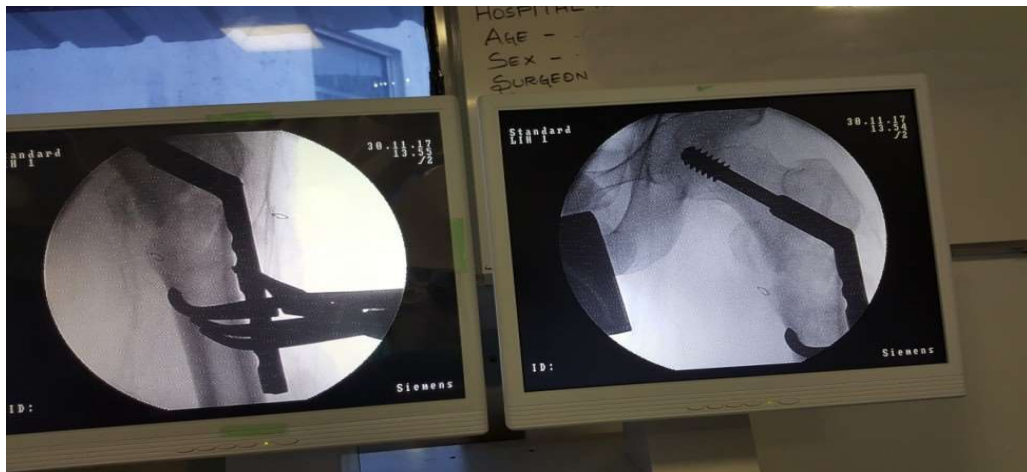




PLATE INSERTION



FINAL C-ARM PICTURES



MUSCLE CLOSURE



SKIN CLOSURE

OBSERVATIONS

In this series 30 patients with trochanteric fractures admitted to RLJ hospital of SDU medical college, during August 2015 to June 2017 were studied. Following observations were made.

Age and Sex Incidence:

The average age was 66 years. The youngest patient was 40 years oldest patient 85 years. In this study, 20 cases were males and 10 were females. Male to female ratio for the whole series was 2:1.

TABLE 2: Age distribution

Age group (years)	Total no. of cases	%
40-49	2	6.7
50-59	8	26.65
60-69	6	20.00
70-79	8	26.65
> 80	6	20.00
Total	30	100

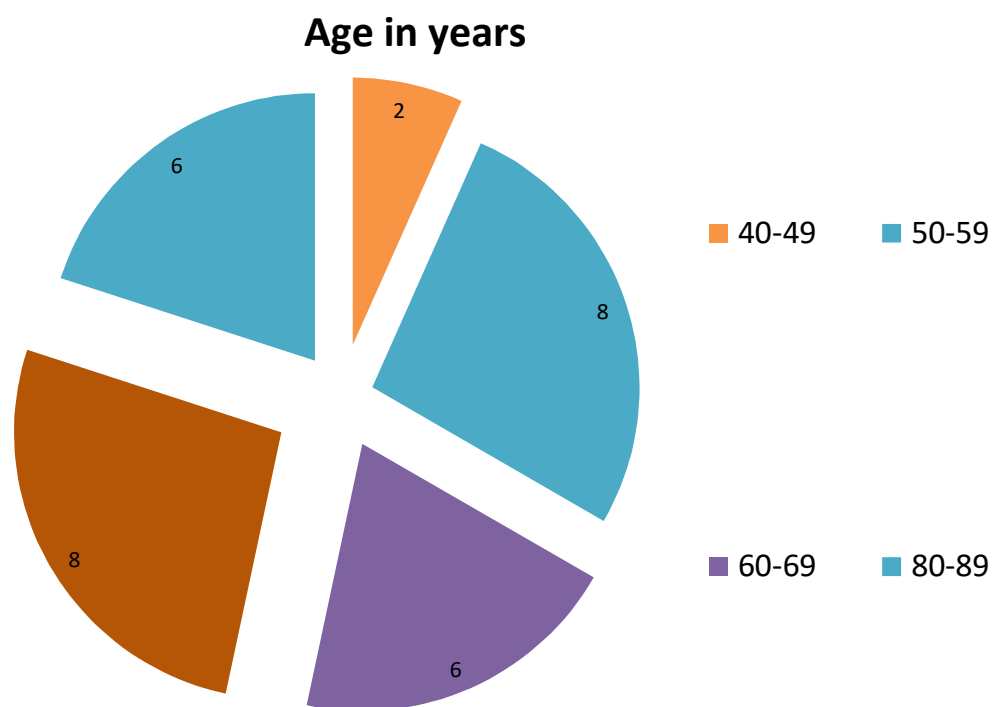


CHART 1: Age distribution

TABLE 3: SEX DISTRIBUTION

Sex	No. of cases	percentage
Male	20	66.65
Female	10	33.35
Total	30	100

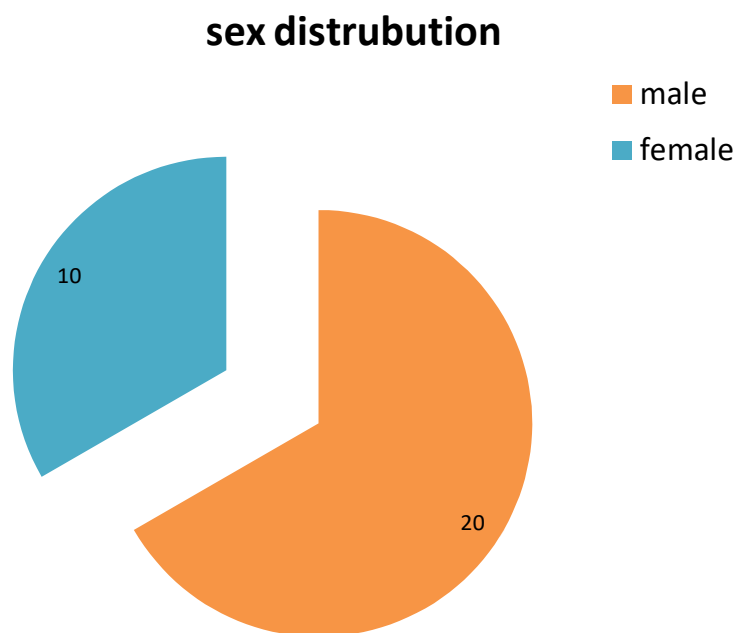


CHART 2: Sex distribution

TABLE 4: SIDE DISTRIBUTION

SIDE INVOLVED	NO. OF CASES	%
RIGHT	16	53.35
LEFT	14	46.65
TOTAL	30	100

Intertrochanteric fractures of right hip was affected in 16(54%) patients and left hip in 14 (46%) cases.

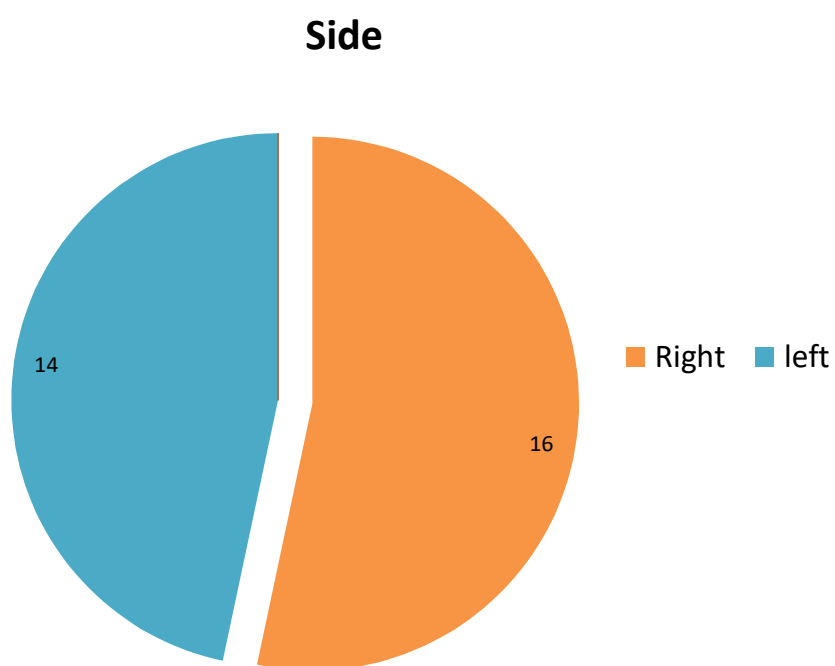


CHART 3: Side affected

Table 5: MODE OF INJURY

Mode	No. of cases	%
RTA	7	23.35
FALL	23	76.65
Total	30	100

Most of the fracture are due to fall 23 (76.65%) .

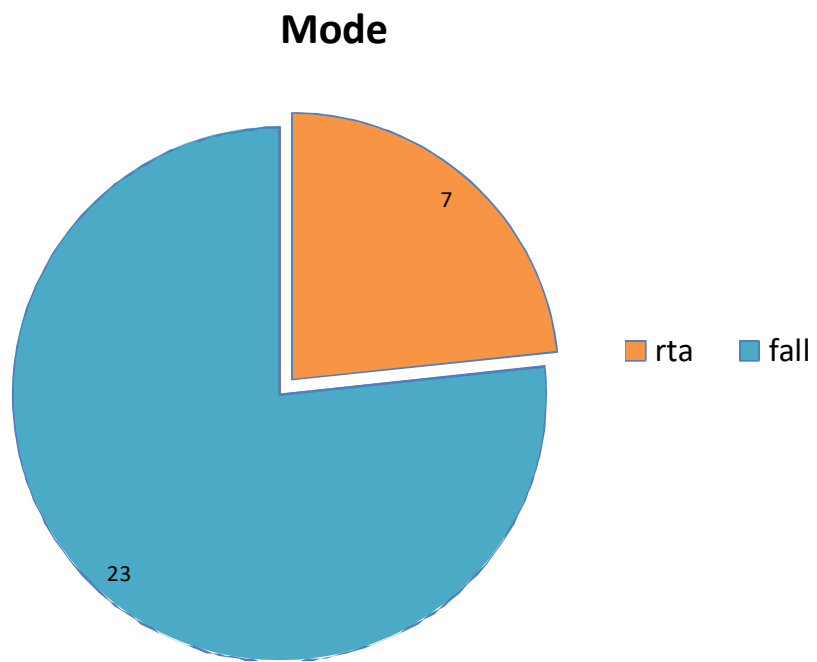


CHART 4: Mode of injury

TYPE OF FRACTURE

Most of the patients in our study group were in type II Boyd and Griffin.

TABLE 6: TYPE OF FRACTURE

Grade	No of Patients	%
I	4	13.3
II-	12	40
III	10	33.3
IV	4	13.3
Total	30	100

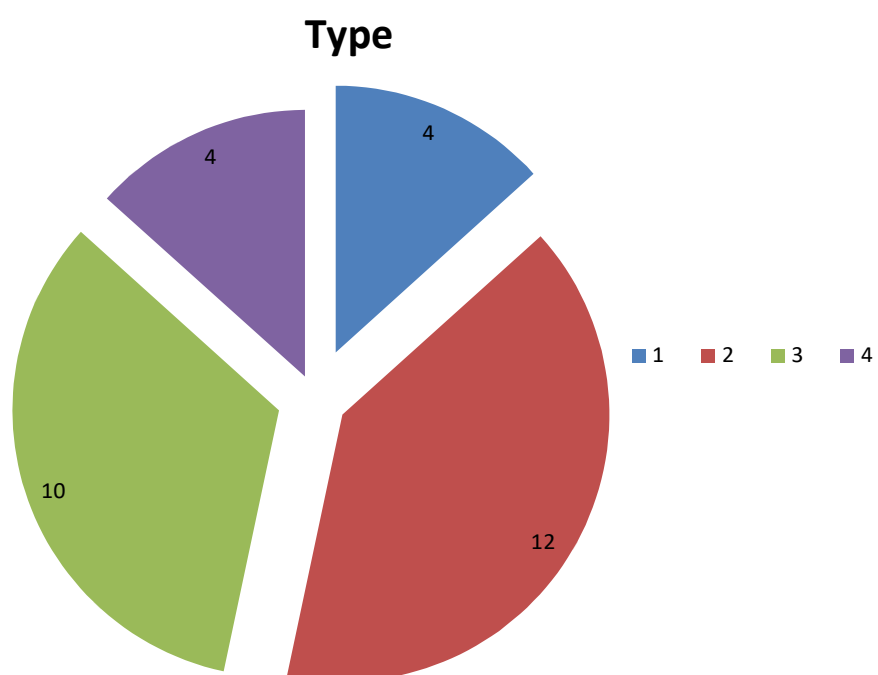


CHART 5: Type Of Fracture

TABLE 7: POSITION OF DHS IN POSTOPERATIVE X-RAY

position	No. of cases	%
Posterior	9	30
Central	19	63.3
Superior	2	6.67
Total	30	100

The position of DHS in majority was central 19 (63.3%) then posterior in 9 (30%) and superior in 2 (6.6%).

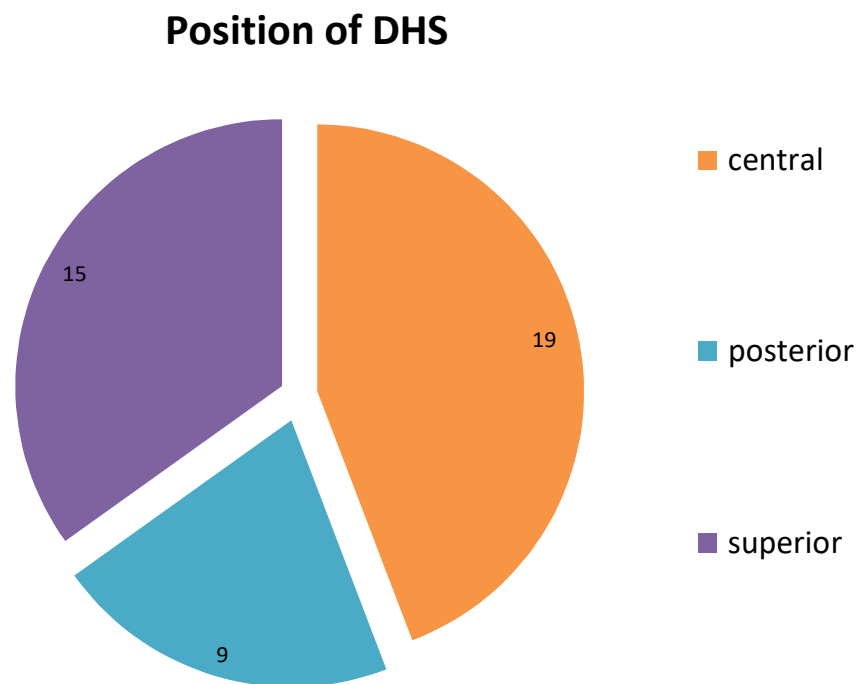


CHART 6: POSITION OF DHS

TABLE 8: TIME TAKEN FOR FULL WEIGHT BEARING

Maximum	Minimum	Mean
18 weeks	6 weeks	12.16± 2.9 weeks

Duration (weeks)	No. of cases	%
6-12	12	40
12-15	16	53.3
> 15	2	6.7

Weight bearing

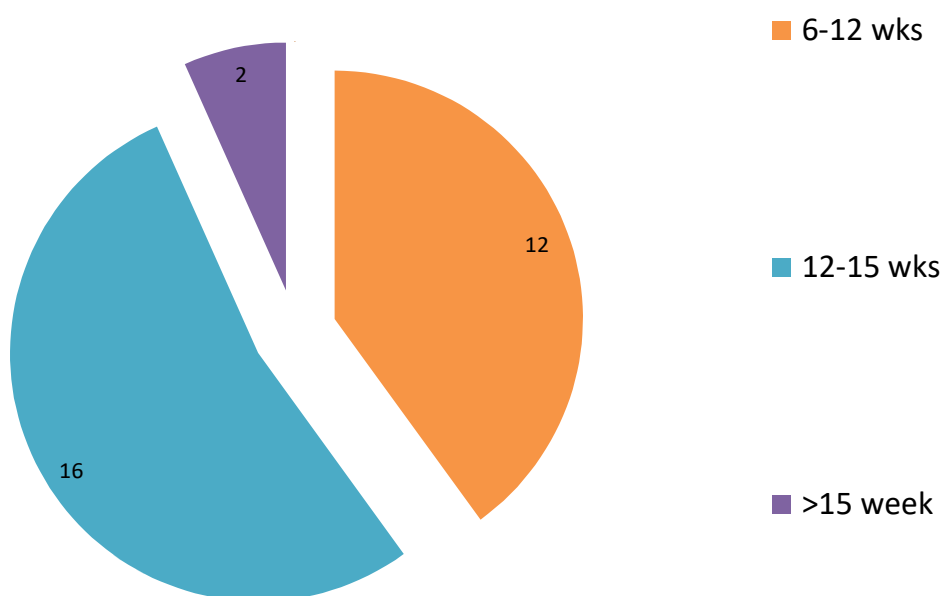


CHART 7: WEIGHTBEARING

TABLE 9: RESULTS BASED ON PARKER'S MOBILITY SCORE

Outcome	No. of cases	%
Excellent	10	33.34
Good	18	60.00
Fair	2	6.66
Total	30	100

Most of the cases had good outcome i.e. 60%, while 6.66% cases resulted as fair outcome. Excellent : (8-9), good : (6 to 7) fair : (less than 5) .mean parker mobility score is 7.4 ± 1.2

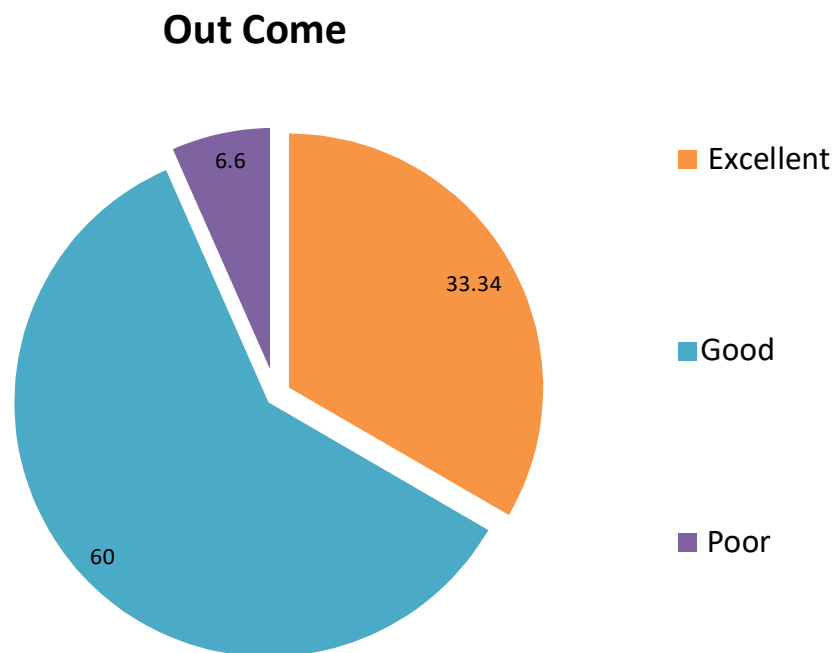


CHART 8: RESULTS

TABLE 10 : LIMB SHORTENING

SHORTENING	No. of cases	%
No shortening	26	86.65
1 cm	3	10
1.5 -2 cm	1	3.35
Total	30	100

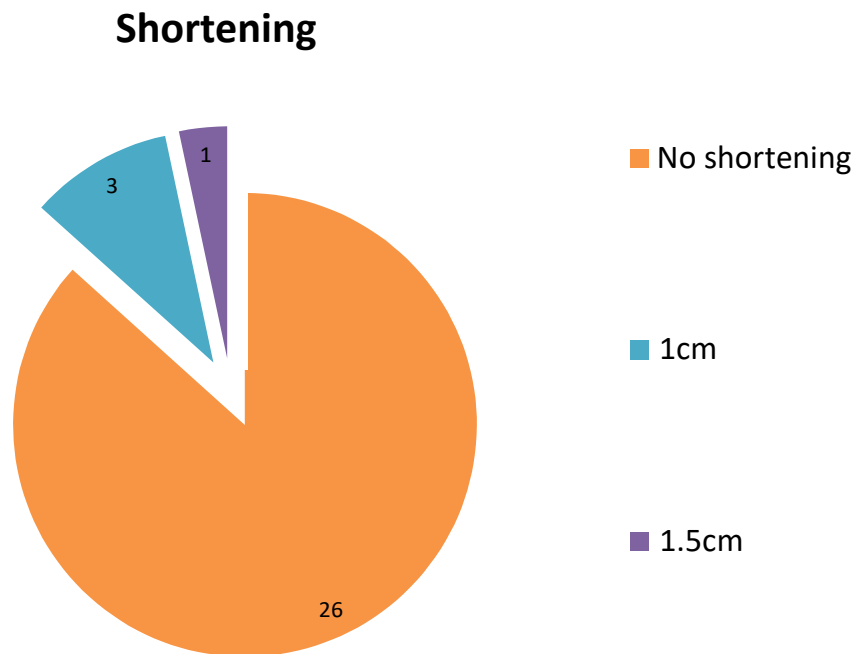


CHART 9: LIMB SHORTENING

In the present study, 26 (86.6%) had no shortening.

TABLE 11: COMORBID STATUS

	No. of cases	%
Anemia	3	10
Hypertension	3	10
DM	4	13.3

TABLE 12: COMPLICATIONS

	No. of cases	%
Limp	4	13.35
Shortening	4	13.35
Occasional pain	15	23.3
Superficial infection	3	10
Screw back out	2	6.66

Most patients in the present study had occasional pain 15(23.3%), which was relieved by medications, Superficial infection in 3 (10%) which subsided on antibiotics and limp and shortening seen in 4(13.3) cases, which was corrected by heel rise.

CHART 10: COMPLICATIONS

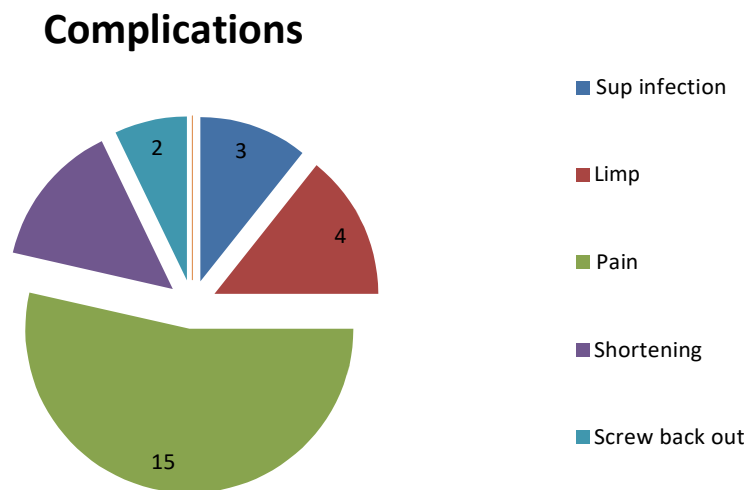
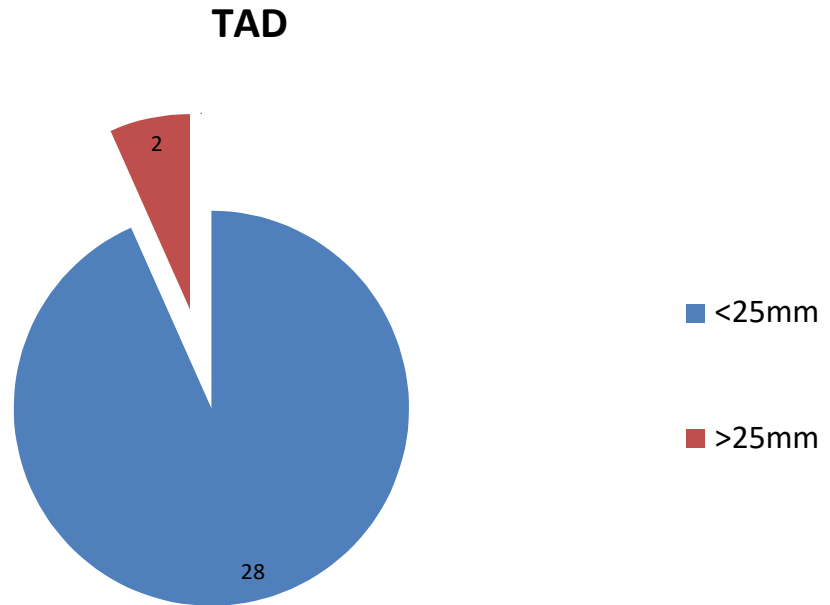


Table 13: TAD (Tip Apex Distance)

	No. of cases	%
Less than 25 mm	28	93.4
More than 25 mm	02	6.6
Total	30	100

Most of the cases had TAD below 25mm

CHART 11: TAD



TECHNIQUE OF FIXATION

All the fractures were fixed with Dynamic Hip Screw with locking side plate.

ANAESTHESIA

All the patients were operated on spinal anesthesia or epidural anesthesia.

TIME BETWEEN INJURY AND SURGERY

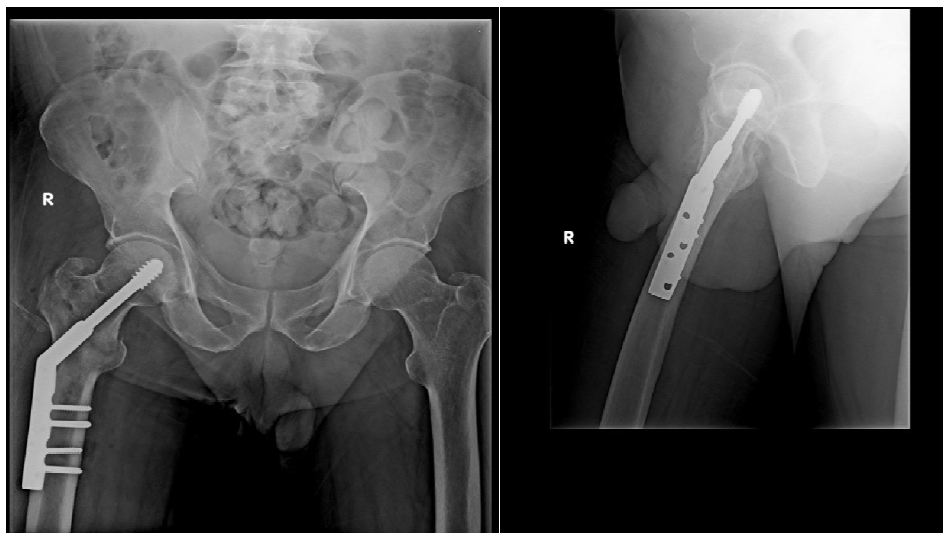
All the cases are operated with 72 hours of admission , were on upper tibial skeletal traction prior to surgery.

FIGURE 21 –PATIENT X RAYS AND CLINICAL PICTURES

CASE NO - 25



PRE OP XRAY



IMMEDIATE POST OP X-RAY



FINAL FOLLOW UP X-RAY

FLEXION IN KNEE EXTENSION



SQUATTING



SITTING CROSS LEGGED





FLEXION IN KNEE FLEXION

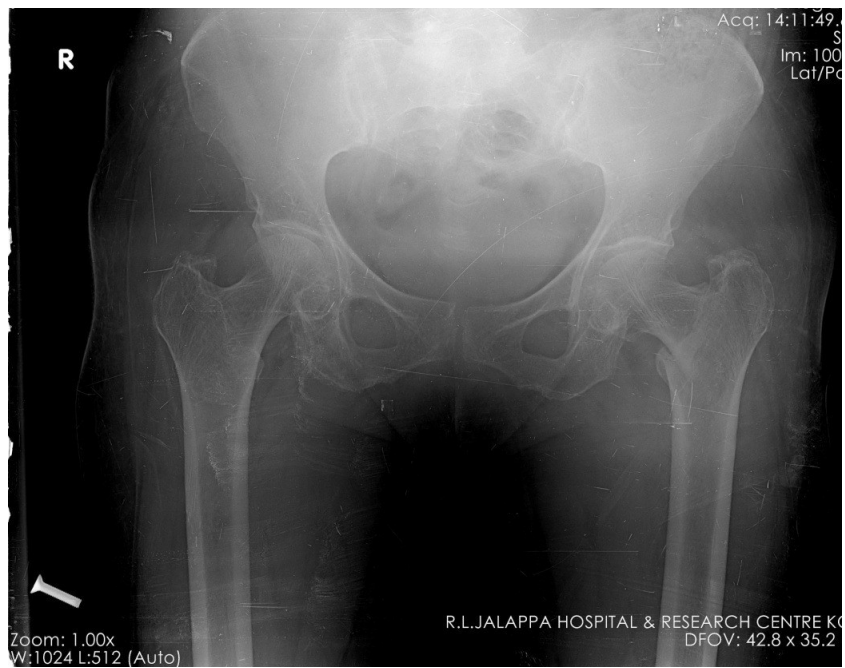


HIP ABDUCTION



HIP ADDUCTION

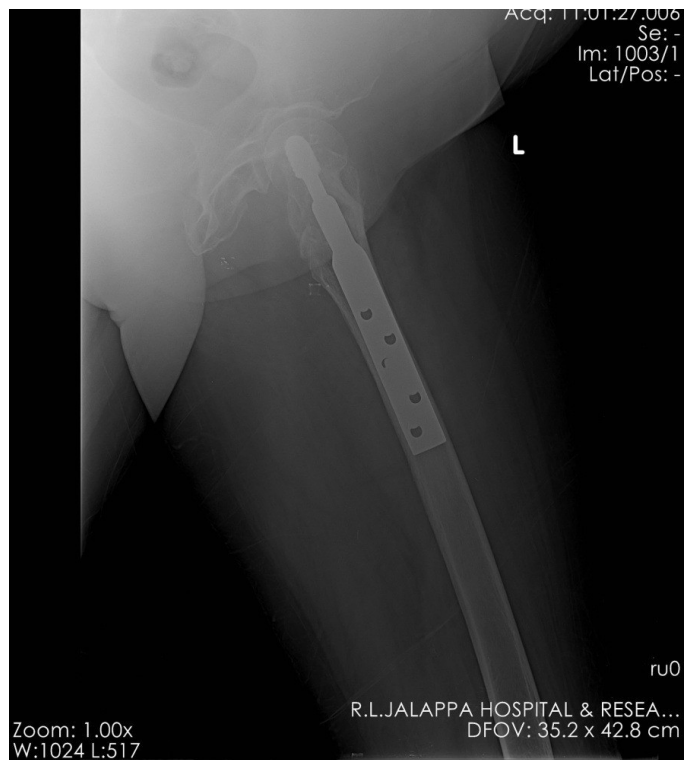
CASE 19



PRE OP X-RAYS



IMMEDIATE POST OP X-RAYS



AT THE END OF FOLLOW UP



FLEXION IN KNEE EXTENSION



ADDUCTION

ABDUCTION





FLEXION IN KNEE FLEXION

EXTERNAL ROTATION



INTERNAL ROTATION



DISCUSSION

At present it is generally believed that, all intertrochanteric fractures should be internally fixed to reduce the morbidity and mortality by early ambulation, but differences still exist regarding the type of implant to be used, hence this study was taken up to analyse results of DHS with locking side plate .

In the present study, the average age 66 yrs was comparable to those of other authors,

TABLE 14:AGE OF INCIDENCE

Authors	Average age
Karl Lunsp et al. ⁽⁷³⁾	81.0
Eckriffner et al. ⁽⁶³⁾	75.1
Boydd and Griffin ⁽⁸⁾	69.7
R C Gupta ⁽⁷⁴⁾	51.2
Yin shiunlee ⁽⁴⁷⁾	71.8
Sammer ajith ⁽⁷⁵⁾	71.74
G S Kulkarni ⁽²⁶⁾	62
Present study	66

SEX INCIDENCE

In the present study male: female was 60:40.

There was a male sex preponderance in contrast to female preponderance as observed by various other authors which may be due to

- a. Indian males being more active & mobile than females
- b. Indian females are mainly confined to household activities and are less prone to sustain an extracapsular fracture of hip.

TABLE 15: SEX INCIDENCE

Authors	Year	Female	Male
Wolfgang et al. ^(23,27)	1982	185 [64.4%]	102 [35.6%]
GS Kulkarni ⁽²⁶⁾	1984	76 [55%]	64 [45%]
Yih shiunnlee ⁽⁴⁷⁾	2007	24 [40%]	36 [60%]
Sameer ajith ⁽⁷⁵⁾	2017	3 [33.6]	13[63.6]
Present study	2017	10 [33.3%]	20 [66.6%]

MODE OF INJURY

Trochanteric fracture were more common following trivial fall.

TABLE 16: MODE OF INJURY

		Fall
Gupta RC ⁽⁷⁴⁾	1974	79.4%
Hornby et al. ⁽²⁹⁾	1989	80%
Yin shiunkee ⁽⁴⁷⁾	2007	85%
Sameer ajit ⁽⁷⁵⁾	2017	81%
Present study	2017	76.6%

SIDE INVOLVED

In the present study out of 30 cases Right hip was involved in 16(53%) and Left hip in 14 (47). In studies conducted by Wade P A and R C Gupta right trochanteric fractures were more common, whereas in studies made by Kenzor et al. and Cleveland et al. left trochanteric fracture were common.

TABLE 17: SIDE INVOLVED

	Right side
A K Singh et al.(2006) ⁽⁷⁶⁾	60%
Sameer ajit (2017) ⁽⁷⁵⁾	52.6%
Present study	53 %

CLASSIFICATION OF FRACTURE BASED ON BOYD AND GRIFFIN

In present study 40% of fractures are type 2 similar to study by A K Singh et al.(2006)⁽⁷⁶⁾

TABLE 18: CLASSIFICATION OF FRACTURE

Type	A.Ksingh et al	Present study
I	3.75%	13.3%
II	66.25%	40%
III	12.5%	33.3%
IV	10.0%	13.3%

POSITION OF DHS IMMEDIATE POST OPERATIVE X-RAY

In the immediate post operative X-ray the position of the DHS was central in 19 (63.3%), posterior in 9 (30.0%) and superior in 2 (6.67%).

Superior position was associated with screw back out . This observation was similar to those made by Doherty John H and John L and yin shiunlee who recommended central placement of screw.

TABLE 19: POSITION OF DHS IMMEDIATE POST OPERATIVE X-RAY

Study	Central position
Doherty John H and John L ⁽¹⁸⁾	82%
yin shiunlee ⁽⁴⁷⁾	75%
Present study	63.3%

SHORTENING

In the present study about 26 (86.7%) had no shortening, 3 cases (10%) had 1 cm shortening. 1 case (3.3%) had shortening more than 1 cm, similar to the study by Sammer A et al .Shortening seen in other results are shown as below.

TABLE 20:SHORTENING

SHORTENING	Sammer arjith ⁽⁷⁵⁾ (%)	Klinger et al ⁽⁴⁴⁾	Present study %
1 cm	10.5	8	10
>1cm	10.5	-	3.35

PAIN

Pain is an important criterion for evaluation of hip fractures which could be due to implant failure, joint penetration, infection, or avascular necrosis .

About 50% of patients had occasional pain which subsided by medication, pain not affecting their daily activities.

INFECTION:

In our study no deep infection occurred. Superficial infection was seen in 10% patients which subsided by antibiotics, similar to other studies.

TABLE 21:INFECTION

Study	Infection
Kulkarni G S ⁽²⁶⁾	1 %
Sameer ajit ⁽⁷⁵⁾	10.5%
In Present	10%

FUNCTIONAL OUTCOME BASED ON PARKER MOBILITY SCORE

We had excellent results in 33.3% , good in 60% , and fair in 6.6 %. The mean Parker mobility score was 7.4 comparable with other studies as shown below.

**TABLE 22: FUNCTIONAL OUTCOME BASED ON PARKER MOBILITY
SCORE**

Study	year	Excellent	Good	poor
Nilesh ⁽⁵⁷⁾	2014	92%	4%	4%
Present study	2017	33.3%	60%	6.6%

TABLE 23: Mean Parker Mobility Score

Study	Central position
Nilesh B ⁽⁵⁷⁾	8.4
Sameer ajit ⁽⁷⁵⁾	7.3
Present study	7.4

CONCLUSION

- Intertrochanteric fractures are essentially fracture of middle age and elderly, with osteoporotic bones.
- Most of the intertrochanteric fractures are seen in males.
- Most of the fractures belong to grade II classification of Boyd and Griffin.
- Dynamic hip screw with locking plate is the operative treatment of choice for the intertrochanteric fractures.
- The study showed Dynamic hip screw with locking plate to be a versatile, stable, acceptable implant fixation in trochanteric fractures.

SUMMARY

In the present study, 30 cases of intertrochanteric fracture of femur were managed by dynamic hip screw with locking plate. The data obtained was analyzed and results evaluated.

- Average age incidence in the present study was 66 years.
- Predominantly males (66.6%) were affected.
- Most cases occurred after a fall which was statistically significant.
- Type II (Boyd and Griffins)fractures were more common.
- All the cases were put on skeletal traction prior to surgery.
- Central positioning of DHS is essential for good outcome .
- Outcome Parker mobility score at their last follow up : 33.4 % had excellent , 60 % good , 6.6 % fair .
- 28 (93.4%) patients were able to bear weight within 12-15 weeks.
- DHS with locking plate are suitable for trochanteric fractures.
- DHS locking allows for fracture collapse, automatic medialisation after collapse, locking screw hold shaft tightly even in osteoporotic bones and hence gives stability.

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PROFOMA

Name : Case no :
Age : Ip/op no :
Sex : Doa :
Address : Dos :
Occupation : Dod :
Diagnosis :

Chief complaints :

History of presenting illness :

Mode of the injury- Road traffic accidents , fall , assault ,sports injuries

Past history :

Family history:

Personal history:

General physical examination:

Vital signs Systemic examination

BP CVS

RR RS

PR CNS

Temperature PA

Local examination:

- Inspection- Attitude , swelling , deformity , wounds , others.
- Palpation- Local rise of temperature , tenderness , abnormal mobility , crepitus .
- Measurements - Length of the lower limb Right Left
- Movements - HIP –flexion, extension, adduction, abduction, internal and external rotations.
- Distal neuro vascular status – femoral artery .
 - Sensory disturbances
 - Motor disturbances

- Associated injuries

Investigations:

Blood : Haemoglobin TC

ESR DC

RBS Blood urea

S.creatinine HIV HbsAg

Sodium, potassium

Urine: Albumin, Sugar

ECG :

Radiography: x-ray of hip and femur Antero posterior and Lateral views

Treatment:

Preoperative -skeletal traction ,
-Antibiotics
-Analgesics

Type of anaesthesia: Spinal/Epidural/General

Surgical procedure

-open reduction

-Additional procedures

-Intra operative complications

Postoperative - Antibiotics

-Check x-rays

-Complications

-Revision procedures

-Secondary procedures

FOLLOW UP :

	Radiographs	Hip movements	Complications
AT 1.5 MONTH			
AT 3 MONTH			
AT 6 MONTH			

Parkers mobility score for Assessment of mobility.

Score is the total,0 to 9

Mobility	No Difficulty	With an aid	With help from another person	Not at all
Able to get about the house	3	2	1	0
Able to get out of the house	3	2	1	0
Able to go shopping	3	2	1	0

Excellent – 8 or 9 , Good – 6 or 7 ,fair – less than or equal 5

PATIENT INFORMATION SHEET

I patient named have been explained about the procedure to be performed(DHS WITH LOCKING PLATE), also the alternate procedures that can be performed(DHS,PFN)and complications associated with the procedure. I am willing to get operated with DHS WITH LOCKING PLATE for inter trochanteric fracture femur.

Signature

Date

CONSENT FORM

I/we_____have been explained in details the condition of the patient and need for surgery. I can understand the need for study and method used in conducting the study. I hereby give full consent to use my case details x-rays, investigations and photographs for research purposes

Age:

Sex:

Address:

Signature/LTI

Date :

Place :

STATISTICAL METHODS APPLIED

Descriptive statistics

The Descriptive procedure displays univariate summary statistics for several variables in a single table and calculates standardized values (z scores). Variables can be ordered by the size of their means (in ascending or descending order), alphabetically, or by the order in which you select the variables (the default).

Cross tabs procedure

The Crosstabs procedure forms two-way and multiway tables and provides a variety of tests and measures of association for two-way tables. The structure of the table and whether categories are ordered determine what test or measure to use.

Observations are presented as number and percentages with corresponding different characteristics. Since the present study is purely descriptive observational study. No statistical analysis is necessary

KEY TO MASTER CHART

A	✿ Anemia
AB	✿ Hip abduction
CEN	✿ Central
CM	✿ Co-Morbid
D	✿ Diabetes Mellitus
F	✿ Flexion of hip
HTN	✿ Hypertension
LLD	✿ Limb length disparity
OCC	✿ Occasional.
POS	✿ posterior
PS	✿ Parker Mobility Score
P1	✿ Able to get about the house
P2	✿ Able to get out of house
P3	✿ Able to go shopping
RTA	✿ Road traffic Accident
SUP	✿ Superior
SUP INF	✿ Superficial Infection
TAD	✿ Tip Apex Distance
TY	✿ Type Of Fracture
WB	✿ Weight bearing in weeks

SL NO	Name	UHIDNo.	Age	Sex	CM	Mode	TY	SIDE	S P	TAD	ROM HIP (F A)	WB	LLD	COMPLICATIONS	P1	P2	P3	P S	RESULTS
1	A1	394616	72	M	NIL	FALL	II	LEFT	CEN	<2.5CM	F: 110, AB: 35	10	NIL	SUP INF	3	2	2	7	GOOD
2	A2	409916	70	M	NIL	RTA	II	LEFT	POS	<2.5CM	F: 110, AB: 30	12	NIL	PAIN (OCC)	3	2	2	7	GOOD
3	A3	342043	80	M	NIL	FALL	I	RIGHT	CEN	<2.5CM	FULL	8	NIL	NIL	3	3	3	9	EXCELLENT
4	A4	223095	62	M	NIL	FALL	II	LEFT	SUP	<2.5CM	F: 115, AB: 35	12	NIL	PAIN (OCC)	3	2	2	7	GOOD
5	A5	356244	48	M	NIL	FALL	II	RIGHT	CEN	<2.5CM	FULL	9	NIL	NIL	3	3	3	9	EXCELLENT
6	A6	312606	55	M	D	RTA	III	RIGHT	CEN	<2.5CM	F: 110, AB: 30	14	NIL	SUP INF,PAIN (OCC)	3	2	1	6	GOOD
7	A7	220325	70	M	NIL	FALL	I	RIGHT	POS	<2.5CM	FULL	8	NIL	NIL	3	3	3	9	EXCELLENT
8	A8	203412	70	F	D,A	FALL	III	RIGHT	POS	<2.5CM	F: 115, AB: 35	14	NIL	PAIN (OCC)	3	2	2	7	GOOD
9	A9	206064	55	M	NIL	FALL	III	LEFT	CEN	<2.5CM	F: 110, AB: 30	14	NIL	PAIN (OCC)	3	2	2	7	GOOD
10	A10	208434	85	F	NIL	FALL	II	RIGHT	CEN	<2.5CM	F: 115, AB: 30	10	NIL	NIL	3	3	3	9	EXCELLENT
11	A11	275984	55	F	NIL	RTA	IV	LEFT	CEN	<2.5CM	F: 95, AB: 25	14	1 CM	PAIN (OCC)	3	2	2	7	GOOD
12	A12	353377	80	M	NIL	FALL	III	RIGHT	SUP	<2.5CM	F: 115, AB: 40	10	NIL	PAIN (OCC)	3	2	2	7	GOOD
13	A13	472128	65	F	NIL	FALL	III	LEFT	CEN	<2.5CM	F: 110, AB: 40	15	NIL	NIL	3	2	2	7	GOOD
14	A14	221087	75	F	A	FALL	II	LEFT	POS	<2.5CM	F: 115, AB: 35	15	NIL	PAIN (OCC)	3	2	1	6	GOOD
15	A15	240455	85	F	NIL	FALL	II	LEFT	CEN	<2.5CM	FULL	10	NIL	NIL	3	3	3	9	EXCELLENT
16	A16	308784	67	M	NIL	FALL	III	LEFT	POS	<2.5CM	F: 110, AB: 30	15	NIL	NIL	3	2	2	7	GOOD
17	A17	255013	84	F	DM	FALL	IV	LEFT	POS	<2.5CM	F: 95, AB: 20	16	1 CM	SUP INF,PAIN	2	2	1	5	FAIR
18	A18	284343	56	M	NIL	RTA	III	LEFT	CEN	<2.5CM	F: 110, AB: 35	15	NIL	NIL	3	2	2	7	GOOD
19	A19	478410	60	F	A	FALL	I	LEFT	CEN	<2.5CM	FULL	6	NIL	SCREW BACK OUT,PAIN	3	3	3	9	EXCELLENT

20	A20	217266	50	M	NIL	FALL	IV	RIGHT	POS	>2.5CM	F: 115, AB: 30	15	1 CM	PAIN (OCC)	3	2	2	7	GOOD
21	A21	225098	70	F	HTN	FALL	II	RIGHT	CEN	<2.5CM	FULL	10	NIL	NIL	3	3	3	9	EXCELLENT
22	A22	279258	80	M	NIL	FALL	III	LEFT	CEN	<2,5CM	F: 110, AB: 30	15	NIL	NIL	3	2	2	7	GOOD
23	A23	339892	60	M	D	FALL	IV	RIGHT	CEN	>2.5CM	F: 90, AB: 20	18	1.5 CM	PAIN (OCC)	2	2	1	5	FAIR
24	A25	421872	60	M	NIL	FALL	III	RIGHT	POS	<2.5CM	F: 115, AB: 35	12	NIL	SCREW BACK OUT,PAIN	3	2	2	7	GOOD
25	A24	404409	74	M	NIL	FALL	II	RIGHT	CEN	<2.5CM	FULL	10	NIL	NIL	3	3	3	9	EXCELLENT
26	A26	267371	54	M	HTN	RTA	III	LEFT	POS	<2.5CM	F: 110, AB: 30	14	NIL	PAIN (OCC)	3	2	2	7	GOOD
27	A27	449620	40	M	NIL	RTA	II	RIGHT	CEN	<2.5CM	F:110, AB: 30	14	NIL	NIL	3	2	2	7	GOOD
28	A28	396112	54	M	NIL	FALL	II	RIGHT	CEN	<2.5CM	FULL	10	NIL	NIL	3	3	3	9	EXCELLENT
29	A29	402054	76	F	HTN	FALL	III	RIGHT	CEN	<2.5CM	F: 115, AB: 40	12	NIL	PAIN (OCC)	3	2	2	7	GOOD
30	A30	313918	56	M	NIL	RTA	I	RIGHT	CEN	<2.5CM	FULL	8	NIL	NIL	3	3	3	9	EXCELLENT

NO	Name	UHIDNo.	Age	Sex	CM	Mode	TY	SIDE	S P	TAD	ROM HIP (F A)	WB	LLD	COMPLICATIONS	P1	P2	P3	P S	RESULTS
1	A1	394616	72	M	NIL	FALL	II	LEFT	CEN	<2.5CM	F: 110, AB: 35	10	NIL	SUP INF	3	2	2	7	GOOD
2	A2	409916	70	M	NIL	RTA	II	LEFT	POS	<2.5CM	F: 110, AB: 30	12	NIL	PAIN (OCC)	3	2	2	7	GOOD
3	A3	342043	80	M	NIL	FALL	I	RIGHT	CEN	<2.5CM	FULL	8	NIL	NIL	3	3	3	9	EXCELLENT
4	A4	223095	62	M	NIL	FALL	II	LEFT	SUP	<2.5CM	F: 115, AB: 35	12	NIL	PAIN (OCC)	3	2	2	7	GOOD
5	A5	356244	48	M	NIL	FALL	II	RIGHT	CEN	<2.5CM	FULL	9	NIL	NIL	3	3	3	9	EXCELLENT
6	A6	312606	55	M	D	RTA	III	RIGHT	CEN	<2.5CM	F: 110. AB: 30	14	NIL	SUP INF,PAIN (OCC)	3	2	1	6	GOOD
7	A7	220325	70	M	NIL	FALL	I	RIGHT	POS	<2.5CM	FULL	8	NIL	NIL	3	3	3	9	EXCELLENT
8	A8	203412	70	F	D,A	FALL	III	RIGHT	POS	<2.5CM	F: 115, AB: 35	14	NIL	PAIN (OCC)	3	2	2	7	GOOD
9	A9	206064	55	M	NIL	FALL	III	LEFT	CEN	<2.5CM	F: 110, AB: 30	14	NIL	PAIN (OCC)	3	2	2	7	GOOD
10	A10	208434	85	F	NIL	FALL	II	RIGHT	CEN	<2.5CM	F: 115, AB: 30	10	NIL	NIL	3	3	3	9	EXCELLENT
11	A11	275984	55	F	NIL	RTA	IV	LEFT	CEN	<2.5CM	F: 95, AB: 25	14	1 CM	PAIN (OCC)	3	2	2	7	GOOD
12	A12	353377	80	M	NIL	FALL	III	RIGHT	SUP	<2.5CM	F: 115, AB: 40	10	NIL	PAIN (OCC)	3	2	2	7	GOOD
13	A13	472128	65	F	NIL	FALL	III	LEFT	CEN	<2.5CM	F: 110, AB: 40	15	NIL	NIL	3	2	2	7	GOOD
14	A14	221087	75	F	A	FALL	II	LEFT	POS	<2.5CM	F: 115, AB: 35	15	NIL	PAIN (OCC)	3	2	1	6	GOOD
15	A15	240455	85	F	NIL	FALL	II	LEFT	CEN	<2.5CM	FULL	10	NIL	NIL	3	3	3	9	EXCELLENT
16	A16	308784	67	M	NIL	FALL	III	LEFT	POS	<2.5CM	F: 110, AB: 30	15	NIL	NIL	3	2	2	7	GOOD
17	A17	255013	84	F	DM	FALL	IV	LEFT	POS	<2.5CM	F: 95, AB: 20	16	1 CM	SUP INF,PAIN	2	2	1	5	FAIR
18	A18	284343	56	M	NIL	RTA	III	LEFT	CEN	<2.5CM	F: 110, AB: 35	15	NIL	NIL	3	2	2	7	GOOD
19	A19	478410	60	F	A	FALL	I	LEFT	CEN	<2.5CM	FULL	6	NIL	SCREW BACK OUT,PAIN	3	3	3	9	EXCELLENT
20	A20	217266	50	M	NIL	FALL	IV	RIGHT	POS	>2.5CM	F: 115, AB: 30	15	1 CM	PAIN (OCC)	3	2	2	7	GOOD
21	A21	225098	70	F	HTN	FALL	II	RIGHT	CEN	<2.5CM	FULL	10	NIL	NIL	3	3	3	9	EXCELLENT
22	A22	279258	80	M	NIL	FALL	III	LEFT	CEN	<2,5CM	F: 110, AB: 30	15	NIL	NIL	3	2	2	7	GOOD
23	A23	339892	60	M	D	FALL	IV	RIGHT	CEN	>2.5CM	F: 90, AB: 20	18	1.5 CM	PAIN (OCC)	2	2	1	5	FAIR
24	A25	421872	60	M	NIL	FALL	III	RIGHT	POS	<2.5CM	F: 115, AB: 35	12	NIL	SCREW BACK OUT,PAIN	3	2	2	7	GOOD
25	A24	404409	74	M	NIL	FALL	II	RIGHT	CEN	<2.5CM	FULL	10	NIL	NIL	3	3	3	9	EXCELLENT
26	A26	267371	54	M	HTN	RTA	III	LEFT	POS	<2.5CM	F: 110, AB: 30	14	NIL	PAIN (OCC)	3	2	2	7	GOOD
27	A27	449620	40	M	NIL	RTA	II	RIGHT	CEN	<2.5CM	F:110, AB: 30	14	NIL	NIL	3	2	2	7	GOOD
28	A28	396112	54	M	NIL	FALL	II	RIGHT	CEN	<2.5CM	FULL	10	NIL	NIL	3	3	3	9	EXCELLENT
29	A29	402054	76	F	HTN	FALL	III	RIGHT	CEN	<2.5CM	F: 115, AB: 40	12	NIL	PAIN (OCC)	3	2	2	7	GOOD
30	A30	313918	56	M	NIL	RTA	I	RIGHT	CEN	<2.5CM	FULL	8	NIL	NIL	3	3	3	9	EXCELLENT