STUDY OF ACETABULAR EROSION AND ACTIVITY LEVEL AFTER HEMIARTHROPLASTY, IN NECK OF FEMUR FRACTURE PATIENTS AFTER A MINIMUM PERIOD OF 2 YEARS

Dissertation Submitted

by

DR. A. VINAYAGA MOORTHY. M. B. B. S

Dissertation submitted to

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY, CHENNAI,

In partial fulfilment of the requirements for the degree of

MASTER OF SURGERY IN ORTHOPAEDICS

Under the guidance of

Dr. V. SHYAM SUNDAR, M.S. (ORTHO) ,

Professor

DEPARTMENT OF ORTHOPAEDICS,

PSG INSTITUTE OF MEDICAL SCIENCES AND RESEARCH

COIMBATORE

2014

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled **"STUDY OF ACETABULAR EROSION AND ACTIVITY LEVEL AFTER HEMIARTHROPLASTY, IN NECK OF FEMUR FRACTURE PATIENTS AFTER A MINIMUM PERIOD OF 2 YEARS"** is a bonafide and genuine research work carried by me under the guidance of **Dr. V. SHYAM SUNDAR, M.S (Ortho), Professor**, Department of Orthopaedics, PSGIMS & R, Coimbatore.

Place:

Date: **Dr. A. Vinayaga Moorthy**

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"STUDY OF ACETABULAR EROSION AND ACTIVITY LEVEL AFTER HEMIARTHROPLASTY, IN NECK OF FEMUR FRACTURE PATIENTS AFTER A MINIMUM PERIOD OF 2 YEARS"** is a bonafide work done by **Dr. A. Vinayaga Moorthy** in partial fulfillment of the requirement for the degree of M.S. (Orthopaedics).

Place :

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ENDORSEMENT BY THE HOD / PRINCIPAL OF THE INSTITUTION:

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February 28, 2014

To
Dr A Vinayagamoorthy
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The Institutional Human Ethics Committee, PSG IMS & R, Coimbatore -4, has reviewed your proposal on 18th December, 2013 in its expedited review meeting held at IHEC Secretariat, PSG IMS&R, between 9.30 am to 10.30 am, and discussed your study proposal entitled:

"Study of acetabular erosion and activity level after hemiarthroplasty in neck of femur fracture after minimum of 2 years"

The following documents were received for review:

1. Duly filled application form
2. Proposal
3. Informed consent form
4. Data collection tool
5. CV
6. Budget

After due consideration, the Committee has decided to approve the study.

The members who attended the meeting at which your study proposal was discussed are as follows:

Name	Qualification	Responsibility in IHEC	Gender	Affiliation to the Institution Yes/No	Present at the meeting Yes/No
Dr P Sathyan	DO, DNB	Clinician, Chairperson	Male	No	Yes
Dr S Bhuvaneshwari	M.D	Clinical Pharmacologist Member - Secretary	Female	Yes	Yes
Dr Sudha Ramalingam	M.D	Epidemiologist Alt. Member - Secretary	Female	Yes	Yes
Dr Y S Sivan	Ph D	Member –Social Scientist	Male	Yes	Yes
Dr D Vijaya	Ph D	Member – Basic Scientist	Female	Yes	Yes

The approval is valid for one year.

We request you to intimate the date of initiation of the study to IHEC, PSG IMS&R and also, after completion of the project, please submit completion report to IHEC.

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This Ethics Committee is organized and operates according to Good Clinical Practice and Schedule Y requirements.

Non-adherence to the Standard Operating Procedures (SOP) of the Institutional Human Ethics Committee (IHEC) and national and international ethical guidelines shall result in withdrawal of approval (suspension or termination of the study). SOP will be revised from time to time and revisions are applicable prospectively to ongoing studies approved prior to such revisions.

Kindly note this approval is subject to ratification in the forthcoming full board review meeting of the IHEC.

Yours truly,

25-2-14

Dr S Bhuvaneshwari
Member - Secretary
Institutional Human Ethics Committee

SECRETARY
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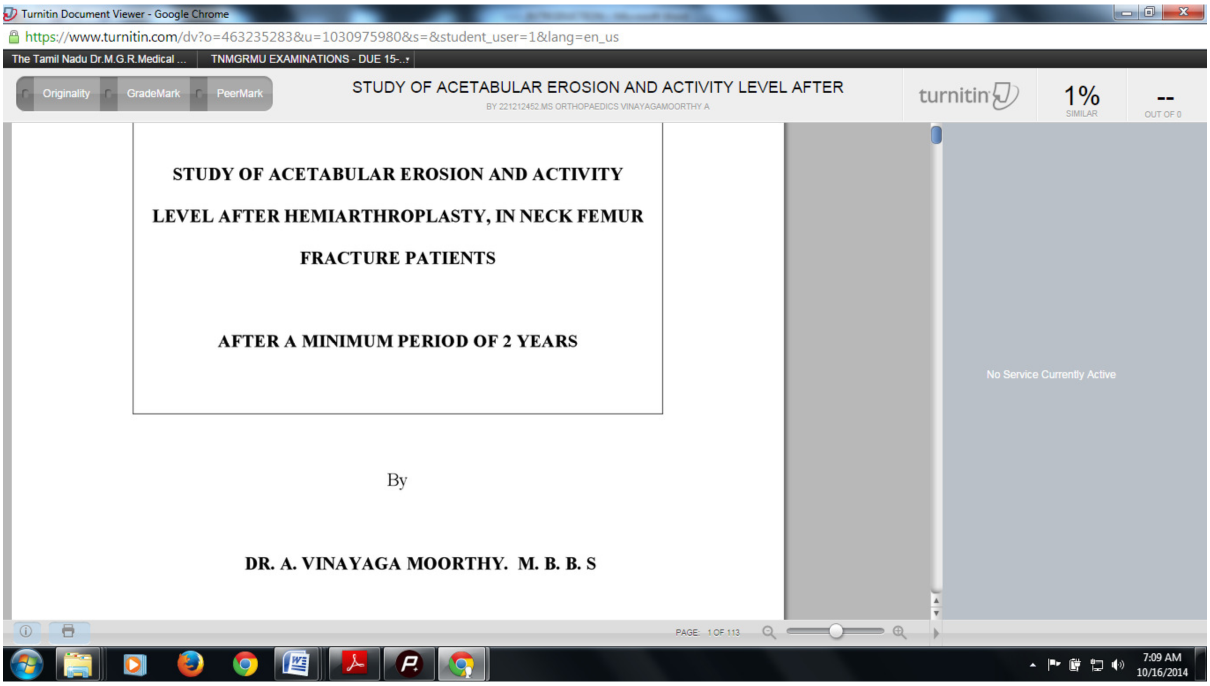
PLAGARISM CERTIFICATE:



ACKNOWLEDGEMENT

I thank the god for giving me the strength to perform all my duties. It is indeed a great pleasure to recall the people who have helped me in the completion of dissertation. Naming all the people who have helped me in achieving this goal would be impossible, yet I attempt to thank a selected few who have helped me in diverse ways.

I acknowledge and express my humble gratitude and sincere thanks to my beloved teacher and guide **Dr. V. ShyamSundar M.S (Ortho), Professor, Department of Orthopaedics, PSGIMS&R,** Coimbatore for his valuable suggestion, guidance, great care and attention to details, that he has so willingly shown in the preparation of this dissertation.

I owe a great deal of respect and gratitude to my professors **Dr. B.K. DinakarRai, M.S (Ortho), Professor& HOD, Department of Orthopaedics, PSGIMS&R and Dr. S.M. Arvindkumar, M.S (Ortho), Professor, Department of Orthopaedics** for their whole hearted support for completion of this dissertation.

I also express my sincere thanks to my Associate professors **Dr. N. Venkateshkumar** D.ortho, DNB, **Dr. Chittaranjan** M.S (Ortho) and **Dr. Prasanna** M.S (Ortho), PSGIMS&R-Coimbatore for their timely suggestions and all round encouragement.

I am immensely indebted to my parents, brothers, In-laws and wife for their continuous support without them this study couldn`t have been reality.

My sincere thanks to the all the Orthopaedics staff& Radiology Technicians**,** post graduate colleagues and my friends for their whole heated support.

Finally I thank my patients and their attenders who formed the backbone of the study without them this study would not have been possible.

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ABSTRACT

TITLE OF THE STUDY:

Study of acetabular erosion and activity level after hemiarthroplasty, in neck of femur fracture patients after a minimum period of 2 years

Introduction:

Neck of femur fractures are one of the devastating injuries of the old age. It is well recognized even from the era of Hippocrates. The exact number of hip fractures worldwide is impossible to determine, but the global incidence in the year 2000 has been estimated at 1.6 million and the projections for the future suggest further increasing numbers. In addition to the suffering of the individual the economic strain on society due to hip fracture is immense. Management of displaced intracapsular hip fracture in elderly remains controversial. Options include hemiarthroplasty or total hip arthroplasty. Total hip arthroplasty has shown better pain relief and clinical outcome, but in the elderly frail population who often suffer from fracture of the neck of the femur, mortality rates are high.

Hemiarthroplasty is one of the commonest procedures done for neck of femur fractures. It provides pain relief and early mobilization.The Austin – Moore and Thompson prostheses have been successful implants in treating fracture neck of femur. Disabling pain and acetabular erosions are frequent complications after the use of Moore prosthesis. So in an attempt to retard the acetabular wear, prolong the life of the implant and delay the need for revision surgery the bipolar prosthesis was developed by James E Bateman in Toronto in 1974, which had the advantage of hip motion occuring at 2 interfaces, primarily at the prosthetic interface and secondarily at the metal – cartilage interface, thus minimising the articular wear. This prosthesis was found to be very useful and results were encouraging.

However in longterm studies show that the bipolar prosthesis start acting as unipolar prosthesis with time and hence leads to some erosion. However not all patients with acetabular erosions are symptomatic.In our study we have evaluated the acetabular erosion after hemiarthroplasty, in neck of femur fracture patients after a minimum period of 2 years and have tried to correlate it with activity level of the patient.

AIM:

1. Early detection of acetabular erosion.
2. To assess the functional outcome after minimum of 2 years after hemiarthroplasty by modified UCLA score.
3. To correlate the functional activity level and radiological acetabular erosion.

MATERIALS AND METHODS:

Source of data:

This is a retrospective radiological and clinical study. The post hemiarthroplasty plain radiographs, showing AP view of hip joint taken in the Department of Radiodiagnosis, PSGIMS&R will be studied along with activity level assessment.

Mode of data collection:

By Convenient sampling method, all the patients undergone hemiarthroplasty, for fracture neck of femur after minimum of 2 years were assessed both radiologically and clinically.

Inclusion criteria:

All patients operated for neck of femur fracture with hemiarthroplasty after

a minimum period of 2 years.

Exclusion criteria:

1.) Surgical site hip Infection.

2.) Any pre existing pathologies around the hip.

3) Previous hip surgeries.

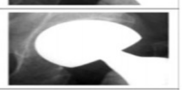
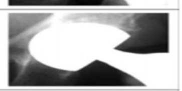
4.) Post-operative periprosthetic fractures.

5). Neurological conditions like CVA, Parkinsonism.

X-ray technique:

A plain anteroposterior view of the operated hip joint is taken and assessed for acetabular erosion grading. Patient positioned in supine, using digital X-RAY, casette tube distance is set to 100cms and the beam is centered directly over the hip.

Radiological assessment

Grade	Radiographic Appearance
0 Normal	
1 Narrowing of articular cartilage; No bone erosion	
2 Acetabular bone erosion; Early migration	
3 Protrusio acetabuli	

Activity level assessment:

MODIFIED UCLA SCORING SYSTEM

- 1. COMPLETELY INACTIVE, DEPENDENT ON OTHER AND CANNOT LEAVE THE RESIDENCE.
- 2. MOSTLY INACTIVE OR RESTRICTED TO MINIMUM ACTIVITIES OF DAILY LIVING
- 3. SOMETIMES GOING TO SOCIAL OUTDOOR ACTIVITIES OR VISITING NEIGHBOURS.
- 4. REGULARLY GOING TO SOCIAL OUTDOOR ACTIVITIES OR VISITING NEIGHBOURS.
- 5. SOMETIMES ENGAGING IN UNLIMITED HOUSE WORKS OR SHOPPING.
- 6. REGULARLY ENGAGING IN UNLIMITED HOUSE WORK OR SHOPPING.
- 7. REGULARLY USING STAIRCASE TO CLIMB.
- 8. LIFTING OR PLAYING WITH SMALL CHILDREN.
- 9. INVOLVING IN HEAVY LABOUR WORKS.
- 10. REGULARLY USING PUBLIC TRANSPORT.
- GOOD --- 7 TO 10
- FAIR --- 4 TO 6

POOR --- BELOW 4

LITERATURE REVIEW:

Thompson Hemiarthroplasty and Acetabular erosion: T.W. Philips, London, Ontario, Canada, from the Orthopaedic research laboratory, St.Joseph health centre and division of Orthopaedic surgery, University of Western Ontario, London

The prevalence, severity and clinical importance of acetabular erosion secondary to hemiarthroplasty of the hip are largely unknown. The factor that had the highest correlation with severity of the erosion were the level of physical activity and the duration of follow-up. Author`s analysis shows that the erosion progressed at an average of 3% per year in active patients. Post operative level of activity is determined by patient`s age and type of residence at the time of fracture.

Clinical relevance of acetabular erosion in young patients with a bipolar hip prosthesis: G. Kiekens, J. Somville, A. Taminiau- University Hospital Antwerp, UZA, Belgium, Department of Orthopaedics and Trauma, University Hospital Leiden, LUMC, The Netherlands, Department of Orthopaedics.

Young patients who had undergone bipolar hemiarthroplasty for proximal femur malignant tumor resection were followed up for a mean time of 81.8 months. The erosion and activity were assessed by x-rays and clinical examination. They did not report pain and had a good quality of life. The risk of late acetabular erosions were predicted by anticipated longevity of the patient and the level of activity.

Degeneration of acetabular articular cartilage to bipolar hemiarthroplasty: Kyoung Ho Moon, Jun soon kang, Tong joo lee, Sang hyeop lee, Sung wook choi and Man hee won- Department of Orthopaedics, Inha university Hospital, Incheon, Korea.

Considering the life expectancy and activity of patients who require hip arthroplasty, it could be predicted by radiologically measuring the degeneration rate of the acetabular articular cartilage.

Measurement of acetabular erosion: The effect of pelvic rotation on common landmarks. R.G. Wetherel, A.A. Amis, F.W. Heatley from St. Thomas` hospital and imperial college, London.

The line drawn between acetabular margins are significantly more accurate for proximal migration, than teardrop, sacroiliac or sacroiliac-symphysis line. Line drawn tangential to the brim and through the horizontal mid-point of the obturator foramen is more accurate than Kholer`s line, ilio-ischial or iliopubic line. In combination the two lines can give more accurate assessment and they are less affected by the difference in rotation commonly found in plain radiographs.

Retrospective evaluation of bipolar hemiarthroplasty in fracture of the proximal femur

North American Journal of Medical Sciences 2010 September, Vol 2. No.9

The aim of the study is to find out which treatment option can lead to a best clinical and functional outcome. It is concluded as 2 years result of bipolar hemiarthroplasty is good but THR- total hip replacement was found to be better.

CONCLUSION:

As the duration after surgery and activity level increases, the acetabular erosion rate increase. Long term study is needed to assess the erosion level which will give an insight into the factors influencing erosion and it can be prevented.

INTRODUCTION:

Neck of femur fractures are one of the devastating injuries in the old age. It is well recognized even from the era of Hippocrates. The accurate number of hip fractures worldwide is impossible to determine, but the global incidence in the year 2000 has been estimated at 1.6 million and the projections for the future suggest further increasing numbers. In addition to the suffering of the individual the economic strain on society due to hip fracture is immense.

Management of displaced intracapsular hip fracture in elderly remains controversial. Options include hemiarthroplasty or total hip arthroplasty. Total hip arthroplasty has shown better clinical outcome and lesser reoperative rate, but in the elderly frail population who often suffer from fracture of the neck of the femur, morbidity rates are high.

Hemiarthroplasty is one of the commonest procedures done for neck of femur fractures. It provides pain relief and early mobilization. The Austin – Moore and Thompson prostheses have been successful implants in treating fracture neck of femur. Disabling pain and acetabular erosions are frequent complications after the use of Moore prosthesis. So in an attempt to retard the acetabular wear, prolong the life of the implant and delay the need for revision surgery the bipolar prosthesis was developed by James E Bateman in Toronto in 1974, which had the advantage of hip motion occuring at 2 interfaces, primarily at the prosthetic interface and secondarily at the metal – cartilage interface, thus minimising the articular wear.

This prosthesis was found to be very useful and results were encouraging. However in longterm studies show that the bipolar prosthesis start acting as unipolar prosthesis with time and hence leads to some erosion. However not all patients with acetabular erosions were symptomatic.

In our study we have evaluated the acetabular erosion after hemiarthroplasty, in neck of femur fracture patients after a minimum period of 2 years and have tried to correlate it with activity level of the patient.

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REVIEW OF LITERATURE:

HISTORICAL PRESPECIVE:

In 1821, Anthony White of the Westminster Hospital in London, performed the first arthroplasty, where an arthritic or joint surface is replaced. The procedure helped with pain and mobility, but failed with stability.

In 1826, John Rhea Bartonii performed the first ostetomy[1], where a bone is cut to shorten, lengthen, or change its alignment. Unfortunately, this procedure had unpredictable results. Early solutions also included removing calcium[2] deposits and damaged cartilage.

Professor Themistocles Glück

In 1891, Professor Themistocles Glück led the way in his development of a hip implant[1] fixation. He produced an ivory ball and socket joint that he fixed to bone with nickel plated screws. He also used a mixture of plaster of Paris, and powdered pumice with resin for fixation. Glück‘s studies on hip replacements led to greater advancements that wereimplemented on other joints, including knee joints. He was also one of the first to propose implementing joints from corpses and amputated limbs . He proposed the idea by demonstrating in animal experiments that the cavity in the bone for the bone marrow would accept the shaft of the artificial joint if it is stably anchored within it.

Glück was also a pioneer in proposing the idea of biocompatibility, which explains how a foreign material placed in the body must be well tolerated by the patient's body.

In 1925, Surgeon in Boston- Massachusetts, M.N. Smith-Petersen, M.D., molded a piece of glass into the shape of a hollow hemisphere which could fit over the ball of the hip joint and provide a new smooth surface for movement. While proving biocompatibility, the glass could not withstand the stress of walking and quickly failed.

One concern in prosthetics is using a material that is biocompatible and will not cause adverse effects once implanted, an idea Glück had introduced earlier. M.N. Smith-Peterson continued his studies and pursued other materialsincluding plastic and stainless steel. A dramatic improvement was made in 1936 when scientists manufactured a cobalt-chromium alloy[4].

This new alloy was both very strong and resistant to corrosion, and is still being used today.

While this new metal proved to be a great success, the actual resurfacing technique was not adequate.

HIP RESURFACING:

Hip resurfacing involves removing the cartilage from the surface of the femoral head and replacing it with a metal cap. This may save the hip joint for 20 to 30 years.

1938- Dr. Judet used acrylic for resurfacing[5]. Unfortunately, the material fell short of expectations and tended to fall loose.

By this time it became clear that artificial joint material had to be biocompatible and withstand the stresses of the body.

In the 1950s, Frederick R. Thompson[6] and Moore developed hemiarthoplasty implants. Their type of hip replacement replaced the arthritic femoral head, but failed to replace the acetabulum.

In 1958, John Charnley[7] from England introduced the idea of using Teflon for acetabular component. Later he advocated polyethylene. He used PMMA[8] as bone cement for implant fixation.

EVOLUTION BY YEARS:

1827 – John Barton did osteotomy at the subtrochanteric region.

1867 – Oilier did research in joint damage.

1885 – Ollier's book on joint resection raises much interest in inter positional arthroplasty

1894 – Jules Pean: prosthetic replacement of tuberculosis shoulder.

1902 – John Murphy used fat and fascia as an interposition for arthroplasty and goes on to use this for hip, knee, elbow, and jaw.

1903 – Delbert: hip replacement.

1917 – William Baer reports on 100 patients using allograft interposition; in Baltimore.

1921 – Putti uses all kinds of interpositions in Italy. 1923 - Hey Groves replaces ivory ball and stem.

1923 – Marius Smith-Peterson[9] starts developing a mold arthroplasty, first using glass and later Vitallium on the advice of his dentist.

1937 – Methyl methacrylate marketed as Plexiglass.

1938 - Philip Wiles replaces both the femoral head and acetabulum with a metal prosthesis in six patients with juvenile rheumatoid arthritis; 13 years later on patient was walking without pain.

1939 - McKee makes models of a hip prosthesis but war stops him from trying it out

1951- He reports on three patients. He continues to improve the design of his metal-on-metal[10] -prosthesis until he retires and the advantages of metal- on -plastic become clearer.

1943 - Austin Moore[11] and Harold Bohlman: femoral head replacement for tumor, the original design has side plates, but later they introduced the idea of an intramedullary stem.

1946 - Robert and Jean Judet develop mushroom shaped head prosthesis. The material is acrylic, which breaks, and the stem - following the axis of the neck - is biomechanically unsound.

1950 - Charnley starts to develop hip replacement but gives up in favour of arthrodesis. Finds that a failed central dislocation arthrodesis[12] provides painless movement and advocates this for a short time.

1951 - McKee and Farrar describe a metal-on-metal replacement in Norwich.

1952 - F.R.Thompson: femoral head replacement

1953 - Edward Harboush in New York uses dental cement to hold a hip prosthesis and a cup in place.

1954 - John Charnley hears a squeaking Judet prosthesis and hits on the idea low-friction arthroplasty.

1961 - Charnley's report in the Lancet.

1962 - High density polyethylene.

1964 - Peter Ring: metal-on-metal cementless replacement with a screw in the acetabulum.

1968 – Hip Society established under the leadership of Frank Stinchfield

1970 - Ceramic surfaces are introduced by Hulbert.

1973 - Porous coating (Cameron, Mcnab, and Pillar, also Tronzo, Lord, and Hahn.). Food and Drug administration approves use of acrylic cement, opening the way for general use in hip replacements.

1823- Barton of Philadelphia performed osteotomies of upper femur.

1885- Oilier published his work on osteotomy in France.

1923- Smith-Peterson did first glass mold arthroplasty and later followed it with Cobalt-Chromium[13]-Molybdenum Cup arthroplasty; which was a giant step forward in the concept of hip replacement.

1943- Moore and Bohlman reported a Chrome-Cobalt endoprosthesis.

1946- Judets used an endoprosthesis - an acrylic femoral head with an attached stem passing through the inter-trochanteric region. Many modifications of the endoprosthesis were made by Mckeever, Valls, Thomson, et al.

1948- Philips Wiles attempted an unsuccessful total hip arthroplasty.

1951- McKee and Watson-Farrar performed a stainless-steel total hip Replacement and modified their prosthesis in 1956.

1950- Moore[11] placed his first intra-medullary stainless-steel prosthesis.

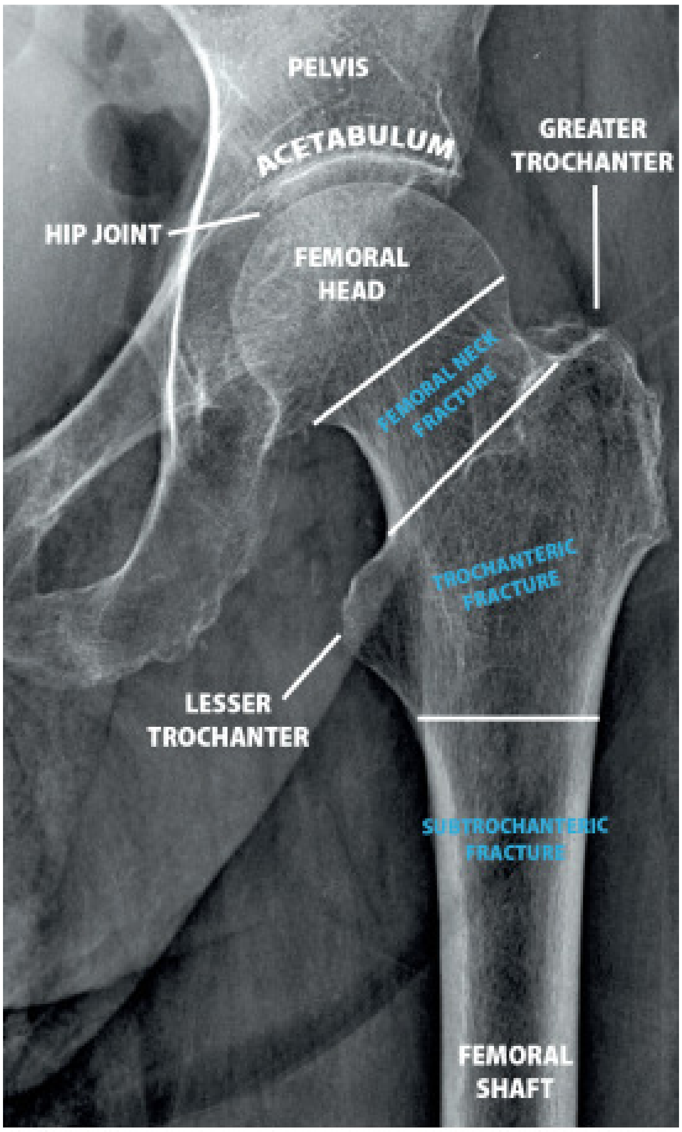
1971- Charnley credited Kiaer and Janson with first using methyl-methacrylate.

1973 Amstuth and colleagues began work on their tharies surface replacement.

1974- Bateman, and Gilberty designed a multiple-bearing endoprosthesis with an interposing free riding cup also known as Bipolar or Universal proximal femoral endoprosthesis-basically a combination of the cup arthroplasty and femoral endoprosthesis[14]. The rationale was to lessen the frictional forces between the femoral head and the acetabular cartilage. The femoral could be either secured with cement or press fitted. At present it is also available as a porous-coated stem.

In 1990, Bateman JE described his single assembly total hip prosthesis, as a preliminary report. In which he described the biomechanical principles involved, the implant design, operative technique and some early clinical results.

Hip Joint relevant anatomy:



The hip[15] is a multi-axial ball and socket joint. Femoral head is articulating along with cup shaped acetabulum[1]. Articular surfaces are reciprocally curved and are neither co-existent nor completely congruent.

The surfaces are considered spheroid or ovoid rather than spherical.

The femoral head is covered by articular cartilage except for a rough pit for the ligament of the head (ligamentum teres[16]). In front, the cartilage extends laterally over a small area on the adjoining neck. The cartilage is thickest centrally.

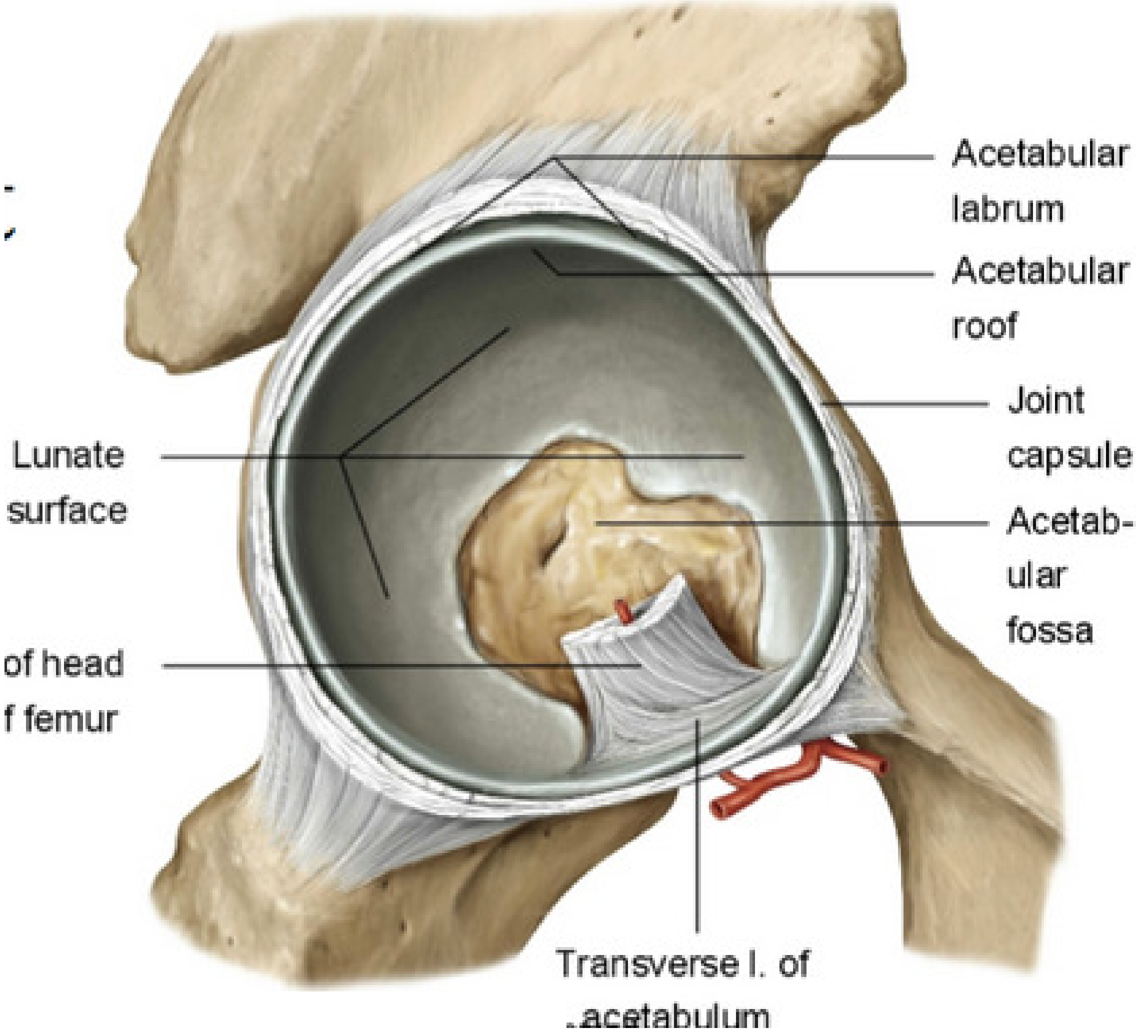
Maximum thickness is in the acetabulum's anterosuperior quadrant and the anterolateral part of the femoral head.

The acetabular articular surface is an incomplete ring, the lunate surface, broadest above where the pressure of the body weight fall in erect posture. It is deficient below, opposite to the acetabular notch.

Acetabular labrum:

It is a fibroacartilagenous rim attached to the acetabular margin, deepening the cup, under which vessels and nerves enter the joint.

Acetabular Labrum

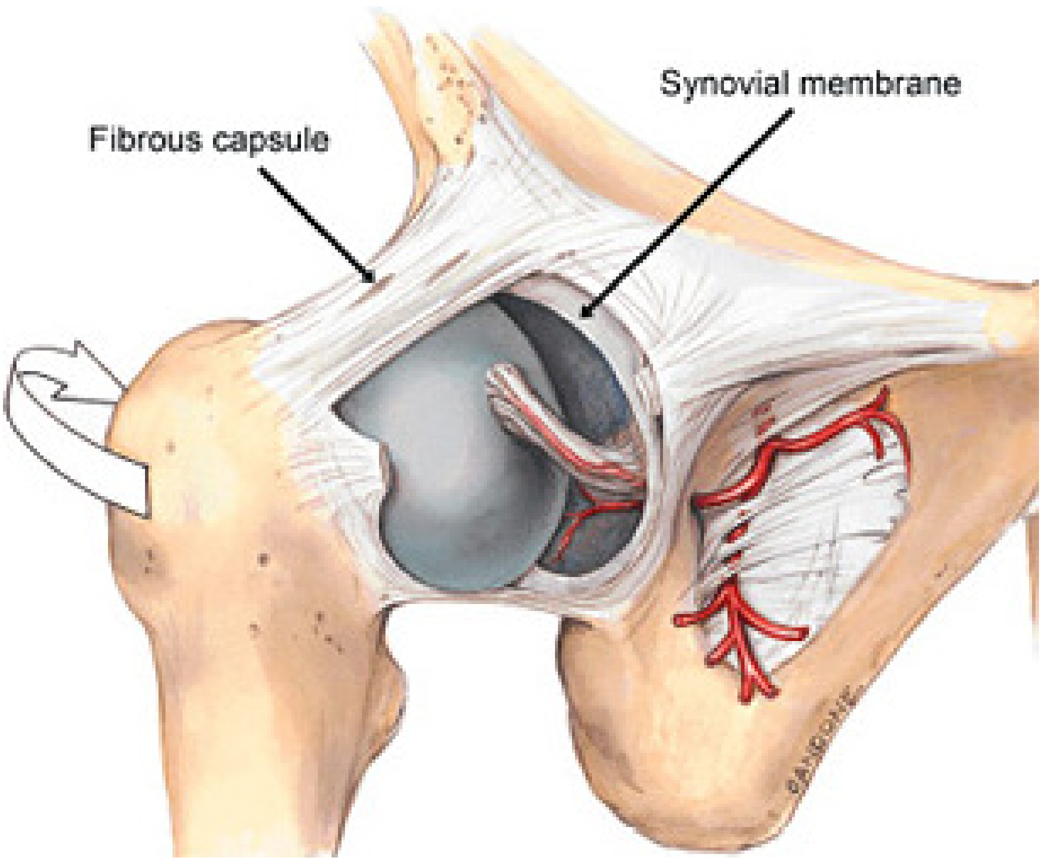


Fibrous capsule:

It is placed above the acetabular rim 5-6mm beyond the labrum, behind, it is attached about 1 cm above the inter-trochanteric crest. The capsule contains two layers- inner orbicularis around the femoral neck and blending with the pubofemoral and ischiofemoral ligaments, and an outer longitudinal layer.

The circular layer is not directly attached to bone.

Synovial membrane:



Starting from the femoral articular surface, it runs around neck, capsule, labrum, ligaments and acetabulum.

Iliofemoral ligament:

It is also known as Bigelow's[16] ligament, Triangular or inverted Y shaped. It is one of the strongest ligaments in the body. Its apex is formed by iliac spine and the rim, and the base by the line of intertrochanteric region.

Pubofemoral ligament:

Triangular in shape, attached to the Superior ramus, iliopubis and obturator bone crest. Distally it is attached to capsule and

Bigelows lig.

Ischiofemoral ligament:

It consists of superior, medial and lateral ligaments of ischiofemoral, extending from ischial bone to base of the neck of the joint.

Ligamentum teres:

It is a triangular flat hand with apex attached to the pit on the femoral head and base on either side of the acetabular notch. It varies in length and sometimes being represented only by a synovial sheath.

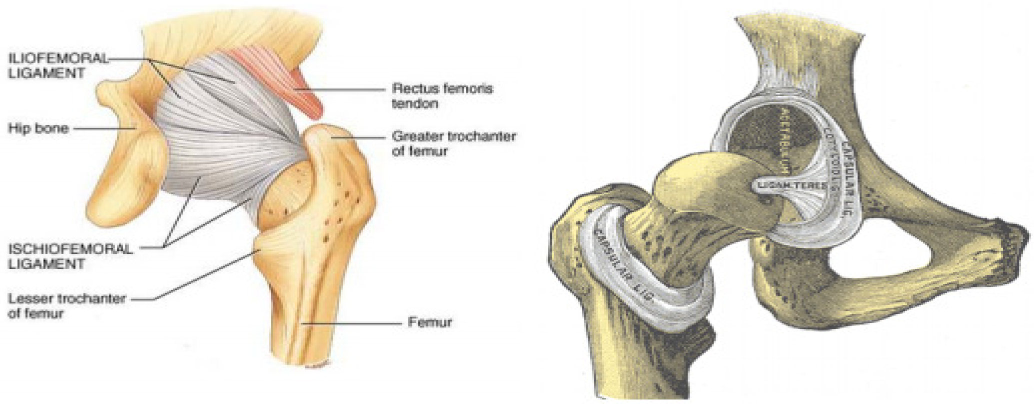
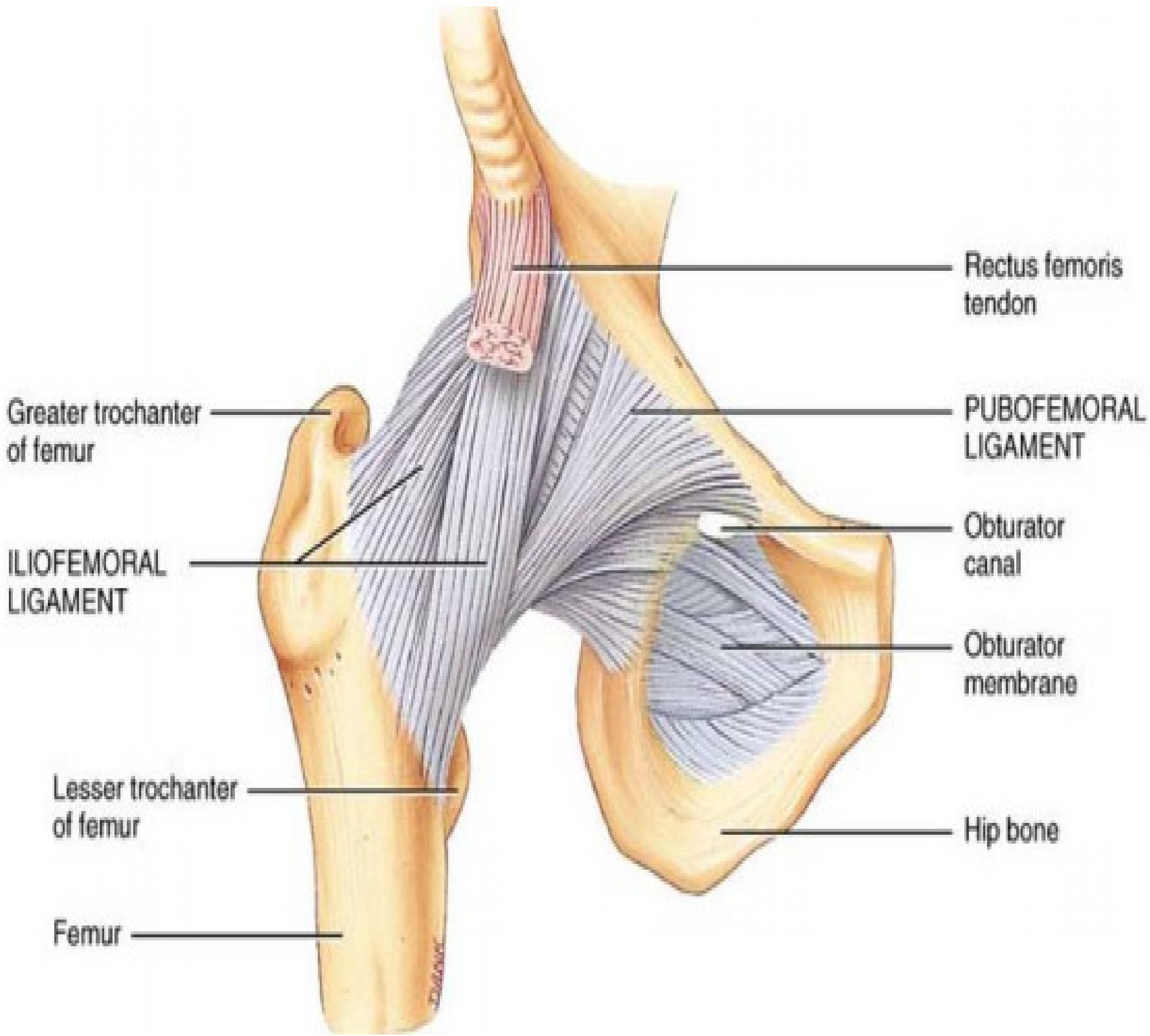


Fig1: Ligaments of the hip joint


Rectus femoris tendon
Greater trochanter of femur
PUBOFEMORAL LIGAMENT
Obturator canal
ILIOFEMORAL LIGAMENT
Obturator membrane
Lesser trochanter of femur
Hip bone
Femur

Relations of Hip Joint:

Anteriorly:

From medial to lateral are:

- Pectineus, which intervenes between the most medial part of the hip and the femoral vein[17].
- Tendon of psoas major separated from the joint by a bursa and the iliacus muscle lateral to it.
- The femoral[18] nerve is in the groove between iliacus and psoas major with the femoral artery anterior to the psoas tendon.
- The straight head of rectus femoris crosses the joint laterally with a deep layer of the fascial iliotibial tract.

Superiorly:

The reflected head of rectus femoris contacts the capsule medially and superolaterally, the capsule blends with the gluteus minimus.

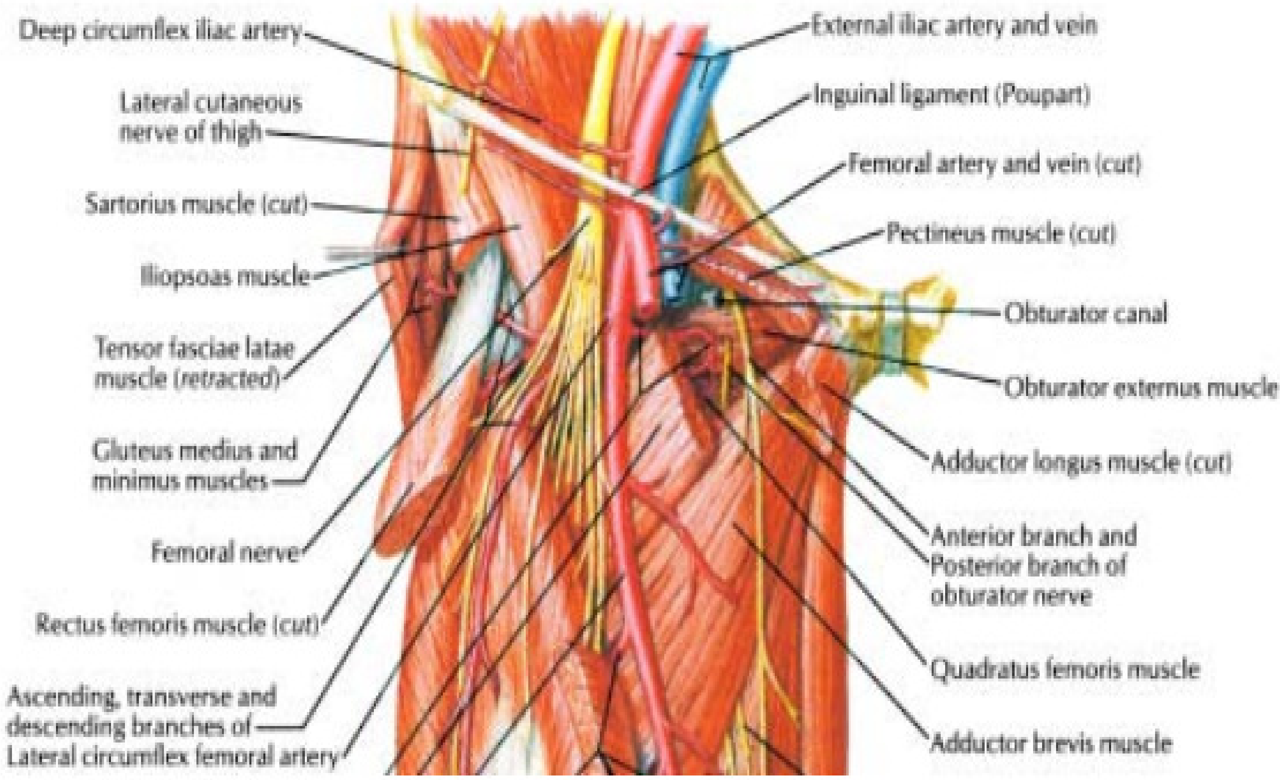
Inferiorly:

It is related to the lateral fibres of pectineus and tendon of externus.

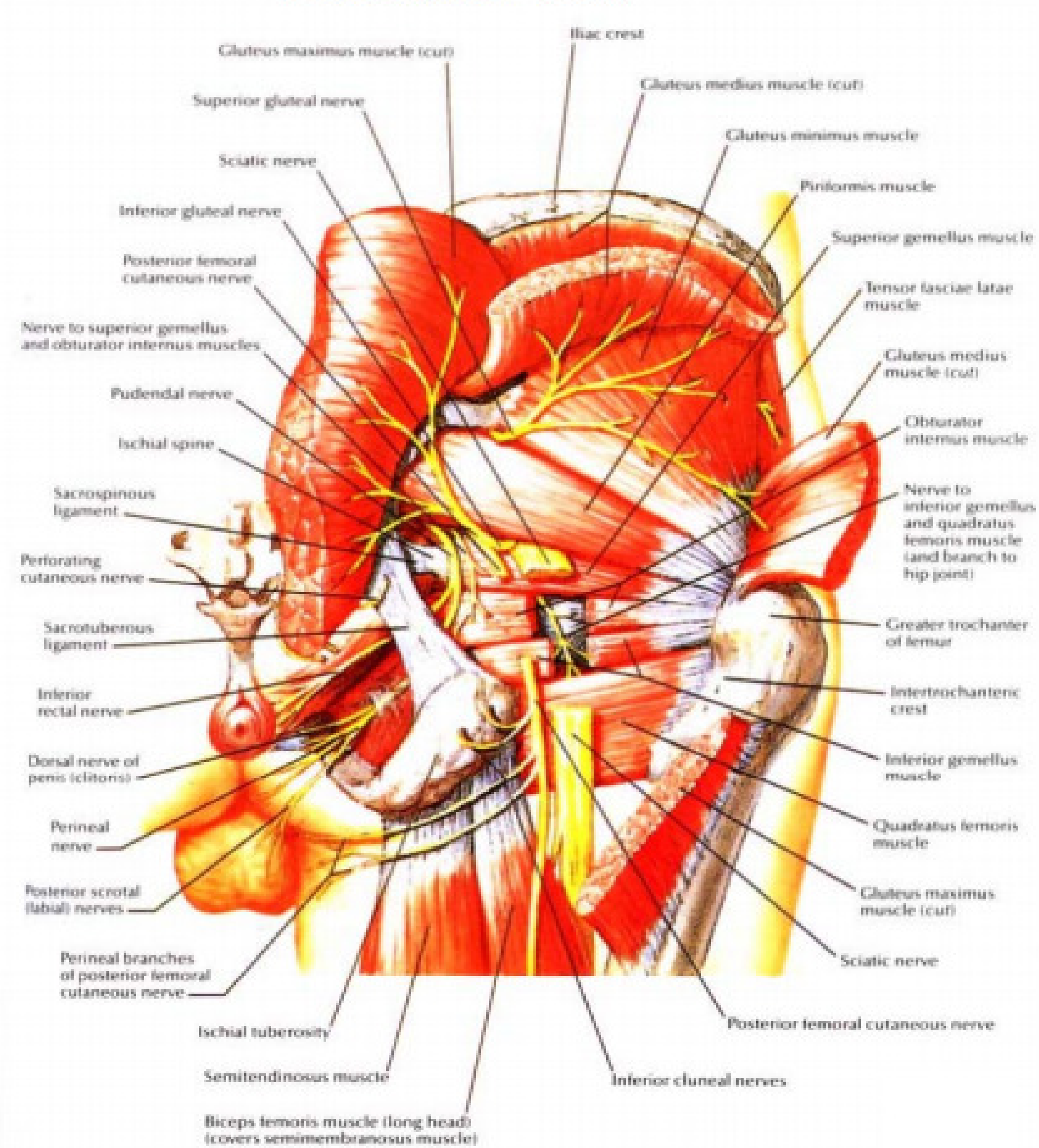
Posteriorly:

Obturator externus tendon with an ascending circumflex artery, by which joint is separated from the quadratus femoris. Tendon of obturator internus and the gemelli separate the sciatic nerve from the joint, and the nerve to quadratus femoris lies deep to the obturator internus[17]. It is also related to the piriformis muscle.

ANTERIOR VIEW



POSTERIOR VIEW



Relations of Hip Joint

Vascular Supply of Hip Joint:

a) Artery of obturator.

b) Circumflex artery medial branch.

c) Artery of gluteus by its inferior branch and superior branch.

Nerve Supply

Hilton's rule:

The nerve that supplies a muscle acting across a joint supplies the joint itself and the skin over the joint.

a) Nerve of femoral.

b) Nerve of obturator.

c) Obturator accessory branch.

d) Quadratus femoris branch.

e) Nerve of superior gluteal.

Movements:

Flexion 90° to 100° with knee extended / 120° with knee flexed

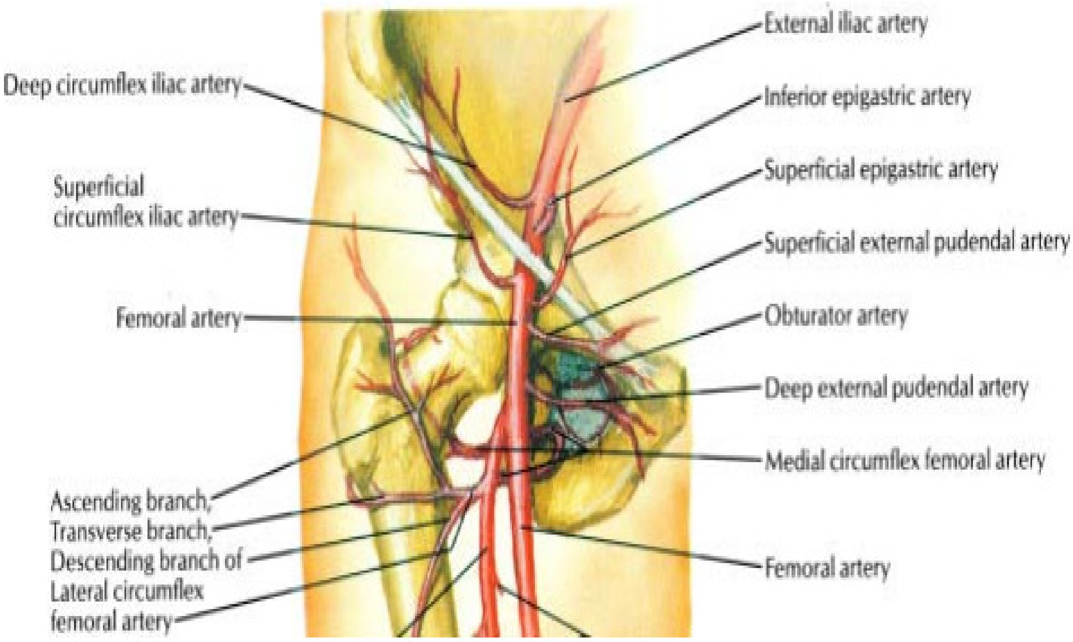
Extension 10 to 20`

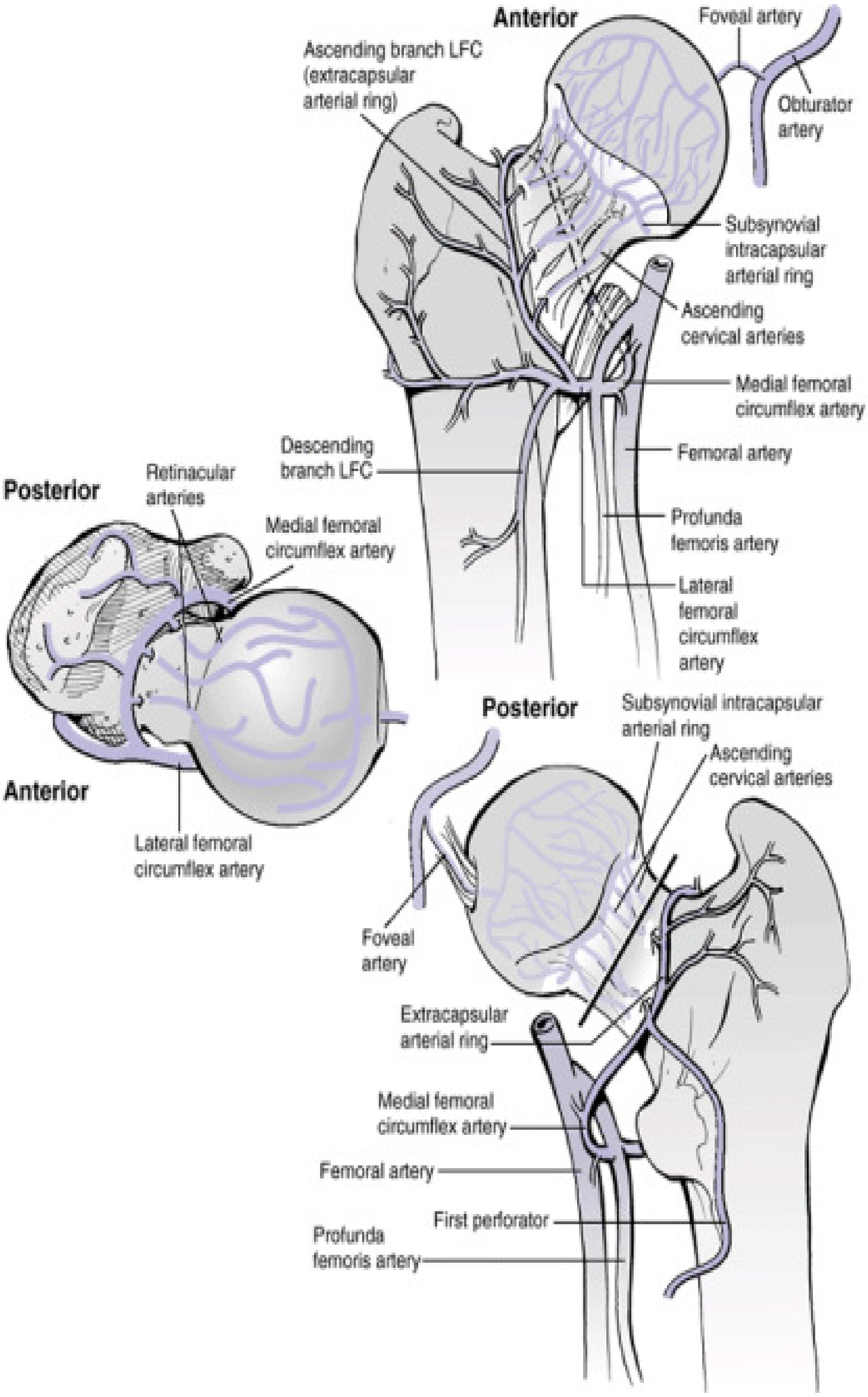
Abduction 30° to 40`

Adduction 30° to 40°

Medial Rotation 30° to 40`

Lateral rotation 30° to 40°





Vascular Supply of Femoral Head and Neck

Kinesiology of the Hip:

MOVEMENT	MUSCLES (Prime Movers and Assisted by)	AXIS
Flexion	Psoas major, Iliacus, Pectineus, Rectus femoris, Sartorius, Adductor Longus (in early flexion from full extension)	Along the centre of femoral neck (pure spin)
Extension	Gluteus maximus, Posterior hamstrings	Along the centre of femoral neck (pure spin)
Abduction	Gluteus medius and minimus Tensor fasciae latae Sartorius	Antero-posterior through femoral head
Adduction	Adductors longus, brevis and magnus, Gracilis, Pectineus	Antero-posterior through femoral head
Medial Rotation	Tensor fasciae latae and Anterior fibres of Gluteus, medius and minimus	Vertical axis through centre of femoral head and lateral condyle with foot stationary on the ground
Lateral Rotation	Oburator Externus and Internus, Gemelli, Quadratus femorus, Assisted by Piriformis, gluteus maximus and Sartorius.	Vertical axis through centre of femoral head and lateral condyle with foot stationary on the ground.

Proximal Femur :

The Proximal end has head, neck, greater trochanter and lesser trochanter.

The Head:

It looks like hemisphere, it faces antero supero medially to articulate with the acetabulum. Posteroinferiorly formed by fovea.

Femoral Neck:

Length is 5 cms, it connects head and shaft by the angle of 127° (113° to 136°). This helps for the movements in the hip. The neck is also set up on at an angle of 10 to 15 degree anteversion. This twisting and turning presumably represents the developmental response of the femur to the upright position. It has flat anterior surface. The surfaces in the posterior aspect are transversely convex and by the long axis it is concave.

Greater Trochanter:

Largest region with quadrangular shape, it starts from neck and shaft junction. The posterosuperior area superomedially extend to posterior aspect of neck, and medially it has the fossa of trochanter.

Lesser Trochanter:

It is a conical posteromedial projection of the shaft at the posteroinferior aspect of its junction with the neck.

Internal Structure of the Proximal end:

The apparently fragile but collectively strong lattices of the struts and trusses seen in trabecular bone and skeletal forms such as tubes, H-girders and ridges predate human invention by millennia. Galileo recognized the significance of trabeculation and also asserted that hollow cylinders are weight for weight, stronger than solid rods.

Calcar femorale[17]:

A thin vertical plate, the calcar femorale or as Bigelow (1900) described it as the true neck of the femur. It starts from linea aspera upto neck trabeculae. Medially necks posterior aspect. Laterally greater trochanter.

Anteriorly lesser trochanter and its crest. The hip prosthesis, rests on the calcar, and its shoulder abuts the calcar femorale and transmits the stress of weight bearing to the shaft via the calcar.

Wolff's Law[17]:

Bone grows and accordingly remodels by changes in the internal architecture, which changes in accordance with mechanical loss. In essence, the law states that bony trabeculae are oriented along the line of stress, if the direction of stress changes, the orientation of the trabeculae also changes.

Trabacular Pattern:

The cancellous bone is composed by two distinct trabaculae. In the frontal section these trabaculae are seen to form two arches. One arising over medial (or inner) cortex by femoral shaft and other by taking origin from the lateral (or outer) cortex the trabaculae forming these arches are called compressive and tensile trabaculae respectively because they are disposed along the lines of maximum compression and tension stresses produced in the bone during weight bearing.

These trabaculae have been divided into following five groups.

Trabacular anatomy of proximal femur

a. **Primary compressive group:**

Extend from medial cortex to femoral head. It runs like a slightly curved radial line. Some are thickest and most closely packed.

b. **Secondary compressive group:**

Extends from medial cortex.These arise below the principle compressive group and goes upwards and towards lateral aspect. The trabaculae in this group are thin and widely spaced.

c. **Primary tensile group:**

This trabaculae springs from cortex`s lateral aspect below the group of greater trochanter. These trabaculae are thickest among the tensile group curve upwards and inwards by the femoral neck and ends in the base of head.

d. **Secondary tensile group:**

The trabaculae which arise from the lateral cortex below the principal tensile trabaculae. The trabaculae of this group arch up and medial towards the upper end of femur

e. Greater trochanter group:

Formed by slender and poorly defined tensile trabaculae from lateral cortex behind greater trochanter and ends superiorly. In the femoral neck, the principle compressive, the secondary compressive and primary tensile trabaculae enclose an area containing some thin and loosely arranged trabaculae.

This area is called "Ward's Triangle. The thick trabaculae appear as dense continuous lines while the delicate ones are not visible. Thus the areas like Ward's triangle appear empty while rests of the trabaculae are delineated depending on their density.

Singh's Index[17]:

The 'Singh's Index' is the grading of the trabecular appearance in X-ray. There are 6 grades as follows:

Grade VI: Every trabaculae groups will be present with cancellous upper end.

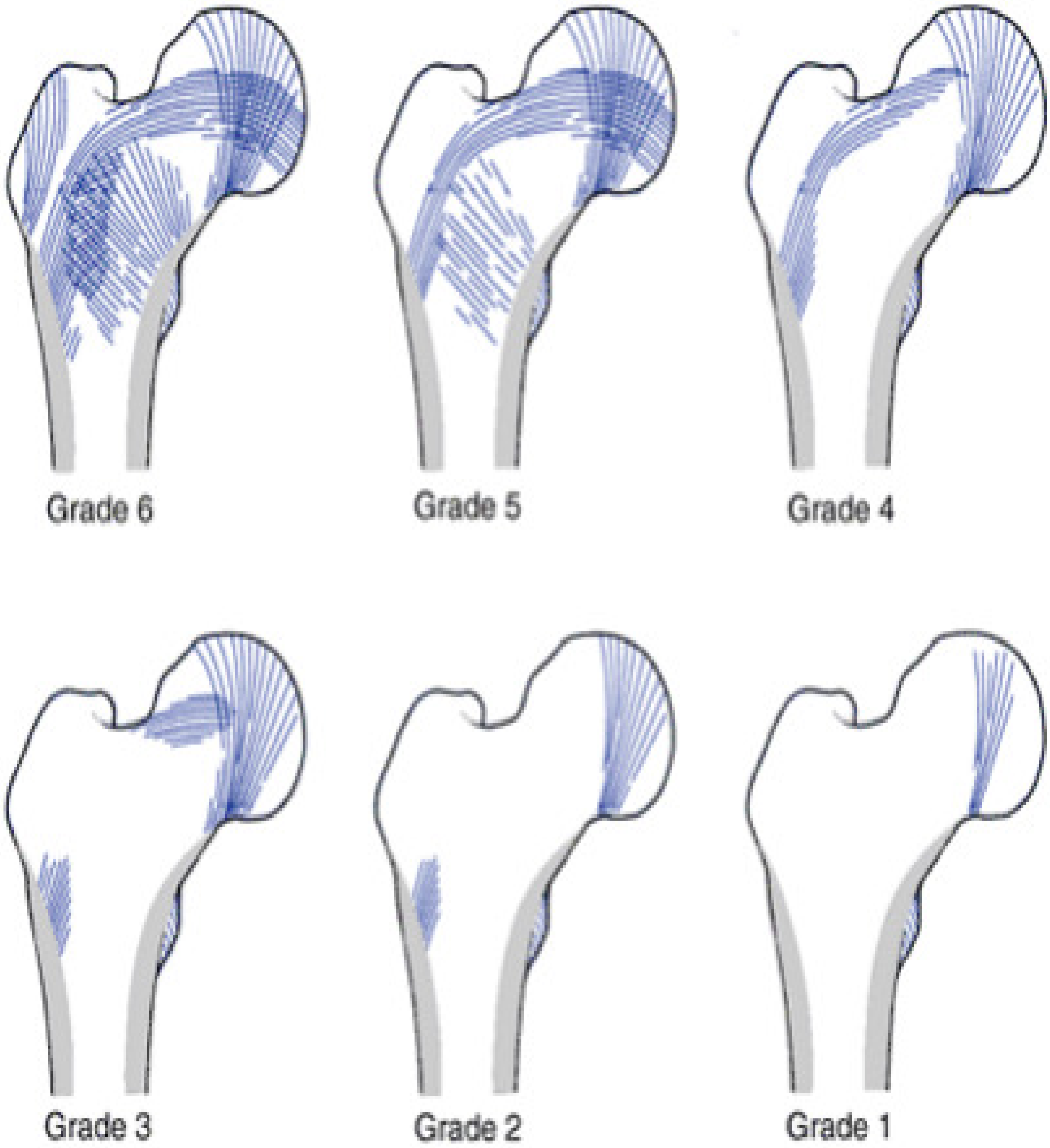
Grade V: The Principle (Primary) group and compressive trabaculae are present. Secondary trabaculae are absent.

Grade IV: Reduced principle group trabaculae. May be evident from the lateral aspect to the proximal femur.

Grade III: There is a break in the trabaculae group opposite to greater trochanter.

Grade II: Only principle compressive trabaculae are found. Others are more or less completely resorbed.

Grade I: Even principle compressive trabaculae are markedly reduced.


Grade 6
Grade 5
Grade 4
Grade 3
Grade 2
Grade 1

Blood Supply of the Femoral Head:

Described by Crock

It has 3 major divisions

a. Ring of arteries around base of neck.

b. Branches from ascending arteries of femoral cervical region.

c. Ligamentus arterial branch of teres.

The extra capsular ring- posteriorly by medial branch of circumflex and anterior aspect by lateral branch of femoral circumflex. The fracture proximal to the neck surface makes injury to the arteries. Posterior groups are most important among all other groups. Injury to these vessels during surgeries on the hip via the posterior approach increases the risk of avascular necrosis of head of the femur. Second ring is formed by arteries of epiphyseal. These arteries communicates by superior metaphyseal and ligamentum Teres arteries, which are branches of the obturator and medial circumflex femoral arteries.

Clinical significance of vascular anatomy:

Fracture neck of femur occuring distal to the superior retinacular vessels and the displacement is minimal, both sources of blood supply may remain intact and prognosis is good (less chance of avascular necrosis). Abnormal degree of rotatory movement of the femoral head may destroy its own blood supply as any other form of displacement. With complete displacement of head, only medial epiphyseal vessels supply the head. In approximately 30% of cases the loss of blood supply is total, the foveolar vessels are insufficient and entire head becomes necrotic.53 In 70% of cases, the nutrition of the femoral head is partially or wholly preserved by foveolar vessels.

When avascular necrosis is partial, it usually involves a large area of the head at the upper outer portion, the region about the fovea remaining viable.

Applied Biomechanics of hip joint[17] :

When the weight of the body above the lower extremities rests equally on two normal hip joints, the static force on each hip is one half of, or less than one third, the total body weight. When, for example, the left lower extremity is lifted as in the swing phase of walking, the weight of the left lower extremity is added to that of the body weight, and the centre of body gravity, normally in the median sagittal plane, is displaced to the left. The abductor muscles exert a counter-balancing force to maintain equilibrium. The pressure exerted on the head of the right femur is the sum of these two forces. Each force is related to the relative length of levers. If the abductor lever is one third that of the lever arm from the head to the center of gravity, the downward pull of the abductors must be three times the force of gravity to maintain balance.

Therefore, the total pressure on the head is four times the superimposed weight.

The longer the abductor lever (i.e., the more laterally placed insertion of the abductors), the less the ratio between the levers, the less the abduction force required to maintain balance, and the less the pressure force on the femoral head.

The stance phase load in head of femur is about 3 times of body weight. Crowninshield,et al. proposed it as 3.5 to 5 times, upto 10 times while running. Joint forces act in the coronal plane and gravity of body`s centre lies anterior in S2 spine, which lies posterior to the joint, in the sagittal axis to bend prosthesis stem posteriorly.

Frictional Torque force:

This is produced when the loaded hip moves through an arc of motion. It is the product of the frictional force times the length of the lever arm, that is the distance given point, only surface of the head moves during given arc of motion.

Neck length and offsets:

The ideal femoral reconstruction reproduces the normal centre of rotation in head of femur, which is influenced by,

- Vertical offset or vertical height: Restoring this distance is essential to Correct leg length. Using a stem with variable neck lengths provides a simple means of adjusting this distance.

- Medial offset (Horizontal offset) – This restores moment arm by abductor muscles and prevents dislocation.

- Anterior offset or femoral neck version: This refers to the orientation of neck to coronal plane. Retroversion of the femoral is essential for stability of the replaced joint. 10 to 15 degrees is seen normally in femur.

In coronal plane [A] joint forces move the stem towards medial aspect, and sagittally moves the stem in the posterior aspect. In combinaton they create a torsion in the stem.

Neck of femur fracture risk factors:

a. **Age:**

There is steep rise in the incidence after sixth decade, especially in females.

The rate of increase for women is exponential above the age of 60 years. The bodily changes associated with ageing are responsible both for increasing the chances of an individual falling and for weakening the bone to such an extent that even a minor trauma will result in a fracture. Long term physical activity has been shown to reduce the risk of fracture.

b. <u>Sex:</u>

A preponderance of female patients is observed in all studies. The relative proportion varies between 1.7:1 (Levine et al., 1970) and 4.5:1 (Parker et al., 1992). Use of supplemental vitamin D3 and calcium has been shown to reduce the risk of hip fracture in elderly women.

c. <u>Life style:</u>

Sedentary life style has increased the incidence of hip fractures as evidenced by increased incidence in urban than rural population. According to Boyce and Vessey physical activity among people between the ages of 15 and 45 years who sustained hip fracture was less than the control group. The most elderly and infirm group of population are often encouraged to become more immobile which increases the risk of falling by exacerbating muscle weakness.

d. <u>Race:</u>

Incidence in Negroes is half that among white population. Mexican Americans have risk of one-third of white Americans (Bauer et al.). The studies indicate genetic predisposition to fracture neck femur. The highest incidence is seen in caucasian race (Makin and Solomon). All though bone mass has been shown to the greater in black people a lower rate of falling probably more important in the explanation of different relative frequency of fracture hip in black & white.

e. **Season:**

A seasonal risk of falling that is higher in summer in Korea and higher in winter in Scandinavia.

f. **Old fracture:**

The risk of second fracture hip is twice the risk of first fracture because of increased likely hood of falling.

g. **Geographical variation:**

Considerable variation in incidence around the world is related to environmental factors such as climate, diet, life style and degree of industrialization apart from hereditary factors.

h. **Nutrition:**

Patients who sustain hip fracture have been reported to have reduced skin fold thickness compared with age matched controls and reduced upper arm circumference and low body weight. According to Boston et al. thinner patients are more likely to develop hypothermia in cold weather and this would result in impaired co-ordination and increased tendency to fall. Another explanation is that bone strength is preserved in those patients with a larger body weight.

i. Smoking and Alcohol

j. Medications:

Patients on chronic medications that could affect bone strength sustain a hip fracture. Corticosteroids reduce bone strength on prolonged use. Thyroxine[23] increases bone turnover and causes osteoporosis. Sedatives, tranquillizers, anticonvulsants and antihypertensive drugs are also known risk factors.

k. Medical conditions:

Many medical conditions have been associated with increased risk of falls, bone weakness and hip fracture. Few examples are cardiac arrhythmias, CCF, Parkinsonism, CVA, anemia, malignancy, Paget's disease, etc.

Bipolar Prosthesis:

The bipolar prosthesis introduced by James. E. Bateman and Gilberty during 1974. Similar Bipolar prosthesis were later manufactured with some modifications, mainly in the design of stem. Other commonly known versions are Monk duo Pleet (Monk 1976), Hasting's bipolar prosthesis (Biotechnic, France) and Bipolar endoprosthesis (Inor India, Talwalker type). The provision of completely mobile head element and the addition of another head surface motion in the acetabulum create a compound system. This provides a greater distribution on the bearing surfaces, thus minimizing wear and tear changes both on the implant and on containing tissues. Such considerations were met by building a prosthesis of cobalt – chromium alloy (VitalliumHowmedica), consisting of a femoral stem with a collar, neck and 22 mm spherical bearing at it's proximal end. Locked onto this bearing is a capped metallic cup or cap, i.e., the head which constitutes a second bearing surface which articulates with the acetabulum. The assembled device represents an integrating bearing system for the hip joint replacement.

The Bipolar prosthesis (Talwalker type) has got a stem length of 157 mm, thickeness is 8 mm and material for the stem is Stainless steel AIS 316. The stem has got fenestration which is optional. It has got vertical shoulder which sits on the medial calcar, has long neck, of length 35.0 mm, neck shaft angle is 125 degrees, diameter is 19.00 mm. The size of the femoral head is 26 mm. The femoral head articulates with the inner surface of acetabular cup which is covered by (HDPE) High Density PolyEthyleneand outer surface is stainless steel. The size of acetabular cup will vary from 39 to 51. Simplest of currently available Bipolar prosthesis like Indian version and monk prosthesis have an Austin Moore type stem and the small femoral head cannot be detached from the outer metallic cup – (UHMWPE) Ultra High Molecular Weight PolyEthylene insert complex.

Better and modified versions of Bipolar prosthesis have a modular systems with inter-changeable stems (fenestrated, solid, straight, long, pororus, press fit, cement compatible, Interchangable). Small diameter head (metallic or ceramic) allows adjustment of neck length, different sizes of outer metallic cup UHMWPE, insert with press fit locking mechanism over small head (Biotechnic, France).

The movements between 2 interfaces contribute to greater range of motion and possibly less migration of the prosthesis. Modular version of Bipolar prosthesis can be easily converted to total hip replacement in case of any complications occurring in acetabular side.

Principle of Bipolar prosthesis:

Acetabular wear is diminished through reduction of total amount of motion that occurs between the acetabulum and metallic outer shell by interposition of second low – friction inter-bearing within the implant. Because of compound bearing surface, bipolar designs provide greater overall range of motion than either unipolar designs or conventional total hip arthroplasty.

Biomechanics of the implant[26]:

The forces on the joint act on coronal plane, but as the body's centre of gravity[27] (in the midline anterior to S2 vertebral body) is posterior to the axis of the joint, they also act in saggital plane to blend the stem of the prosthesis posteriorly .During gait cycle[28], Forces are directed against the prosthetic femoral head from a polar angle between 15 and 25 degrees anterior to sagittal plane of the prosthesis during stair climbing and Straight leg raising, the resultant force is applied at a point further anterior on the head. Such forces are applied at a point even further anterior on the head. Such forces cause posterior deflection or retroversion of femoral component.

The low coefficient of friction of a metallic head articulating with a polyethylene cup as a bearing is fundamental to bipolar arthroplasty. The coefficient of friction is the measure of resistance enecountered in moving one object over the another[52]. It varies according to material used the finish of the surfaces of the materials, the temperature and whether the device is tested in the dry state or with a specific fluid as a lubricant. Load may be another factor.

Frictional torque forces are produced when the loaded hip moves through an arc of motion. It's the product of frictional force times length of the lever arm, that is the distance given point only surface of the head moves during given arc of motion.

Ideal Prosthesis :

The ideal femoral reconstruction reproduces the normal centre of rotation of femoral head . this location is determined by 3 factors:

Vertical Height (Vertical offset)[29] –

Restoring this distance is essential to correct the leg length. Using a stem of variable neck lengths provides a simple means of adjusting this distance.

1. **Medial Offset (Horizontal offset)**[30] – Inadequate restoration of this offset shortens the moment arm of the abductor musculature and results in increased joint reaction force, limp and bony impingement which may result in dislocation.

2. **Version of femoral neck (Anterior offset)**[31] – Version refers to the orientation of the neck in reference to cornal plane and it's denoted as anteversion or retroversion. Retroversion of the femoral version is important in achieving stability

of the prosthetic joint. The normal femur has 10 to 15 degrees of anteversion.

<u>Advantages of Bipolar prosthesis</u>:

Wide range of movements:

It's due to size and geometry of inner bearing i.e., the rim of polyethylene insert on metallic neck of prosthesis, after a certain arc of abduction – adduction movements and then the further movement occurs between acetabulum and outer metallic cup of prosthesis.

1) ***Stability – improved*** : At the degree of movement of the inner bearing, when the joint tends to dislocate, it's prevented by movement of the outer bearing in opposite direction.

2) ***Prevents the Complications – like*** :Acetabular erosion and protrusioacetabulli, loosening of the stem. The bipolar prosthesis is designed as an alternative to unipolar endoprosthesis. It works on the principles of 'low friction arthroplasty'.

The bipolar has 2 layers of movements with an inner low friction bearing, where small metallic head articulates UHMWPE insert and outer stainless covering – polyethylene insert which articulates against the acetabulum. A friction differential thus exists at 2 planes of movements, so that even in presence of minute irregularities of acetabular surface, most of motion tends to occur at the inner bearing. The friction between acetabular cartilage and the outer metallic cup is markedly reduced.

This reduced reaction against acetabular cartilage is better tolerance of bipolar prosthesis, reduces erosion and corresponding reduction in penetration of the acetabulum. Shock –absorbing character of the UHMWPE insert also reduces impact load on acetabulum during weight bearing. The small diameter of femoral of inner head reduces the resistance to motion and thereby also reduces the forces of mechanical loosening of femoral stem. Bipolar prosthesis designed primarily with aim of reducing the frictional stress and thereby decreasing the acetabular erosion and loosening of the stem. The complications of fracture such as Nonunion and Avascular necrosis which could occur following Internal fixation are avoided.

3) ***Increased life span of the prosthesis*** :As it's a low friction arthroplasty, the wear and tear is minimal in both implant and the acetabulum. Hence the life span of the prosthesis is more when compared to other universal endoprosthesis.

4) ***Can do THR later*** : Bipolar design affords the advantage of low friction arthroplasty without implanting a separate acetabular component. As absence of fixed acetabualrcup eliminates the potential complications with use of Methyl methacrylate for fixation of the acetabular cup, which increases the duration of surgery and complications associated with fixing the cup with cement.

5) Immediate weight bearing[32] and avoids bed-ridden complications.

6) Bipolar prosthesis was originally devised for use in cases of fractur neck of femur to overcome the long term complications of Moore's and Thompson's prostheses like

Acetabular erosion, protrusion acetbaulli and proximal migration of the prosthesis. Till date the bipolar prosthesis has been extensively used in traumatic cases and several long term study has been published, which clearly document the improved results as compared to single assembly prosthesis

Mechanism of injury in fracture neck of femur:

Kocher predicted 2 mechanisms-

1. Greater trochanter direct trauma

2. Lateral rotation of involved extremity

3. Cyclical force loading which tend to create micro & macro fractures.

Mechanism of Bone failure :

1. A structure will fail if it suffers from the overloadings, and such a situation would arise if the system is unable to absorb the energy applied to it. In the hip joint this over loading can occur as a result of number of independent but often inter – related factors. The following being

important : falling, Impairment of energy absorbing mechanisms and bone weakness.

2. Falling : In standing, the body possesses a considerable amount of potential energy. In falling, the potential energy converts to kinetic energy, which upon impact with the floor must be absorbed by the structures of the body, if a fracture is not to occur. In a average cordination may be slower and thus the energy absorption may not be adequate to prevent a fracture.

   It's interesting the fractures of neck of femur are more common in patients with Rheumatoid arthritis, Diabetes mellitus who are likely to have neuromuscular defect (Alffram 1964). In the elderly the normal protective muscle contraction in the event of slip rather than a fall may lead to an uninhibited muscle contraction around the hip and produce sufficient force to fracture neck of femur without implicating any other fracture.

3. Bone weakness : In the presence of osteoporosis or osteomalacia there is reduction in the bone strength to

approximately to 3/4th of the normal healthy young bone (Frankel 1974) and a lower energy absorbing capacity leads to failure. Griffiths et al (1971) showed that fatigue fractures can occur in elderly if the neck of femur is cyclically loaded with in the physiological range, senile subcapital fractures in the osteoporotic bone due to fatigue, preceded by an accumulation of isolated trabecular fatigue fractures have been demonstrated by Freeman et al (1974). Thus fatigue of an elderly bone can occur without a fall.

4. Patterns of femoral neck fractures: It's influenced by the resultant of force which is applied at the moment prior to fracture. Frankel in 1950 has shown experimentally that if bending component is increased relative to compressive component (a ratio of 1.6) then a transverse fracture is likely. If the bending component is reduced to compressive component (a ratio of 1.7) a subcapital fracture with a spike, finally a subcapital fracture is produced. The resultant line of forces from the muscle contractions produce a subcapital fracture experimentally; a pattern of fracture seen after an

eltrocution. Basal and inter-trochanteric fractures have not been explained satisfactorily since they could not be reproduced satisfactorily.

<u>Classification of Femoral neck Fractures</u>:

Any system of classification of fractures is useful only if it considers the severity of bone leisionand serves as a basis for determining the type of treatment used, the chance of achieving a stable rigid surgical fixation and the likely outcome of treatment. In intra-capsular fracture neck of femur, classification should sid in prediction of the risks of Non-union and Avascular necrosis.

1) Anatomical classification
2) Pauwel’s classification
3) Garden’s classification
4) AO Classification

<u>Anatomical Classification</u>[33]:

The first anatomical classification of fracture neck of femur was done by Sir Astley Cooper in 1823. He classified them into

A) Intra-capsular

B) Extra-capsular

Intra – capsular fractures further classified as

i) Subcapital fractures : Fracture line immediately beneath the head.

ii) Transcervical Fractures : Fracture line passing in between head of femur and greater trochanter.

iii) Basicervical fracture.

Banks had divided femoral neck fractures, anatomically into 4 types. Classical subcapital, wedge subcapital, Inferior beak fracture and Mid neck fracture. First 3 are essentially subcapital fractures.

Before the advent of effective internal fixation, Impaction was the most important prognostic factor, whether occurring at the time of injury or being produced subsequently by attending clinican. Consequently early systems of classification stressed the presence of impaction or displacement of the intra-capsular fracture. This is best exemplified by Waldenstorm in (1924) who classified them into: Impacted Abduction fracture (Valgus), Impacted Adduction fracture (Varus) and Non – impacted fractures.

Pauwel's Classification:

Based on the fracture line and the angle of inclination with the horizontal Plane. Pauwels (1937) classified subcapital fractures into 3 types.

Type I – Fracture line is less than 30 degrees from the horizontal.

Type II – Fracture line is between 30 to 70 degrees from the horizontal.

Type III – Fracture line is > 70 degrees to horizontal.

As a fracture progresses from the type I to type III, the obliquity of the fracture line increases and theoretically the shear forces at the fracture site also increase. The incidence of union is also good in Pauwel's type I due to impaction and the incidence of AVN is about 13 %. Where as in Pauwel's type II and III the incidence of Nonunion is 12 and 8 % and the incidence of AVN is 33 % and 30 % respectively.

Garden's Classification :

Type I – Fracture is incomplete, with the head tilted in postero-lateral direction. This is an impacted fracture.

Type II – Fracture is Complete, but no displacement

Type III – Fracture is complete with partial displacement.The trabecular pattern of the femoral head does not line up with that of the acetabulum, demonstrating incomplete displacement between the femoral fracture fragments.

Type IV – Complete fracture with complete displacement. The trabeculae of femoral head realign themselves with trabaeculae within the acetabulum.

A.O. classification :

Fracture neck of femur is based on the modification of Pauwel's grading with further sub-division into subcapital, transcervical, basicervicaland mid – cervical. In this system fractures of femoral neck are classified as:

B 1 : Sub – capital, without displacement or minimal

B 2 :Transcervical

B 3 : Displaced sub – capital fracture

B 1 : Subdivided into B 1.1 – more than 15 degree valgus impaction

B 1.2 – less or 15 degrees valgus.

B 1.3 – Non-impacted

B 2 : Subdivided into B2.1 – Basicervical[17]

B2.2 – Midcervical with adduction

B2.3 – Midcervical with shear

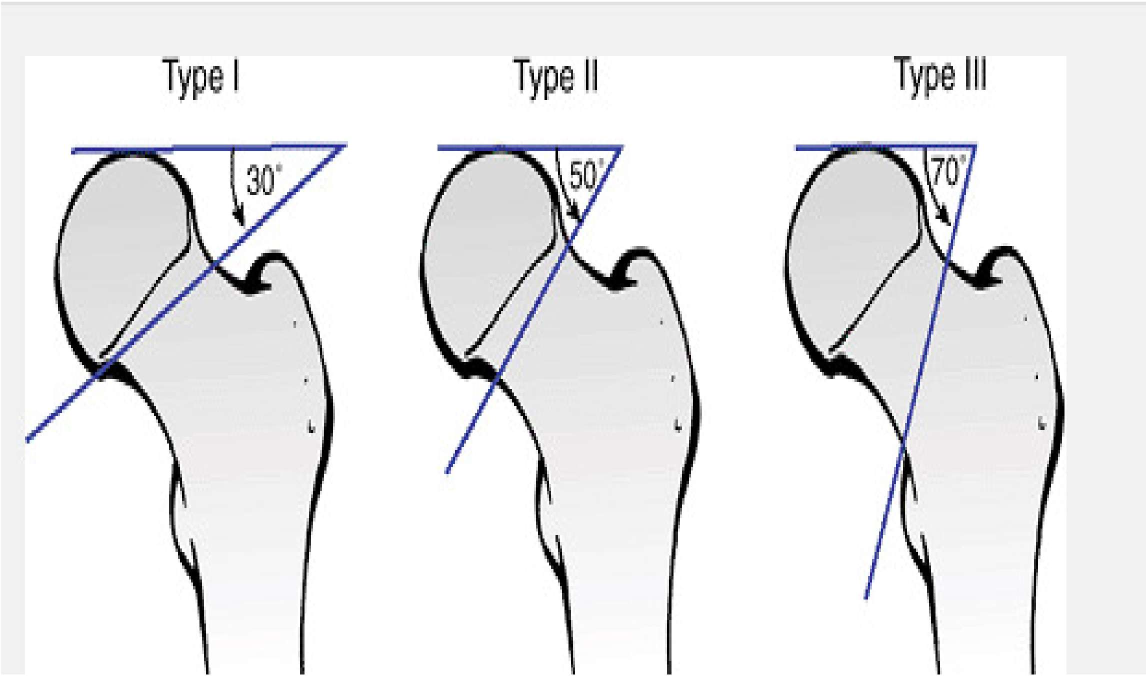
B 3 : Subdivided into B 3.1 – Moderate displacement in varus angle and externally rotated

B 3.2 – Moderate displacement and vertically translated and externally rotated

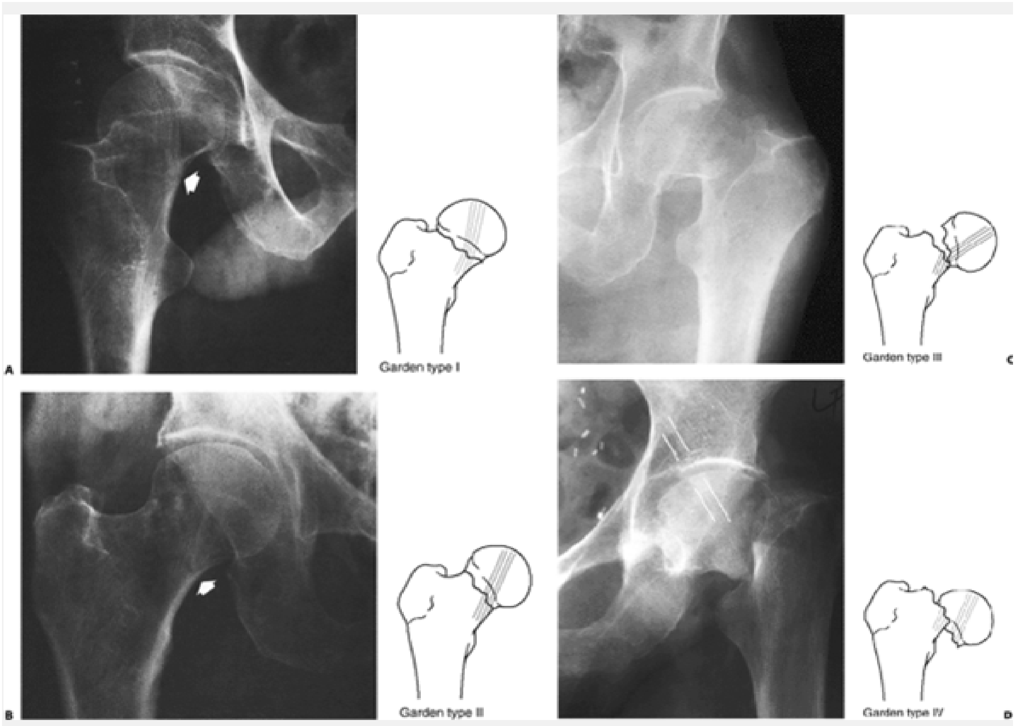
B 3.3 – Marked displacement

Among all, B 3 has the worst prognosis.

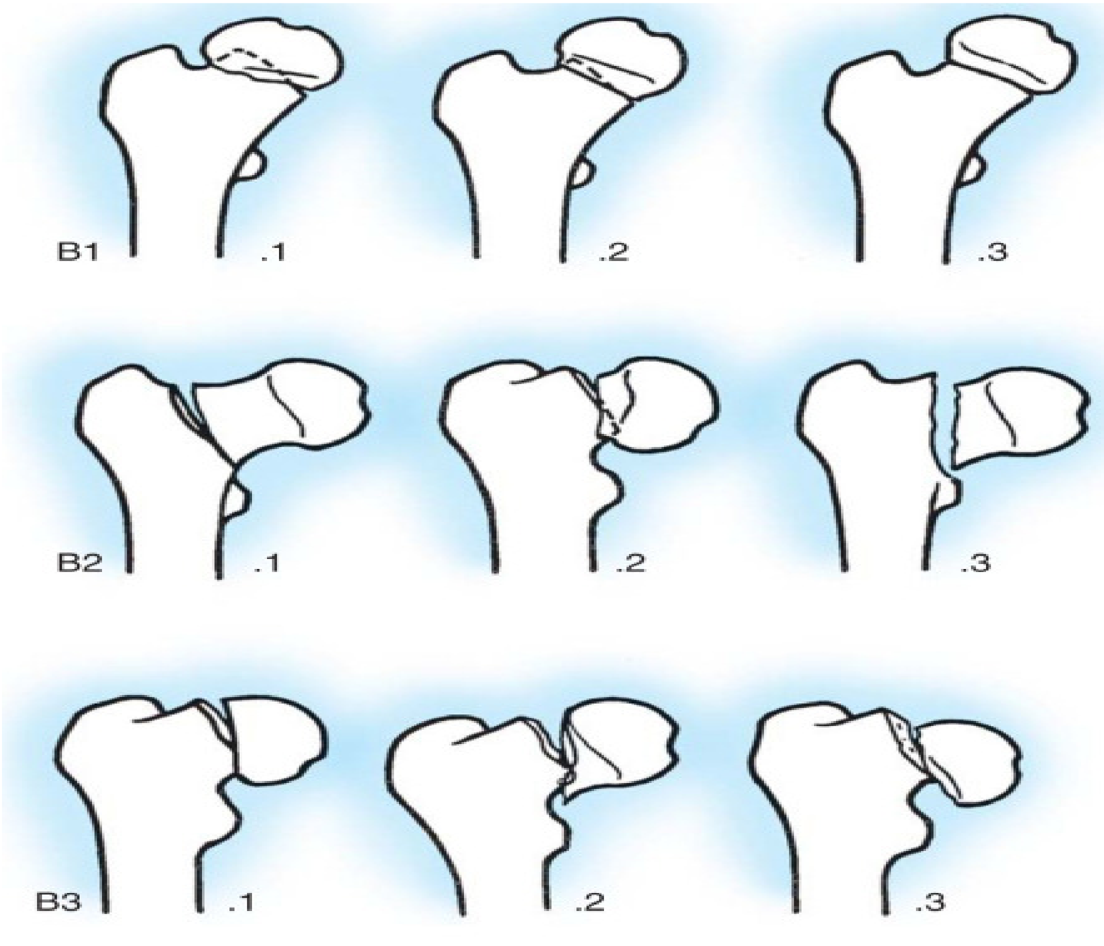
Pauwell's Classification



Classification by Garden's



AO Classification- Fractures Of Neck Of Femur



Radiography for the Hip:

The hip joint is usually diagnosed in antero-posterior (AP) view with heels Separated and the toe symmetrically forwards and medially. In this position the femur is rotated medially and the femoral neck becomes parallel to the film. In a normal hip the line of the upper margin of the obturator foramen is continuous with the curve that of under surface of the neck and the medial side of the shaft of femur (Shenton's line). In case of fracture or dislocations this line is broken.

Complications of Neck of femur fractures:

Non union: causes

Vascular and fracture anatomy, Intra-capsular nature of fracture, Absence of cambium layer of periosteum, Poor surgical technique, Comminution of the posterior cortex, Age of the patient, co-morbidities, Difficulty in reduction of fracture and maintaining reduction.

Avascular necrosis[38] of head: causes

Poor reduction, excessive rotation along the longitudinal axis or excessive vlagus at the time of reduction and improper screw fixation

Treatment:

Displaced fractures:

In the meta-analysis research published in JBJS 2003:85A:1673-81 by Mohit Bhandari MD, et al have found hemiarthroplasty is a better option than internal fixation. Even though it has complications like infection, increased operative time and blood loss, it has more advantages like reduced risk of AVN, non union, early mobilization and reduced re-operative rates.

Undisplaced fractures:

Closed reduction and internal fixation with multiple cannulated screws or with a compression screw and side plate and accessory screws in cases with comminuted lateral cortex

Complications:

i) **Early**- Nerve injuries : Sciatic, femoral, obturator and peroneal nerves. Haemorrhage and haematoma formation, Bladder injuries and urinary tract complications, Limb length discrepancy, Vascular injuries, Dislocation and subluxation, fracture, infection and thrombo-embolism.

ii) **Late**- Heterotropic ossification, implant failure, acetabular erosion and groin pain.

In the study of Thompson Hemiarthroplasty and Acetabular erosion done by T.W. Philips, London state that the prevalence, severity and clinical importance of acetabular erosion secondary to hemiarthroplasty of the hip are largely unknown. The factor that had the highest correlation with severity of the erosion are the level of physical activity and the duration of follow-up. Author`s analysis shows that the erosion progressed at an average of 3% per year in active patients. Post operative level of activity is determined by patient`s age and type of residence at the time of fracture.

Clinical relevance of acetabular erosion in young patients with a bipolar hip prosthesis by G. Kiekens, J. Somville, A. Taminiau-Netherlands state that young patients who had undergone bipolar hemiarthroplasty after proximal femur malignant tumor resection were followed up for a mean time of 81.8 months. The erosion and activity were assessed by x-rays and clinical examination. They did not report pain and had a good quality of life. The risk of late acetabular erosions were predicted by anticipated longevity of the patient and the level of activity. Verberne et al. pointed out that the built-in bearing joint is barely functioning after three months. Because the inner joint becomes fixed after a short period of time, a bipolar prosthesis cannot be expected to be better in preventing acetabular wear than a unipolar hemiarthroplasty. On the other hand, Lachiewski et al. demonstrated that at least 30% of the hip motion occurred between the femoral stem and the acetabular cup. When implanting a bipolar prosthesis there are some technical demands. Exact fit of the prosthetic head into the acetabulum is important. About 90% of the early failure after hemiarthroplasty can be explained through technical errors such as oversized prosthetic head, wrong choice of size and neck length, and loosening and varus pivot. Undersizing the prosthesis head may damage the acetabulum and give early protrusion. When insufficient femoral neck is resected, the excessive pressure on the acetabular cartilage produces erosion.

Degeneration of acetabular articular cartilage to bipolar hemiarthroplasty: Kyoung Ho Moon et al, Korea state that the degeneration of the acetabular articular cartilage after bipolar hemiarthroplasty could be diverse, depending on the material of artificial joints, lubrication level, friction coefficient, direction and strength of the delivered force, activity pattern, sliding dstance. In addition it is influenced by various clinical factors of patients and it is accurately difficult to distinguish and measure the contribution level of each factor. In animal studies, the hard bipolar cup in the histological degeneration process of the acetabular articular cartilage delivers abnormal stress to the articular cartilage resulting in the increase of secretion of degenerative enzymes. These enzymes hydrolyse converted to lysosomal enzymes, which induces the loss of initial glucosaminoglycan, thus changing the biomechanical property of articular cartilages, softening them and causing them to lose elasticity.

Dalldorf et al. found that the progression in the severity of the degeneration after hemiarthroplasty correlated directly with the duration of articulation of the implant with the acetabulum. Such degeneration of articular cartilage becomes the cause of migration of the articular cartilages that is the major cause of the failure of bipolar hemiarthroplasty. The mean thickness of the acetabular cartilage is 1.0 – 3.3 mm. It is thought that all cartilages would show degeneration approximately 7-8 years after surgery, and the abrasion of the acetabular bone would be initiated and the risk of protrusion would be increased. It is thought that considering the life expectancy and activity of the patients who require hip arthroplasty , it could be determined whether to perform total hip arthroplasty or hemiarthroplasty, and the time to convert to total hip arthrplasty after bipolar hemiarthroplasty could be predicted by radiologically measuring the degeneration rate of the acetabular articular cartilage.

Measurement of acetabular erosion: The effect of pelvic rotation on common landmarks. R.G. Wetherel, A.A. Amis, F.W. Heatley from London state that the line drawn between acetabular margins are significantly more accurate for proximal migration, than teardrop, sacroiliac or sacroiliac-symphysis line. Line drawn tangential to the brim and through the horizontal mid-point of the obturator foramen is more accurate than Kholer`s line, ilio-ischial or iliopubic line. In combination the two lines can give more accurate assessment and they are less affected by the difference in rotation commonly found in plain radiographs.

Retrospective evaluation of bipolar hemiarthroplasty in fracture of the proximal femur study by Sakr Mazen, MD, Girard Julien, MD, Fakih Riad, MD state that the surgical treatment option that can lead to a best clinical and functional outcome. The results of hemiarthroplasty are initially better, on longtime survival the functional activities detoriates. Failure in the form of infection, dislocation, and perioperative death occurs earlier while increase in pain, loosening and acetabular erosion are responsible for late complications. The role of total hip arthroplasty for the treatment of displaced intracapsular fractures of proximal femur in active patients is controversial. Some authors have shown that such patients, when treated with a bipolar or unipolar hemiarthroplasty, are at increased risk of developing acetabular erosion that might require later revision to total hip arthroplasty.

MATERIALS AND METHODS:

Source of data:

This is a retrospective radiological and clinical study. The post hemiarthroplasty plain radiographs, showing AP view of hip joint taken in the Department of Radiodiagnosis, PSGIMS&R will be studied along with activity level assessment.

Mode of data collection:

By Convenient sampling method, all the patients undergone cemented bipolar hemiarthroplasty, for fracture neck of femur after minimum of 2 years were assessed both radiologically and clinically.

Inclusion criteria:

All patients operated for neck of femur fracture with cemented bipolar hemiarthroplasty after a minimum period of 2 years.

Exclusion criteria:

1.) Surgical site hip Infection.

2.) Any pre existing pathologies around the hip.

3) Previous hip surgeries.

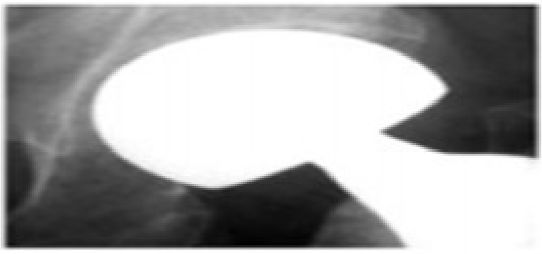
4.) Post-operative periprosthetic fractures.

5). Neurological conditions like CVA, Parkinsonism.

X-ray technique:

A plain anteroposterior view of the operated hip joint is taken and assessed for acetabular erosion grading following the technique of Sakr Mazen, MD, Girard Julien, MD, Fakih Riad, MD. Patient positioned in supine, using digital X-RAY, casette tube distance is set to 100cms and the beam is centered directly over the hip.

Radiological assessment[17]:

Grade	Radiographic Appearance
0 Normal	
1 Narrowing of articular cartilage; No bone erosion	
2 Acetabular bone erosion; Early migration	
3 Protrusio acetabuli	

Activity level assessment[36]**:**

Functional activity level was assessed by Modified UCLA scoring system.

MODIFIED UCLA SCORING SYSTEM

- 1. COMPLETELY INACTIVE, DEPENDENT ON OTHER AND CANNOT LEAVE THE RESIDENCE.
- 2. MOSTLY INACTIVE OR RESTRICTED TO MINIMUM ACTIVITIES OF DAILY LIVING
- 3. SOMETIMES GOING TO SOCIAL OUTDOOR ACTIVITIES OR VISITING NEIGHBOURS.
- 4. REGULARLY GOING TO SOCIAL OUTDOOR ACTIVITIES OR VISITING NEIGHBOURS.
- 5. SOMETIMES ENGAGING IN UNLIMITED HOUSE WORKS OR SHOPPING.
- 6. REGULARLY ENGAGING IN UNLIMITED HOUSE WORK OR SHOPPING.
- 7. REGULARLY USING STAIRCASE TO CLIMB.
- 8. LIFTING OR PLAYING WITH SMALL CHILDREN.
- 9. INVOLVING IN HEAVY LABOUR WORKS.
- 10. REGULARLY USING PUBLIC TRANSPORT.
- GOOD --- 7 TO 10
- FAIR --- 4 TO 6

  POOR --- BELOW 4

Results:

Data Analysis:

Data collected were entered in Excel Spread sheet and analyzed using STATA statistical software package release 11. We used the two-sided independent-samples t test to compare means across dichotomous variables (i.e. men v. women); the one-way ANOVA test for comparison of means across multilevel variables. Simple calculations like Percentages, Proportions and Mean values were derived. A type I error of 0.05 was considered in all analyses.

Total number of patient included in this study was 22. Total number of male patients 12, total number of female patients 10 and mean follow up age was 65 years. Right side hip involved was 11 and left side hipwas 11. The mean follow up period was 3.54 years. The mean modified UCLA score was 6.22.

The number of patients in Grade 0 and 1 acetabular erosion were 16 (72.70%) and in Grade 2 and 3 were 6 (27.30%).

The mean acetabular erosion when correlated with duration since surgery was statistically significant with P value of < 0.001. Grade 0 & 1 has a mean value of 2.81 years and Grade 2 & 3 has a mean value of 5.75 years. This shows there was increased acetabular erosion as the duration post surgery increases.

The acetabular erosion grade when correlated with modified UCLA score was not clinically significant with p value = 0.71. In acetabular erosion Grade 0 and 1 the modified UCLA score was 6.33 and in Grade 2 and 3 the modified UCLA score was 6.18. Since the sample size was small the significance could not be correlated statistically.

As the age of the patient increases there was a gradual reduction in activity.

Table 1: Total number of participants according to gender

Gender	Number of participants
Male	12
Female	10

Table 2: Total number of participants according to age:

Age in Deacades	**Number of participants**
60 – 69	9
70 – 79	11
80 – 89	1
90+	1

Table 3: Mean Modified UCLA score according to Gender

Gender	**N**	**Modified UCLA Score**
Men	12	6.08 ± 0.9
Women	10	6.4 ± 0.7

Table 4: Mean Acetabular Erosion Grade according to side affected

Hip Side	**Number of participants**
Left	11
Right	11

Table 5: Distribution of Patients according to Acetabular Erosion Grades

Acetabular Erosion Grades	**No. of Patients**	**%**
Grade 0 and Grade 1	16	72.70
Grade 2 and Grade 3	6	27.30
Total	22	100%

Table 6: Distribution of the study participants based on duration since surgery and Grades of acetabular erosion

Duration since surgery	**Number of study participants**	**Grades of acetabular erosion**	**Number**	**Percentage (%)**
< 4 years	18	0 and 1	16	88.9
		2 and 3	2	11.1
≥ 4 years	4	0 and 1	0	0
		2 and 3	4	100

Table 7: Mean duration since surgery (in months) according to Acetabular erosion grades

Acetabular Erosion Grades	**N**	**Duration since surgery**
Grade 0 and Grade 1	16	2.81 ± 0.32
Grade 2 and Grade 3	6	5.75 ± 2.36

P-value <0.001

Table 8: Mean Acetabular erosion grades according to duration since surgery (in months)

Duration since surgery	**N**	**Acetabular Erosion Grades**
< 4 years	18	0.67 ± 0.69
≥ 4 years	4	2.25±0.51

P-value <0.001

Table 8 and shows description about Mean Acetabular erosion grades according to duration since surgery (in months). This is statistically significant with P-value (<0.001) Erosion increases as the duration increases.

Table 9: Distribution of patients according to Modified UCLA score

Modified UCLA Score	**N**	**%**
5	5	22.73
6	7	31.82
7	10	45.45
Total	22	

Table 10: Mean Modified UCLA score according to Acetabular Erosion Grades

Acetabular Erosion Grades	**Modified UCLA Score**
Grade 0 and Grade 1	6.33± 0.83
Grade 2 and Grade 3	6.18 ± 0.82

P-value = 0.71(not significant)

Table 11: Mean Modified UCLA score according to Age in Decades

Age in Deacades	**N**	**Modified UCLA Score**
60 – 69	9	6.44 ± 0.73
70 – 79	11	6.18 ± 0.87
80 – 89	1	6 ± 0
90+	1	5 ± 0

Fig 1: Mean Modified UCLA score according to Age in Decades

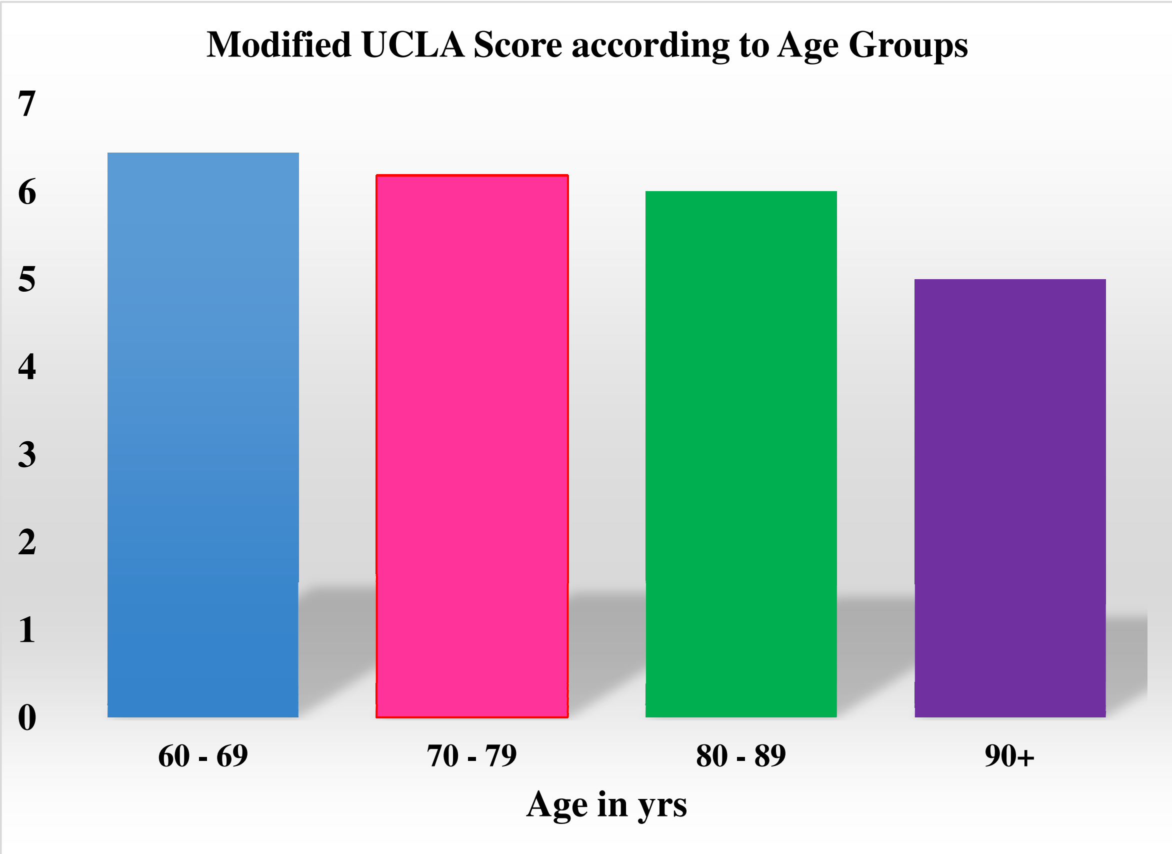


Table 11 and fig.1 shows description of Mean Modified UCLA score according to Age in Decades. As the age increases the activity level decreases.

Discussion:

Incidence of fracture neck of femur is increasing gradually, probably due to increase in life expectancy of individuals. The ideal treatment is still controversial. Two common procedures done for elderly people are hemiarthroplasty and total hip arthroplasty. Some people advocate primary total hip arthroplasty for neck of femur fracture in elderly (Ebramzadeh et al,) Total hip arthroplasty results in more functional activity level and lesser reoperative rates but has more morbidity.

Hemiarthroplasty is more economical especially in developing countries like India and has lesser morbidity, but has a higher reoperation rate when compared to total hip arthroplasty.

The long term complications of bipolar hemiarthroplasty are acetabular erosion, aseptic loosening and infection. Bipolar prosthesis is thought to have lesser incidence of acetabular erosion than unipolar prosthesis due to reduced movement occurring at acetabular prosthesis interface.

In this study we have tried to assess the acetabular erosion by radiological grading and functional outcome by modified UCLA scoring after a minimum period of 2 years after hemiarthroplasty.

Total numbers of patients assessed in this study were 22 and all underwent cemented bipolar hemiarthroplasty. The mean period of follow up was 42 months (range 2 years – 7 years). Six patients (27.30 %) had a moderate to severe acetabular erosion and sixteen patients (72.70 %) had minimal or no erosion. The grade of erosion was found to increase with follow up interval. With the follow up period of less than 4 years (18 patients) 16 patients (88.9%) had nil or minimal erosion and 2 patients (11.1%) had moderate to severe erosion. With follow up period of more than 4 years 4 patients had moderate to severe erosion. The mean follow up period in our study was 3.54 years and the significant accetabular erosion noted was 27.3% this could be compared with the study of Sakr Mazen, MD, Girard Julien, MD, Fakih Riad, MD, they had 33% erosion grade at the follow up period of 3 years.

In this study all the patient `s functional activity level were assessed by modified UCLA score, the mean modified UCLA score was found to decrease with increase in the age of the patients. Due to small study group the correlation of the modified UCLA score and acetabular erosion was not statistically significant. One patient who had the longest period of follow up and maximum grade of acetabular erosion had a good level of functional outcome with modified UCLA score of 7. The pain did not restrict her functional activity.

T.W. Philips, London in his study found that the factors that had highest correlation were the level of physical activity and duration of follow up.

Kyoung Ho Moon et al, also found in their study that the progression of acetabular erosion correlated directly with the duration of articulation of the prosthesis within the acetabulum and this degeneration of articular cartilage becomes the cause of migration of bipolar cup, which is the major cause of failure of cemented bipolar arthroplasty. They also found the cause of degeneration to be multifactorial and it is accurately difficult to distinguish and measure the contributory level of each factor. They also found that all acetabular cartilage will show degeneration approximately 7 to 8 years after surgery.

In our study all the 4 patients who had a follow up of more than 7 years had significant acetabular erosion. Hence the choice of total hip arthroplasty or a hemiarthroplasty in a fracture neck of femur may be determined by the life expectancy and the activity of the patient.

Conclusion:

By this study we suggest an easy and effective way of evaluating acetabular erosion and clinical activity.

There is significant increase in acetabular erosion as the duration after surgery increases.

The clinical activity is by and large not significantly altered as the erosion progress at mid-term follow up.

Limitations of the study:

Small study group and a short period of follow up

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MASTER CHART

S. NO	PATIENT NAME / I.P. NO	AGE	SEX	SIDE OF HIP	DATE OF SURGERY	IMPLANT USED	DURATION SINCE SURGERY	POST OP COMPLICATIONS	PATIENT CURRENT SYMPTOMS	MODIFIED UCLA SCORE	ACETABULAR EROSION GRADE	ASSOCIATED HETEROTROPHIC OSSIFICATION	X- RAY
1	A	65 YRS	M	RIGHT	08.10.10	BIPOLAR HEMI.	3 YEARS	NIL	NIL SIGNIFICANT	7	0	NIL	
2	B	63 YRS	F	LEFT	21.10.10	BIPOLAR HEMI.	3 YEARS	NIL	NIL SIGNIFICANT	6	1	NIL	
3	C	68 YRS	F	LEFT	29.11.10	BIPOLAR HEMI.	3 YEARS	NIL	NIL SIGNIFICANT	6	1	YES	
4	D	69 YRS	F	LEFT	23.12.10	BIPOLAR HEMI.	3 YEARS	NIL	MILD PAIN	7	0	NIL	
5	E	73 YRS	F	RIGHT	25.1.11	BIPOLAR HEMI.	3 YEARS	NIL	NIL SIGNIFICANT	6	1	NIL	
6	F	74 YRS	M	RIGHT	25.2.11	BIPOLAR HEMI.	3 YEARS	NIL	MILD PAIN	7	0	NIL	
7	G	73 YRS	M	RIGHT	26.2.11	BIPOLAR HEMI.	3 YEARS	NIL	MILD PAIN	7	0	NIL	
8	H	60 YRS	F	LEFT	02.03.11	BIPOLAR HEMI.	2 1/2 YRS	NIL	NIL SIGNIFICANT	7	0	YES	
9	I	76 YRS	F	LEFT	17.06.11	BIPOLAR HEMI.	2 1/2 YRS	NIL	NIL SIGNIFICANT	7	0	NIL	
10	J	62 YRS	M	LEFT	18.06.11	BIPOLAR HEMI.	2 1/2 YRS	NIL	NIL SIGNIFICANT	7	0	NIL	
11	K	73 YRS	F	RIGHT	09.06.06	BIPOLAR HEMI.	8 YRS	NIL	MILD PAIN	7	3	NIL	
12	L	85 YRS	M	RIGHT	06.08.06	BIPOLAR HEMI.	7 YRS	NIL	NIL SIGNIFICANT	6	2	YES	
13	M	70 YRS	M	LEFT	16.10.06	BIPOLAR HEMI.	7 YRS	NIL	NIL SIGNIFICANT	7	2	NIL	
14	N	65 YRS	F	LEFT	25.01.90	BIPOLAR HEMI.	7 YRS	NIL	NIL SIGNIFICANT	7	2	NIL	
15	O	76 YRS	M	LEFT	23.08.10	BIPOLAR HEMI.	3 YEARS	NIL	NIL SIGNIFICANT	6	0	NIL	
16	P	78 YRS	F	RIGHT	6.1.09	BIPOLAR HEMI.	3 YEARS	NIL	MILD PAIN	5	1	NIL	
17	Q	78 YRS	M	RIGHT	9.8.10	BIPOLAR HEMI.	2 YRS	NIL	MILD PAIN	5	1	NIL	
18	R	71 YRS	M	LEFT	26.1.11	BIPOLAR HEMI.	2.5 YRS	NIL	MILD PAIN	5	2	NIL	
19	S	76 YRS	M	RIGHT	19.4.10	BIPOLAR HEMI.	3.1 YRS	NIL	MILD PAIN	6	1	NIL	
20	T	94 YRS	M	LEFT	5.7.12	BIPOLAR HEMI.	2.4 YRS	NIL	MILD PAIN	5	1	NIL	
21	U	64 YRS	M	RIGHT	11.10.10	BIPOLAR HEMI.	3 YRS	NIL	MILD PAIN	5	1	NIL	
22	V	68 YRS	F	RIGHT	17.6.10	BIPOLAR HEMI.	3 YRS	NIL	MILD PAIN	6	2	NIL	