# FUNCTION OUTCOME ANALYSIS WITH REGARDS TO CUP INCLINATION, FEMORAL AND ACETABULAR VERSIONS IN TOTAL HIP ARTHROPLASTY

**Dissertation submitted to**

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# CERTIFICATE

This is to certify that this dissertation titled **"FUNCTION OUTCOME ANALYSIS WITH REGARDS TO CUP INCLINATION, FEMORAL AND ACETABULAR VERSIONS IN TOTAL HIP ARTHROPLASTY"** is a bonafide record of work done by **DR.G.N.SUKUMAR,** during the period of his Post graduate study from June 2017 to June 2019 under guidance and supervision of **Prof.B.Pasupathy, D.ortho, M.S.ortho., DNB.ortho, MNAMS,** in the Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-600003, in partial fulfillment of the requirement for **M.S.ORTHOPAEDIC SURGERY** degree Examination of The Tamilnadu Dr. M.G.R. Medical University to be held in May 2020.

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# DECLARATION

I declare that the dissertation entitled **"FUNCTION OUTCOME ANALYSIS WITH REGARDS TO CUP INCLINATION, FEMORAL AND ACETABULAR VERSIONS IN TOTAL HIP ARTHROPLASTY"** submitted by me for the degree of M.S.Orthopaedicsis the record work carried out by me during the period of **June 2017 to June 2019** under the guidance of **Prof.B.PASUPATHY, D.Ortho, M.S.Ortho., DNB(ortho), MNAMS,** Professor of Orthopaedics, Institute of Orthopaedics and Traumatology, Madras Medical College, Chennai.

This dissertation is submitted to the Tamilnadu Dr.M.G.R. Medical University, Chennai, in partial fulfillment of the University regulations for the award of degree of M.S.ORTHOPAEDICS (BRANCH-II) examination to be held in May 2020.

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# CONTENTS

# INTRODUCTION

In medical nomenclature, arthroplasty refers to reconstruction of a joint.

Even though various procedures like osteotomy, Excisional arthroplasty, Arthrodesis, hemiarthroplasty are available for various hip pathology, it still poses a formidable task for the orthopaedician to give stable hip.

Excision arthroplasty gives pain free hip, but at the expense of producing an unstable gait. The osteotomy is useful in early stage of unilateral hip pathology especially in young adult; its use is limited in end stage arthritis of hip. Arthrodesis gives a pain free stable joint at the expenses of producing much strain on the lumbar spine and knee joint. Hemiarthroplasty is appropriate in elderly individual as the acetabular cartilage undergoes early wear on articulation with metal. It is unsuitable for patient with involvement of acetabulum.

Considering all factor, total hip replacement has as a treatment of choice in patient with arthritis of hip and neck of femur fracture in young patients. It has overcome most of the drawbacks encountered with other procedures.

First prosthetic total hip arthroplasty was done by wiles in 1938. But lot of failures encountered due to poor implant designs and materials. Sir John Charnley first introduced a new concept of low-friction arthroplasty and low friction torque arthroplasty [1].

After the introduction of this concept, new advances have made in THA to avoid failures. For example cementing techniquesin THA.

Furthermore gamma radiation and ultra-high molecular- weight polyethylene (UHMWPE) are introduced to induce crosslinking [1]. The UHMWPE has improved wear characteristics compared to conventional polyethylene [2]. Like this, lot of improvements in every step, implants, surgical techniques and the overall success of this proceduregained a name “Operation of the 20th Century” in 2007 [1].

Total Hip Arthroplasty is very successful in controlling pain, functional limitations of patients [3]. Patients physical health improves significantly in immediate post op period. Pain reduces dramatically within a short post op period. Long-term studies also there will be very good results which prove that these improvements are not short lived. Not only in physical health, and also in mental and social health improvements have been seen after a total hip arthroplasty [3].

Assessment of the acetabular cup and femoral stem position includes anteversion and inclination. Anteversion is defined as the angle between the acetabular axis and the transverse axis. Inclination is the angle between the acetabular axis and the longitudinal axis [(5)]. "Safe zone" concept for cup version and inclination was first introduced by Lewinnek et al [(6)]. Following that lot of studies have conducted to find the optimal orientation, and concluded that 5° to 35° of anteversion and 25° to 55° of inclination is accepted[(4)]. Ranges outside this considered as malposition. This safe zone range is very important in dislocation and long term survival of implants[(6)].

The dislocation rate and good movements of hip are mainly depends on acetabular cup and femoral component.

# AIM OF THE STUDY

Aim of this study is TO ANALYZE THE FUNCTIONAL OUTCOME IN TOTAL HIP ARTHROPLASTY PATIENTS IN RELATION TO CUP POSITIONING AND FEMORAL VERSIONS BY RADIOLOGICALLY BY CT MEASUREMENTS AND CLINICALLY BY HARRIS HIP SCORE.

# REVIEW OF LITERATURE

The main aim of the surgery called arthroplasty was to make the ankylosed joint mobile.In essence, an arthroplasty means to create or reconstruct a joint, to include the restoration, as far as possible, of the integrity and functional power of a diseased joint.

To be successful, **the stability** of the joint must be maintained or restored. The **GOAL OF THR** isto restore the center of rotation of hip joint so that to made the joint biomechanically sound and stable.

In 1891, Professor Themistocles Gluck presented the use of ivory to replace femoral heads of patients whose hip joints had been destroyed by tuberculosis.[10]

In Excisional arthroplasty the bone surfaces of the joint are resected and the space will be allowed to fill by a fibrous tissue. The result will be an unstable joint and a shortened limb.

In 1917 **William Baer**experimented with interpositional arthroplasty, which involved pig bladders submucosabetween articulating hip surfaces of the arthritic hip[8].In Interposition arthroplasty, the joint is reshaped by various techniques and then a prosthetic implant is inserted between the two sides of the joint to prevent ankylosis.

**Chronologic Insight to Interposition Materials and Performing Surgeons**

| Surgeons | Year | Interposition Material |
|---|---|---|
| J. M. Carnochan | 1840 | Block of wood |
| A. S. Verneuil | 1860 | Soft tissue |
| L. Ollier | 1885 | Periarticular soft tissue |
| H. Helferich | 1893 | Pedicle flap of muscle |
| J. E. Pean | 1894 | Thin platinum plate |
| Foedre | 1896 | Pig's bladder |
| J. B. Murphy | 1902 | Fascia lata |
| Hofman | 1906 | Periosteum |
| Lexer | 1908 | Fascia |
| R. Jones | 1912 | Gold foil |
| Loewe | 1913 | Skin |
| Baer | 1919 | Chromicized submucosa of pig's bladder |
| Putti | 1920 | Fascia lata |

From Heybeli N, Mumcu, E. Total hip arthroplasty (history and development). *SDU Tip Fakultesi Dergisi*. 1999;6(4):21–27.

Smith-Petersen of Boston began working on other materials to use for arthroplasties of the hip in 1923. At first he tried using cups made of glass, which broke; then cups of Bakelite, an early plastic material that also failed. He achieved success 15 years later with the adoption of cups made of Vitallium, the first nonreactive metal alloy to be used in orthopaedic surgery(7).“Mold arthroplasty,” as Smith- Petersen called his operation, was carried out through his anterior and lateral incision and consisted of a revision of both the head of the femur and the rim of the acetabulum. Smith-Petersen's Mold arthroplasty became the method of choice for hip arthroplasty.

The most sophisticated interposition arthroplasty procedure was devised by Bateman, who developed the bipolar Prosthesis[9]. Like the mold arthroplasty, the bipolar prosthesis provides two surfaces for motion.

In 1938, Philip Wiles used acetabular and femoral components made of stainless steel in hip replacements[11]. The acetabulum was screwed with the pelvis and the femoralcomponent fixed with plates and screws..

In John Charnley's most important concept of the low-friction arthroplasty he greatly reduced the head size to improve frictional torque [14, 15].

Charnley was able to popularize the use of methyl methacrylate cement for fixation of total hip prostheses in the 1950s[15].Cement was introduced antegrade and little attempt was made at pressurization with the exception of finger-packing the cement. This technique resulted in poor penetration of the bone and loosening. An understanding that cement is not a glue, but rather a grout, led to improved techniques.

In a reaction to problems, efforts were made to promote a more biologic fixation by eliminating the cement altogether and providing a stem with a porous surface allowing for bone ingrowth. Pilliar and Galante's research groups were pioneers in the study of this approach[16].

The use of uncemented implants, both for the stem and for the acetabular components, has placed a high premium on technical skill and has made the procedures much more precise.

Several investigators believed the premature loosening was caused by "cement disease"[17, 18]

Cementless femoral and acetabular components were introduced to address the problem of fixation failure of cemented polyethylene acetabular components[19].

Metal-on-metal bearing surfaces were first used in the 1960s[20]. Metal bearings have low wear rates in the region of 0.004 mm/yr. compared with 0.1 mm/yr. for polyethylene[21]. Use of a metal bearing surface has additional advantages including thinner components, large head diameter, enhanced joint stability, and improved range of motion to neck impingement on the cup. In the last decade, there was a renewed interest in metal-on metal bearing surfaces because of their low wear rates and improved dislocation rates. However, there is tremendous concern for the generation of metal ions, including cobalt and chromium, which are detectable systemically.

Bone-conserving femoral implants were developed to preserve femoral head and neck bone stock. Refinement of implant designs from the 1970s has improved the results of hip resurfacing.

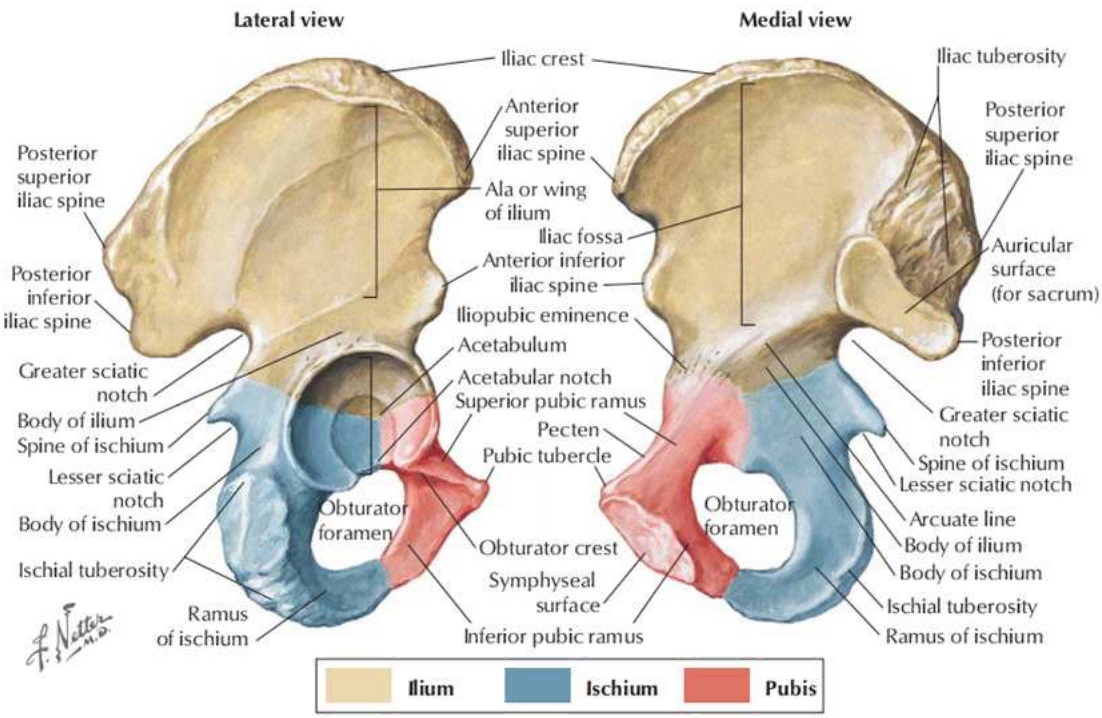
Patient expectations after total hip arthroplasty have changed, with younger patients putting greater demands on surgical techniques, recovery, and implant longevity.

Today, the field of hip arthroplasty has moved beyond a relatively simple goal of improvement in pain scores, to a field that is striving to meet the goals of patients who demand a high-activity, high-quality of life. Modern technology is attempting to deliver implants and skills that can accommodate these expectations, but not without a cost. Many studies have done till now to improve our technical skills in placing the cup and femoral components which are invariably related to functional outcome of this procedure.

# GROSS ANATOMY OF THE HIP JOINT

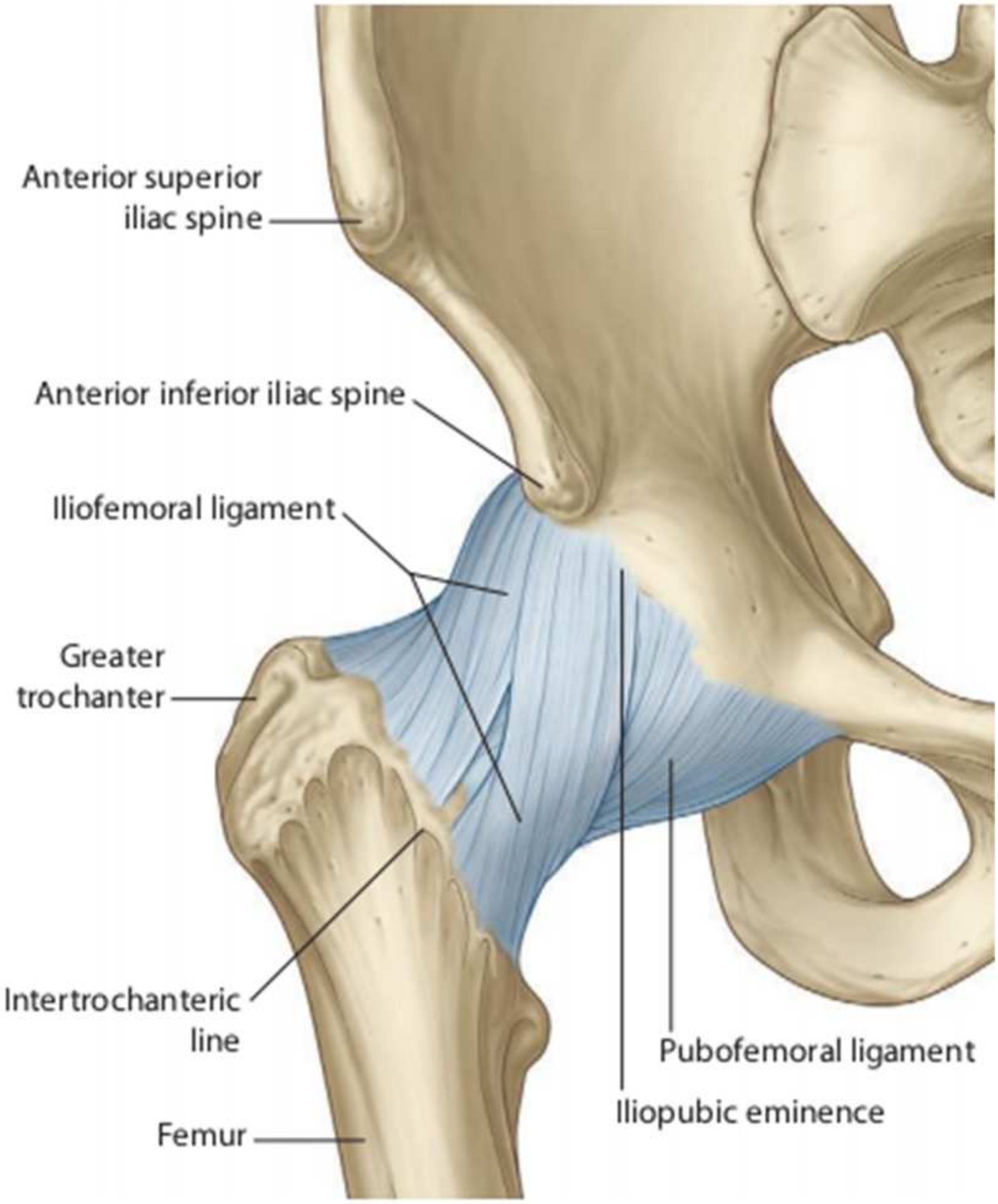
## HIP ANATOMY

The hip joint is a type of ball-and-socket joint which allows a wide range of motion. The acetabulum and the femoral head are the osseous constituents of a normal hip.




The acetabulum forms fromilium, pubis and ischium which are collectively known as triradiate cartilage. This gives rise to the anterior wall, posterior wall and the dome of the acetabulum. On the lateral aspect, it forms a circumferential lip of hyaline cartilage centrally and fibrocartilage on the periphery [22]. During maturation, this cartilaginous cup covering 170$^{o}$ of the femoral head [23].

The triradiate cartilage closes between 14 to 16 years of age [22]. The acetabulum has an average diameter of 52 ± 4 mm and men tend to have larger cup diameters compared to women. Average anteversion of the native acetabulum measures $16^o$ to $21^o$ with an average inclination of $48^o$ [22].



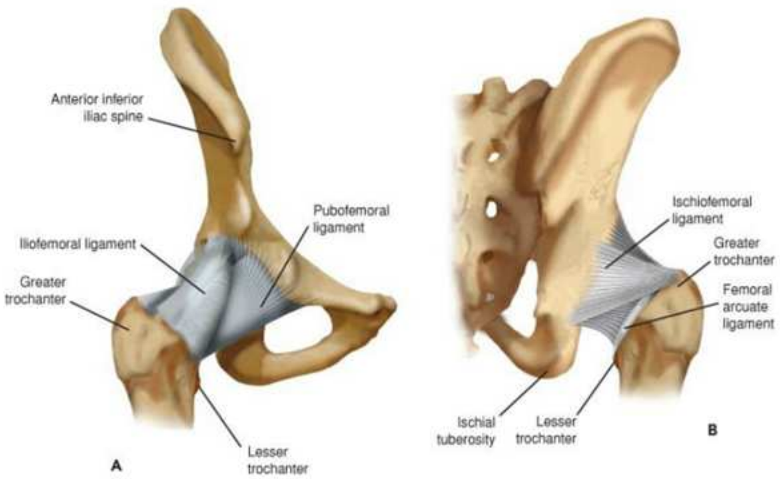
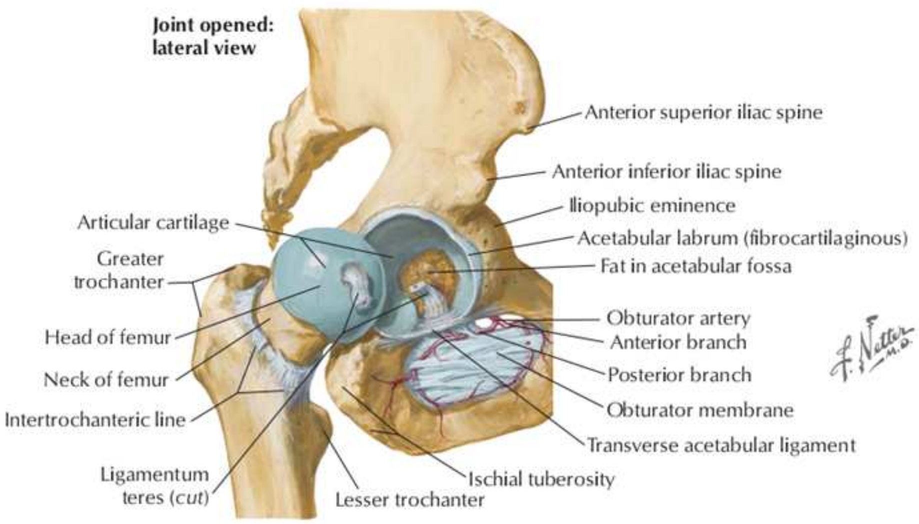



**Figure 11.2.** Capsular ligament anatomy of the hip. Anterior **(A)** and posterior **(B)** views of the extracapsular hip ligaments. (Redrawn from Hewitt JD, Glisson RR, Guilak F, et al. The mechanical properties of the human hip capsule ligaments. *J Arthroplasty*. 2002;17:82–89.)

The transverse acetabular ligament (TAL)forms a tension band which prevents deformation of the acetabular wall from the transmitting force[22]. The acetabulum is supported anteriorly and posteriorly by two strong columns of bone which allows force transmission between the trunk and the lower extremity [22]. The cartilage is normally deficient medially and inferiorly in the acetabulum forming a horseshoe shape. Centre of the acetabular fossa is a central cavity is called as pulvinar.

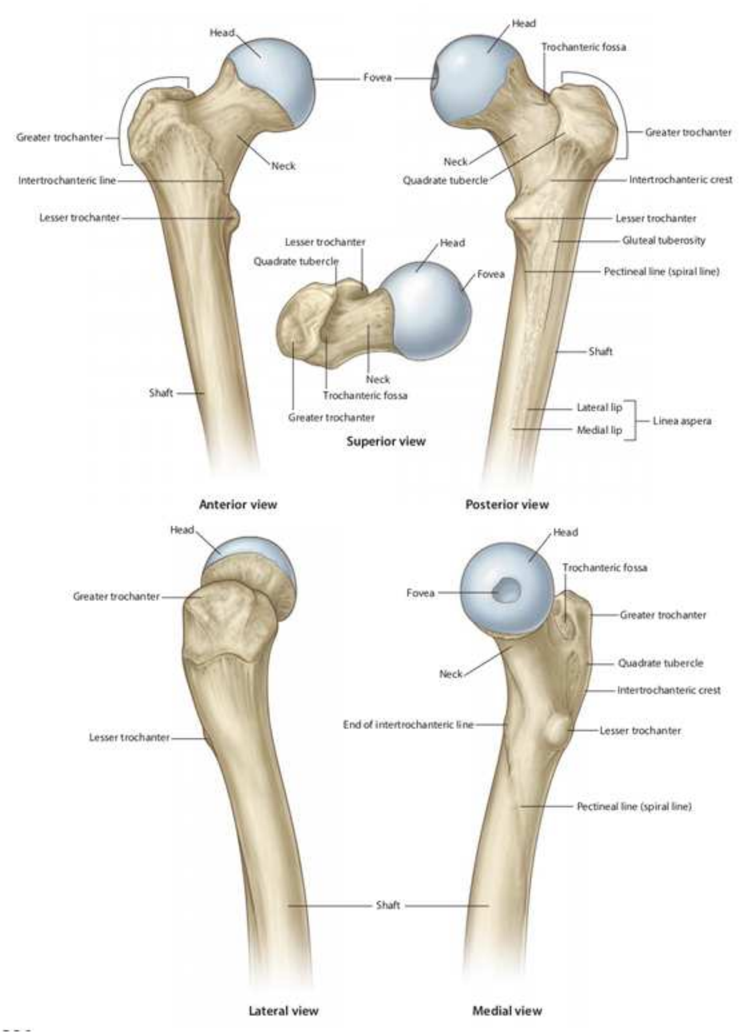


The Ligamentum Teres Femoris, which is attached into the antero-superior part of the fovea is  a triangular in shape. It became tense when the hip is semi flexed, adducted and externally rotated. It is relaxed when the limb is abducted. It connects the acetabulum to the fovea of the femoral head. It has been hypothesized to be a pain generator and instrumental in synovial fluid distribution and stability [22].

The ilio-femoral ligament of Bigelow is the strongest ligament in the body, lies in anterior to the joint. It is attached, above, to the lower part of the anterior inferior iliac spine and below, it divides into two bands, one of which passes downward and is fixed to the lower part of the intertrochanteric line; the other is directed downward and lateralward.

The pubo-femoral ligament is attached, superiorly, to the obturator crest and the superior pubic ramus and below, it attaches with the capsule. The Ischio-femoral ligament attaches from the ischium below and behind the acetabulum and blend with the circular fibres of the capsule.

The proximal femur consists of the femoral head, femoral neck, greater trochanter and lesser trochanter. The normal femoral anteversion is of 10.5 ± 9.22 degrees [22]. The normal neck-shaft angle is125 to 135 degrees [23]. Normally the lesser trochanter is retroverted 31.5 degrees [23].




The spherical shaped femoral head is attached with the ligamentum teres at its fovea. The capsule surrounds the hip joint [22] and provides stability to the joint, and also carries the blood supply [23]. It originates on the lateral aspect of the acetabulum and inserts on the intertrochanteric region of the proximal femur. It consists of longitudinal fibers of iliofemoral, ischiofemoral, and pubofemoral ligaments [23].

Thezone orbicularis forms the inner layer of the capsule[23]. 27 muscles surround the hip joint, which helps in dynamic stability. Additionally other muscles include anteriorly situated hip flexors and posteriorly located hip extensors. The abductors, including gluteus medius, gluteus minimus and tensor fascialata, are located on the lateral aspect of the joint and adductors in the medial compartment. External rotators and internal rotators also constitute the muscle layers surrounding the hip.

**BLOOD SUPPLY**

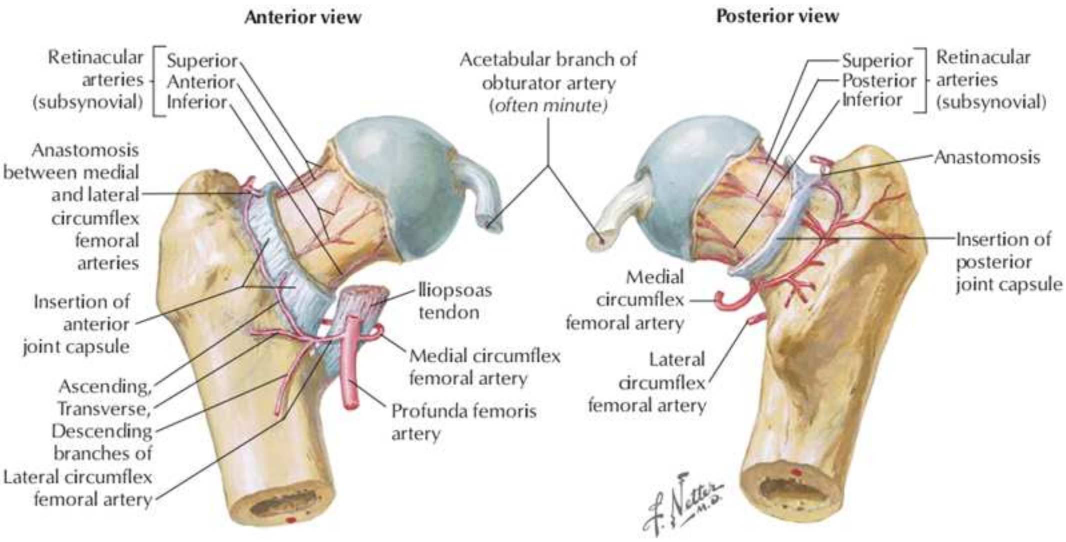
Crock described the arterial supply of the proximal femur into 3 groups as follows

1) The extra-capsular arterial ring at the base of femoral neck.

2) The ascending cervical branches of extra-capsular arterial ring on the surface of the femoral neck.

3) The arteries of the round ligament.

**Figure 17-4: Blood Supply to Femoral Head**



Abranch of medial circumflex femoral artery and lateral circumflex femoral artery with the superior and inferior gluteal arteries forms the extra capsular arterial ring.

At the intertrochanteric line the ascending cervical branch penetrates the joint capsule and passes upward giving rise to retinacular arteries. This gives additional blood supply to the metaphyseal region. Thisexplains the absence of avascular changes in the femoral neck as opposed to the head.

The ascending cervical arteries are divided into four groups based on their relation to the neck of femur - anterior, posterior, medial and lateral. Lateral branch is the main branch which supplies most of the femoral head and neck. At the margin of articular cartilage of the femur, these vessels form a second ring – the sub-synovial intra-articular ring, which can be complete or incomplete.

The artery of ligament teres is a branch of obturator artery or the medial circumflex femoral artery. This arterial supply is often inadequate to provide nourishment to the femoral head.

## VENOUS DRAINAGE OF HEAD AND NECK OF THE FEMUR

The venous outflow from femoral head and neck is by lamina capsular veins which may be double or single and pass infero-medially along the trochanteric line and towards the obturator foramen to drain into the obturator vein. There is no venous drainage through the ligamentum teres.

# ANATOMY OF HIP AS PERTINENT TO TOTAL HIP REPLACEMENT

## FEMUR

The anteversion, neck shaft angle and the relation of femur are of importance as regards to the upper femur.

## ANTEVERSION

The anteversion is the angle at which the faces in the coronal plane with reference to the long axis of the femur. Normal anteversion is $5^{o}$ -$20^{o}$ degrees.

## NECK –SHAFT ANGLE

This is the angle formed between the line drawn along the long axis of the femoral shaft and the line drawn along the center of the head and neck. Normal range is $125^{o}$-$135^{o}$. Angle more than $135^{o}$ is called as coxa valga and below $125^{o}$ is called as coxa vara.

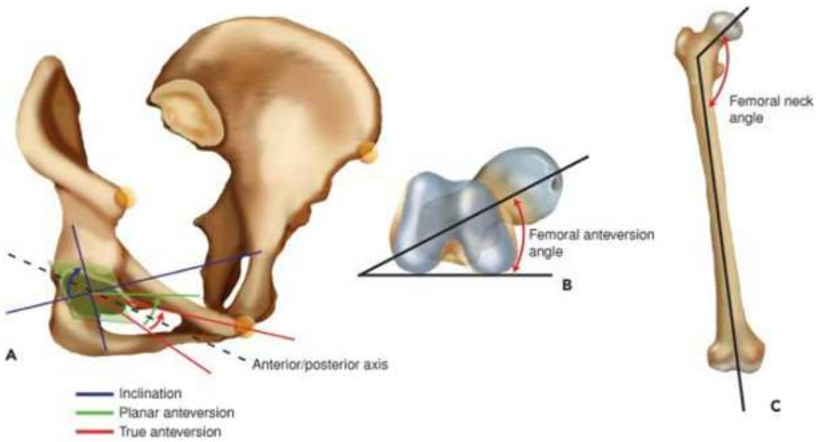



**Figure 11.1.** Pelvic and femoral version. **A:** True acetabular anteversion is the angle between the anterior/posterior axis and the interception line of transverse plane and the cup opening plane. Planar anteversion is the complement to the angle between the normal axis of the cup opening plane and the anterior/posterior axis. Inclination is the angle of the cup rotated along the anterior/posterior axis with respect to the medial/lateral axis (*dashed line* through both hips). The anterior/posterior axis is perpendicular to the frontal pelvic plane formed by two ASIS and pubic symphysis. **B:** Femoral anteversion is the inclination of the femoral neck axis with reference to the retrocondylar line. Viewing along the long axis determined by the best-fit cylinder of the femoral shaft, the neck axis is defined as the centerline of the femoral head and neck model. The

**ACETABULAR VERSION**

The acetabular version, anteversion is $15^{o}$+/-$10^{o}$ and the optional acetabular inclination is $45^{o}$to improve the stability.

**ACETABULAR DEPTH**

Normal acetabulum is spheroidal with a considerable depth. But in patients with Developmental Dysplasia of Hip or septic dislocation of childhood, the acetabulum slopes out leaving a shallow acetabulum. All attempts must be made to locate the true acetabulum and deepen it to sufficient depth to reach the true anatomical and mechanical axis.

**ACETABULAR WALL THICKNESS**

The acetabular wall is not equal in all around. It is thin inferomedially. The thickest portion is the pelvic flare. Articular cartilage in the acetabulum present in a horse shoe shaped area which has to be denuded for cementing the cup.

**MOVEMENTS OF THE HIP**

The hip joint is a ball and socket joint that allows movements in a multidirectional pattern.

1. Flexion – Anteriorly,
2. Extension – Posteriorly,
3. Abduction – Laterally,
4. Adduction – Medially,
5. Rotations – Internal rotation, External rotation,
6. Circumduction - combination of the above movements.

**FLEXION**

In flexion, the thigh comes towards the trunk, the femoral head rotates with the transverse axis which passes through both acetabular fossa. Important muscles for flexion are Iliopsoas - supported by Rectus femoris, sartorius and pectineus. This movement stopped when the thigh is on the trunk and by the hamstrings when knee is in extension. Normal flexion in hip joint is about 120° - 130$^{o}$.

**EXTENSION**

Opposite movement of flexion. Main muscle responsible to carry this movement is Gluteus maximus. Ileo-femoral ligament limits the extension.

Normal range of extension is 5° - 20°.

**ADDUCTION**

This is a coronal plane movement. The femoral head rotates in the acetabulum over an anteroposterior axis. Important muscles arePectineus,adductor longus, adductor magnus, gracilis. It is limited by the tension of the gluteus medius and gluteus minimus. Normal range is 25$^{o}$ – 35$^{0}$.

**ABDUCTION**

This coronal plane movement is the opposite movement to adduction and is brought about by gluteus medius and minimus assists by piriformis. It is limited by tension on the adductors and pubo- femoral ligament. Normal range is 40° - 45°.

## EXTERNAL ROTATION

This is carried out with hip and knee at $90^o$ flexion and rotating the foot towards the opposite side or by log rolling. Gluteus maximus is the main external rotator. The gluteus medius, minimus, piriformis, obturator internus, gamelli and quadratus femoris are the short external rotators. Normal external rotation is about $40^o$-45° as measured in both extension and flexion of the hip.

## INTERNAL ROTATION

Internal rotation occurs with the hip and knee flexed to $90^o$, the leg being rotated in the opposite direction to external rotation and is brought by anterior fibers of gluteus medius and minimus.

Normal range is 40°-$45^0$ in flexion and $30^0$-$35^0$ in extension.

## BIOMECHANICS OF HIP JOINT

The hip joint is a ball and socket joint and the stability is maintained by

- Bony structures
- Ligaments around hip
- Muscles attaching around hip joint,

The abductor muscles are the main stabilizers of the pelvis in coronal plane. Body weight and the tension in the abductor muscles are the total compressive force acting on the hip joint. The bony structures maintain the stability in walking, change of postures from sitting to standing and vice versa.

In, 1807, von weyer the anatomist, culman an engineer developed the stress trajectorial bone theory after comparing the trabecular patterns of cancellous bone between the neck of femur and the fairbrain cane.

During double leg stance the force acting on the hip can be estimated by the proportional distribution of body weight. Each leg equals $1/3^{rd}$ total body weight. So, during simple double leg stance each hip is subjected to a compressive force of about $1/3^{rd}$ total body weight.

Paul calculated the forces acting across femur head, like direction and magnitude in walking. Under normal circumstances, maximum compressionforceis actingon the medial aspect of the neck. There is no tension force in the neck at rest. On loading conditions tension force produced in the lateral and superior aspect of femur neck. Hence, compression is the major force in proximal femur with tension only in abnormal conditions. In the low friction joint the multi axial movement makes the tension in neck less negligible.

## FACTORS ACTING ON HIP JOINT

The factors acting on hip joint are

1. Body weight

2. Muscle forces around hip

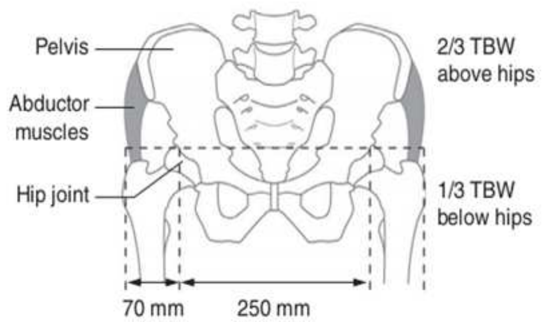



**Fig. 6.3 The anatomical relationships between the hip joint, abductor muscles and the pelvis**. Measurements provided are typical for an adult and are based on anthropometric data. During a double-leg stance, the centre of gravity of the supported upper body is in the midline and passes behind the pubic symphysis. (TBW= Total body weight.)

During running and climbing, forces acting on the hip joint are five times of body weight[24].

Externally actingforces and moments are balanced by forces and moments acting internally like muscle contraction, soft tissue tension and articular reaction forces [24].

The force exerted by the movements across joint is described, in terms of magnification factor to body weight.

One leg standing = 2.5 times of body weight on the joint

One leg support with cane in opposite hand → force in thejoint = body weight

Standing with 2 legs → force = ½ of body weight to each joint

Running → force = 5 times of body weight.

**FORCES ACTING ON HIP**

In normal joint, stress distribution depends on the magnitude and direction of resultant force transmitted through the joint. Shear forces are negligibly small in normal joint because of the extremely low coefficient of friction.

Load on the hip joint is a combination of body weight, activity level, muscular force and the lever arm which acts betweencenter of gravity of the femoral head and the body.

The force acting over the head creates compressive stresses on the medial aspect of the neck and tension stresses on the anterior aspect of the neck. In simple walking, this force acts on the hip alteringanterior to posterior and posterior to anterior. This gives a torsional force effect on the stem.

The total load created on the hip joint is more by the abductor muscle than by the body weight. The ratio of the length of abductor level arm to that of the body weight lever arm is 2.5: 1.

The load and the direction of force acting over the femoral head prosthesis varies with

1. The change in the length of center of rotation to mid line of the body
2. Length of the trochanter to center of prosthesis head
3. Perpendicular distance from center of prosthesis head to axis of femur(Offset of the prosthesis)
4. Varus or valgus alignment of the prosthesis in femur.

**CENTRALISATION OF HEAD AND CHANGES IN LEVER ARM:**

If the site of fulcrum changes from a ratio 1:1 to 1:3 the abductor force has to rise to maintain equilibrium.Load on fulcrum also rises.

The lever arm of abductor may be shortened in arthritis. In these situations the ratio of lever arm of the body weight and abductors may be 4:1 and hence increase the total load on the hip.

Charnley recommended the shortening of body weight lever arm by deepening of the acetabulum [centralization of femoral head] and lengthening of abductor mechanism. This will decrease the total load on the hip by as much as 30%.

Deepening of acetabulum should not be more than 0.5 cm. when the femoral prosthesis had been implanted in exaggerated in valgus, it will decrease the moment of bending and increases proportionately the axial loading of the stem. However valgus portion shorten lever arm of abductor mechanism and so more abductor force will be required.

A varus position even though increases abductor lever arm must be avoided since it increases shear forces hence risk of loosening and stem failure.

In reconstruction of the hip, following dimensions can be modified by the surgeon.

1. Length of the body weight lever arm.
2. Length of the abductor lever arm.
3. Offset of the prosthesis.
4. Varus or valgus alignment of the prosthesis in femur.

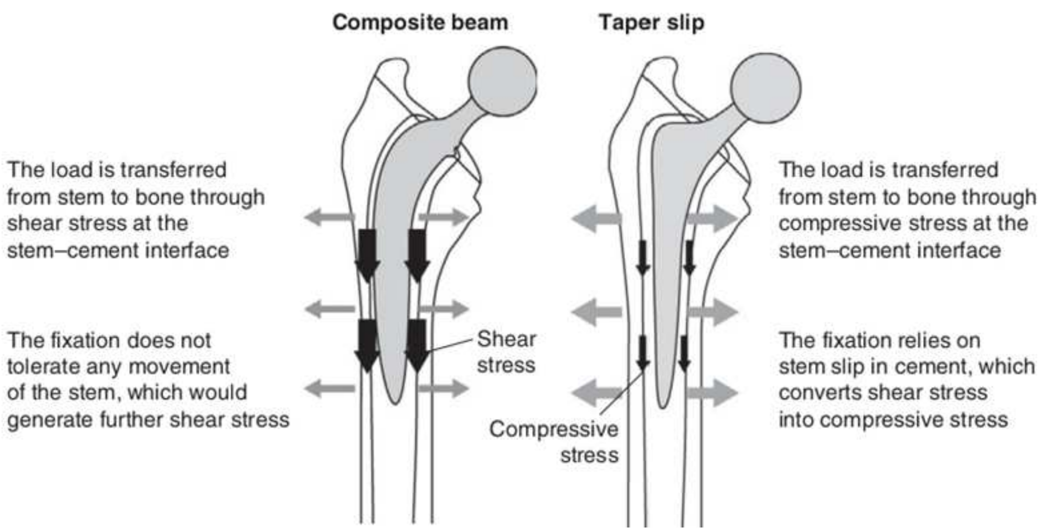
**IN CEMENTED FIXATION**

Implants fixed with bone by using cement gives stability to the construct immediately. As Cement acts as grout and not as an adhesive, there is no renewal of bonding at cement bone interface which leads to decrease in the quality of fixation.

Femoral stem implant design:

1. Composite beam

2. Taper slip




**COMPOSITE BEAM**

This has small protrusion, a collar, at the level of femoral calcar, a pre-coated, roughened fixation surface and a cylindrical profile throughout its length. Proximal calcar helps in prevention of distal sinkage of the stem. Rough surface helps in maximum bonding between stem and cement.

The collar helps in load transmission from stem to the femoral calcar, which is the natural way of load transmission in the proximal femur. The load transferred to the femur by shearstress at the bone cement interface.

## TAPER SLIP STEM

It is a collarless, highly polished surface stem. This prevents stem to be bound with cement. The stem therefore re engaging its taper end in cement which converts it as a more stable fixation. This converts shear stress into radial compression of cement.

## IN CEMENTLESS FIXATION

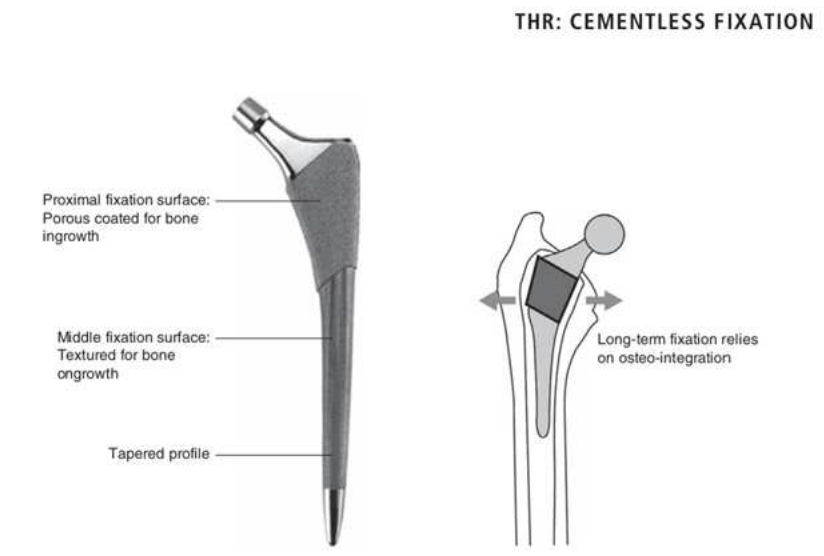



**Fig. 6.9 Design features of a typical cementless fixation femoral stem implant.** (Image is reproduced with permission of Smith & Nephew.)

**Fig. 6.10 Load transfer from stem to bone in cementless fixation femoral stem.** The stem is designed to transfer load mainly at the metaphyseal section as shear stress at the implant–bone interface.

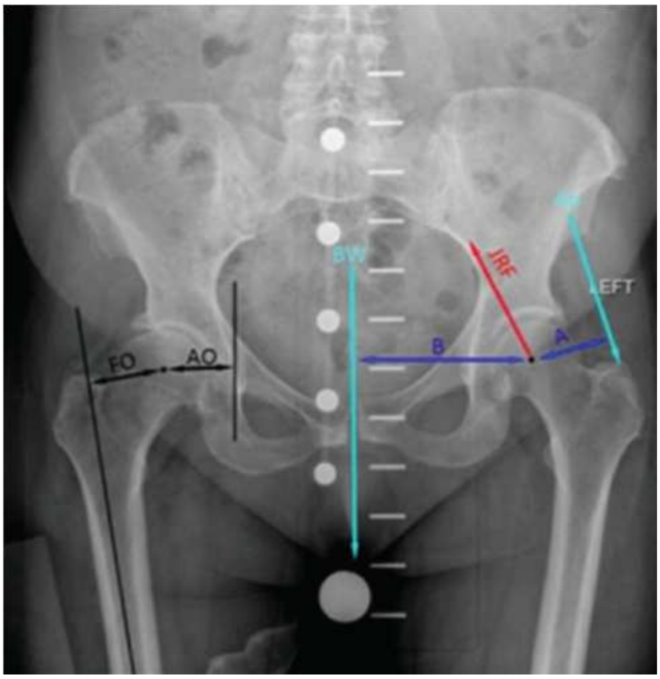
In this the stem has a porous surface or biologically active materials on its surface. The stem is designed to transfer load mainly at the metaphyseal section as shear force.

**ALIGNMENT OF THE COMPONENTS:**

Alignment is a position in the bone cavity and orientation with respect to the body. The femoral stem should be always positioned in valgus in coronal plane and parallel in the sagittal plane with respect to the bone cortices. Varus and back to front placement must be avoided as the normal eccentric loading produces bending forces that are pushing the stem in to these directions.

Optimum position of acetabular cup is medialised in the acetabulum. This also reduces the joint reaction force, by increasing the lever arm of abductor muscles and reducing the lever arm of body weight.

**IMPORTANCE OF ACETABULAR COMPONENT POSITIONING:**

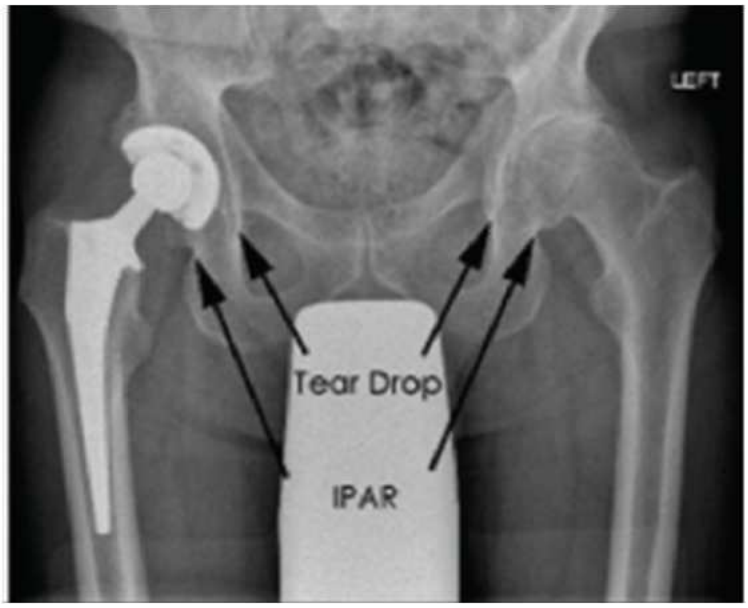



FO- Femoral offset, AO-Acetabular offset, JRF- Joint reaction fore
A-Abductor moment arm, B- Body moment arm

Medialization of the acetabular cup reduces the body lever arm and increases abductor lever arm reducing joint reaction force which is calculated as follows:

Joint reaction force (JRF) = Body Weight (BW) * Body moment arm(B) – Abductor force(Ab) * Abductor moment arm (A)

Reducing the acetabular offset will leads to the femoral stem with greater offset, so that leads to impingement and reduced range of motion.




IPAR –Inferior extent of the posterior acetabular rim

It is important to measure the distance between teardrop and inferior extent of the posterior acetabular rim (IPAR) in the pre op templating to place the acetabular cup correctly.

Cup position in THR Points to be noted :

1. Depth
2. Height
3. Angular placement

1. Depth :

Medolateral position of the cup influences the body lever arm and joint reaction force. It also affects offset, in which reduced offset leads to restricted motion, increased dislocation rate, impaired gait, accelerated wear.

2. Height :

Suproinferior positioning of the cup influences the limb length and also joint reaction force

3. Angular position of the cup :

This influences the anteversion and inclination angles. Abnormalities in these leads to increased risk of dislocation and increased wear rate.

The acetabular component position is a very important step of the surgical technique which is an important factor in the outcome. The acetabular component should be positioned correctly in all planes likesagittal, coronal and axial. More medial or more lateral positions influences offset leading to changes in the lever arm. The anteversion angle of the acetabular cup in the sagittal plane and the inclination angle (also known as abduction angle) in the coronal plane are both important determinants of acetabular position.

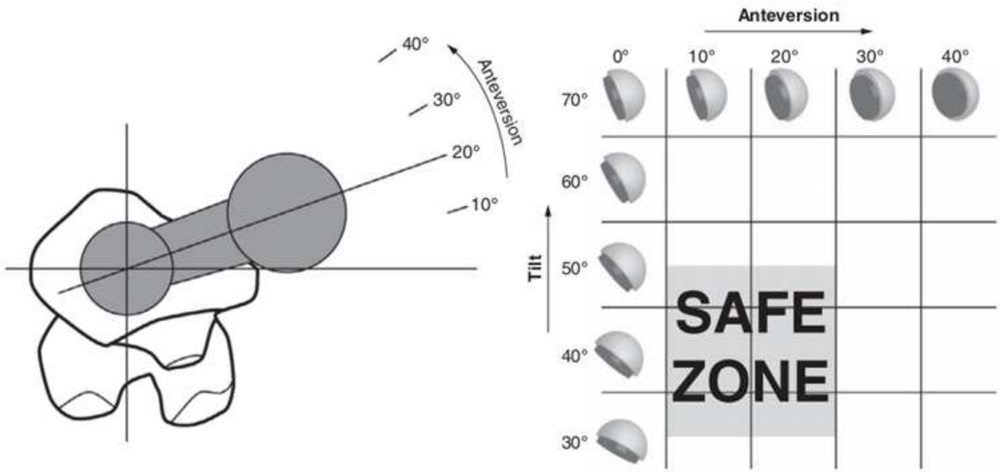
During the implantation process, surgeons use different techniques to judge the positioning of the acetabular component. Sotereanos et al. suggested three osseous pelvic landmarks: the lowest point of the acetabular sulcus of the ischium, the prominence of the superior pelvic ramus, and the most superior point of the acetabular rim [36]. McCollum and Gray recommended the use of the sciatic notch [37] and Maruyama et al. advocated using the acetabular notch angle [38]. Ha et al. later suggested using transverse acetabular notch in combination with anterior acetabular notch for orientation of the cup [39]. These methods help surgeons in individual variations in the hip and pelvic anatomy. Soft tissue landmarks like transverse acetabular ligament also used as a reference. Archbold et al. described the use of transverse acetabular ligament and labrum as a reference to judge height, depth and anteversion of the cup [40, 41].

A number of complications are associated with malpositioning of the acetabular component. Improper acetabular positioningis linked withincreased dislocation rates [24], polyethylene wear [25], edge loading [45], liner fracture [46], and component impingement affecting range of motion [46]. Even though other patient and technical related factors may influence these complications, acetabular positioning is under the direct control of the surgeon and must be optimized. Obtaining accuracy with positioning of the acetabular component, has proven to be very challenging. Many factors affect surgeon's ability to accurately in positioning the acetabular component.

These factors include increased BMI, surgical approach, surgeon volume, surgeon experience and inaccuracies in mechanical guides [25] andalso position of the body which influences the pelvic orientation, and affecting the cup positioning. The lateral decubitus positioning causes increased flexion and adduction of the pelvis and tend to flatten the lordotic curvature of the lumbar spine [37]. These position changes can affect the accuracy of the cup orientation if they are not taken into consideration.

Dislocation is one of the most common and devastating complications after Total Hip Arthroplasty[25]. Acetabular positioning directly affects dislocation rates. Although larger femoral heads dramatically reduced dislocation rates [51], they are not considered a substitute for a proper cup positioning. Lewinnek et al. showed that cups with an anteversion of 15 ± 10 degrees and inclination angle of 40 ± 10 degrees had 1.5% dislocation rates, while acetabular components outside this "safe zone" had a dislocation rate of 6.1% [24]. The correct position of acetabular cup is still a debatable one.

**THE SAFE ZONE ORIENTATION TO MINIMIZE THE RISK OF IMPINGEMENT AND DISLOCATION:**




Femoral stem → Axial plane (Anteversion) = $5^0 – 20^0$

Cup → Coronal plane (Inclination) = $40^0$ +/- $10^0$

Sagittal plane (anteversion) = $15^0$ +/- $10^0$

**FEMORAL STEM OFFSET**

The distance between the centers of the femoral head to the femoral stem axis is known as femoral offset. Fail to restoration of these limits the moment of abductor muscles and increased joint reaction force, limping and impingement.

## FEMORAL HEAD SIZE

Head diameter is an important factor in determining the range of motion, stability, wear rate of newly created joint. Greater the head neck ratio wider the primary arc of motion before impingement.

Linear wear (mm) = original thickness of acetabular cup (mm) – New shortest thickness of acetabular cup (mm), as measured on a plain AP X-ray.

Volumetric wear ($mm^3$) = 3.714 * (radius of femoral head in mm)$^2$ *linear wear (mm)

Volumetric wear is proportion to the frictional torque of the replacement joint.

So, more the femoral head size greater the frictional torque and related volumetric wear.

## COMPONENTS OF TOTAL HIP REPLACEMENT

## BIO MATERIALS

Bio materials should be

1. Bio stable – should withstand hostile atmosphere of biological milieu.

2. Bio compatible – least antigenic, nontoxic, no tissue reaction

## STAINLEES STEEL

Forged steel has higher yield strength but low fatigue strength. Commonly used steel is AISI -316L.

## COBALT BASED ALLOYS

They are highly resistant to corrosion. It causes minimal tissue reaction. Fatigue fracture may occur but to lesser extent than stainless steel.

## TITANIUM BASED ALLOYS

They have excellent corrosion resistant and fatigue strength.

They have high co-efficient of friction results in large amounts of wear particles. Hence not used in joint surface.

## CERAMICS

Aluminium oxide is being used for modular femoral head because of its excellent frictional and wear characteristics with polyethylene.

## FEMORAL COMPONENT

Femoral components include head, neck, collar and an option platform. It is usually made of metal alloy. Co-Cr-Mo alloy, stainless steel alloy, titanium alloy.

**SIZE OF HEAD**

Small head helps in medialisation of fulcrum which leads to lengthening of power arm. This also reduces frictional torque and thus reduces strain on cement bone interface. Disadvantage of small head is that, it tends to subluxate at extreme range of motion.

**NECK DESIGN**

It should allow angular motion without impinging on socket rim.

- ✓ Small the diameter of neck, greater the range of motion without impingement.
- ✓ Greater the recession of neck, greater the range of motion without impingement.

Usually the neck length varies from 25-50 mm.

**MODULAR HEAD**

Using modular heads the neck length can be adjusted with variable head size. This modularity is available only in Muller's system.

**ACETABULAR CUP**

It is made up of Ultra High Molecular Weight Poly Ethylene (UHMWPE).

**IN CEMENTED ACETABULAR CUP:**

It has got metallic rings for radiological identification of its position. Vertical and horizontal groove are presented over the outer surface to increase the stability within cement mantle. A flange at the rim of the component aids in pressurization of the cement as the cup is pressed into position.

**PRE OPERATIVE RADIOLOGICAL ASSESSMENT**

- Anteroposterior view and lateral view were taken.
- In AP VIEW - both hip joints and proximal femur assessment can be done.
- In LATERAL VIEW - Ipsilateral hip and proximal femur assessment can be done.
- X rays were taken with 1O$^{o}$internal rotation for pre-operative assessment and templating.

**AIM OF PRE OPERATIVE TEMPLATING X RAYS:**

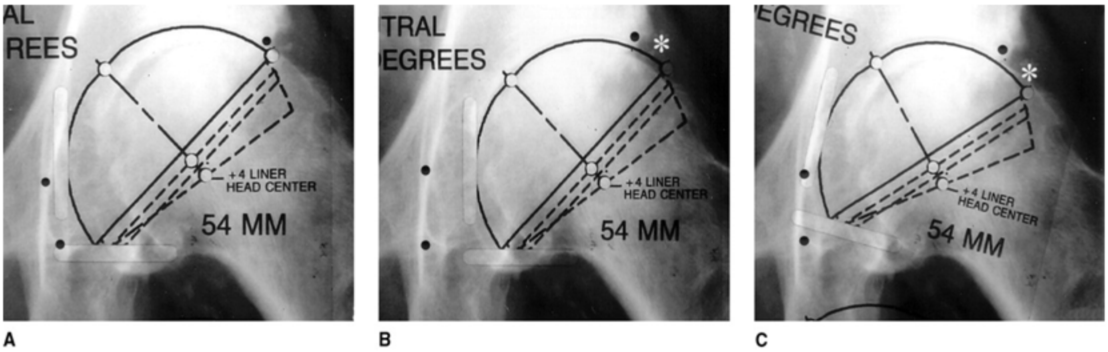
- To determine the size of implants.
- To measure the acetabular and femoral offset.

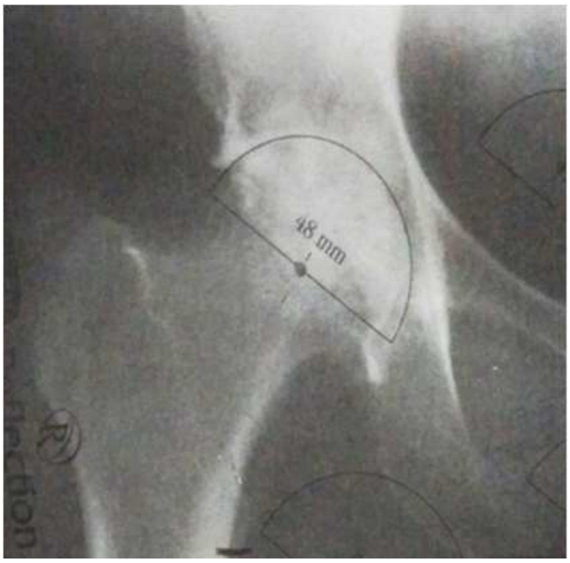
- To restore the center of rotation of hip joint to maintain correct femoral and acetabular offset.

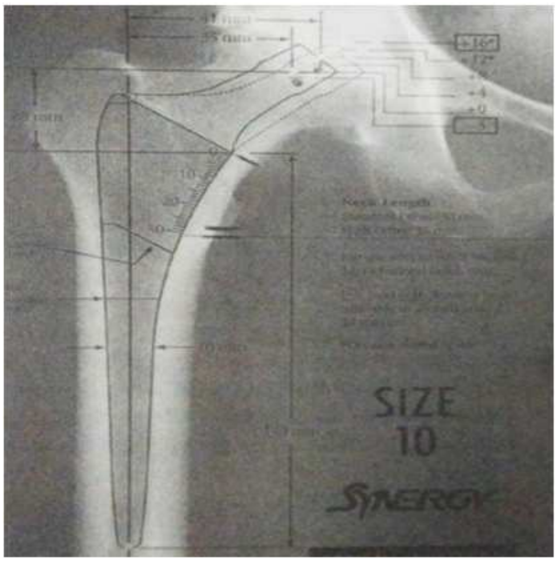
- To restore the limb length discrepancy.

- To anticipate any acetabular defect requiring grafting.

**TEMPLATING**



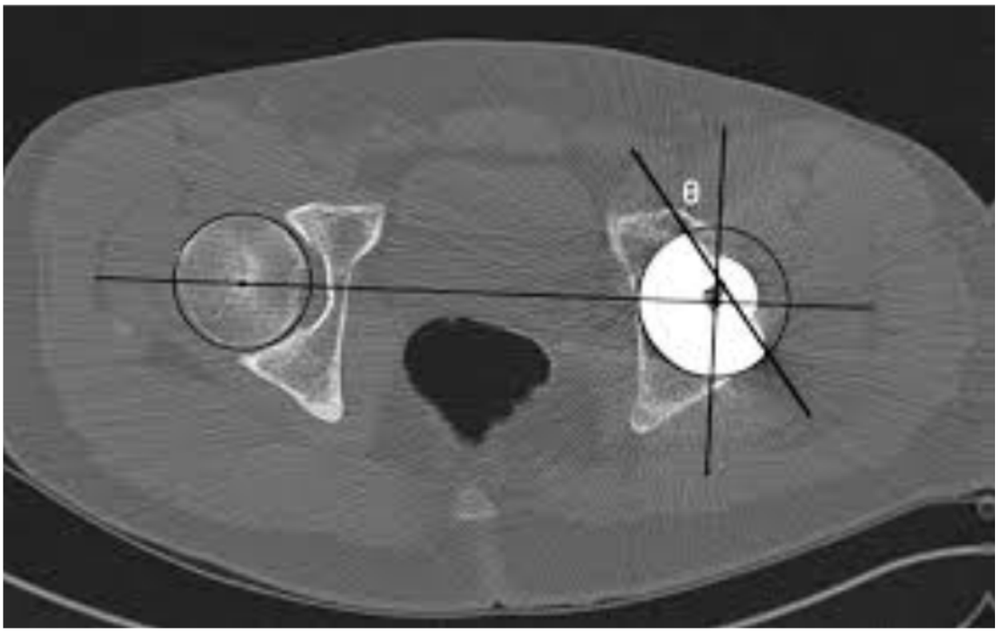

Templating will be very much helpful in selection of correct implant that provides the best fit, implant size, neck length and medial offset etc.

**POST OPERATIVE ASSESSMENT OF ACETABULAR CUP**

The angle between the acetabular axis and the coronal plane is known as acetabular cup anteversion. Among various methods to measure the acetabular cup version in both X ray and CT, the CT scan measurement is the best. CT scan measurement has high accuracy and more reliability. In CT scan modified Murray's concept is used.

**METHOD:**

In an axial cut of a CT picture, showing both hips, draw a line connecting the center of the acetabular cavity two hips and a second line perpendicular to the first line through the center. Third line connectingthe most anterior and most posterior point of the acetabular cup. The angle formed between the second and third line is the of acetabular version.



Normal acetabular version is 10 -20 degrees.

But safe zone of acetabular anteversion is 5-25 degrees.

**FEMORAL VERSION**

In a horizontal axial view of CT scan; showing ipsilateral hip

Draw a line from the center of the femoral head to the centre of the greater trochanter.

A second line drew horizontally connecting the centers of two acaetabuli.

The degree between these two lines indicate the degree of femoral anteversion [FH].

**CONDYLAR VERSION**

Draw a first line, tangentially along the posterior surface of the two condyles in axial cut.

The second line is drawn parallel to the floor

The true femoral anteversion is calculated with the femoral condylar version [CH].

**TRUE FEMORAL ANTEVERSION**

If femoral condyle is in internally rotated

The femoral version is = FH+CH

If femoral condyle is in externally rotated

The femoral version is = FH-CH

If femoral condyle is in neutral

The femoral version is - FH=CH


In the evaluation of results of THR, it has been traditional to use Hip scores, there are many functional rating systems.

1. ‘D’ AUBIGNE AND M.POSTEL [1954]

2. CHARNEY[1960]

3. AMSTUTZ CARROLL LARSON [1963]

4. IOWA [1963]

5. HARRIS [1969]

6. MAYO CLINIC [1984]

**SURGICAL TECHNIQUE**

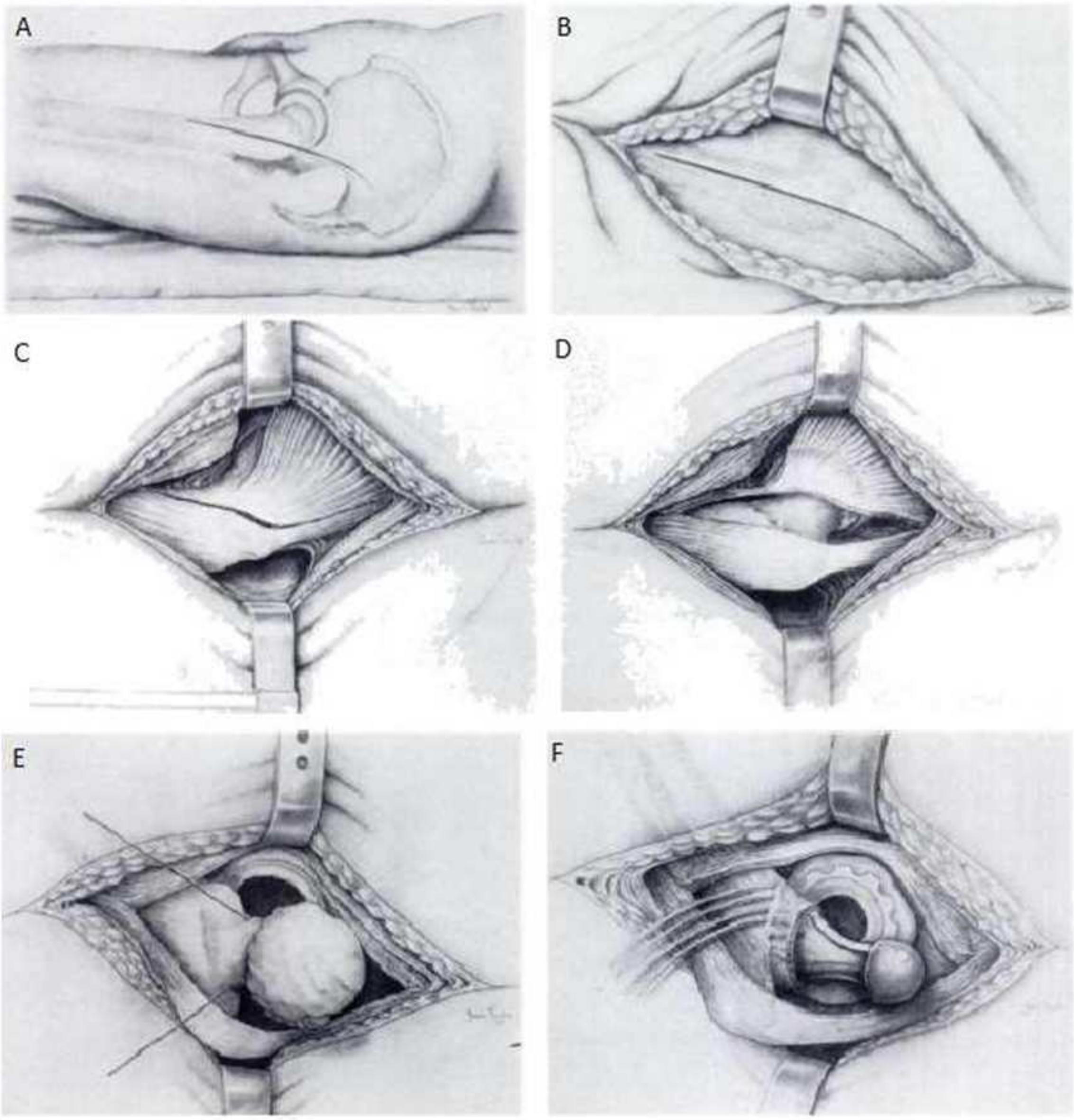
Lot of surgical approaches are there to gain access to the femur and acetabulum in Total Hip Arthroplasty. The Heuter or Smith-Peterson approach (anterior approach), Southern- Moore approach (posterior approach) and Hardinge approach (direct lateral approach) are commonly used approaches by arthroplasty surgeons. Each approach has its own advantages and disadvantages.In these hardringe approach is the most commonly used approach.

**LATERAL APPROACH**

In Hardinge approach patient positioned in supine position. But in modified hardringe approach, patient positioned in lateral position on the unaffected side for the better visualization of the acetabulum and femur.

This good visualization helps in better placement of acetabular and femoral components, so that associated with low dislocation rate. But in this approach abductor muscles are cut and damaged, and also increased risk for superior gluteal nerve [52] which leads to post-operative limping in some patients.

The modified Hardinge approach starts with a lateral skin incision with the greater trochanter in the center. After which subcutaneous dissection done, then the ilio tibial band which arising from the tendons of tensor fasciae lata and gluteus maximus is identified. Gluteus medius muscle over the anterolateral aspect of the femur is exposed after cutting the ilio tibial band. After which the gluteus medius is exposed and split to expose the gluteus minimus which overlies the femoral neck. Then the hip capsule along with the gluteus minimus muscle tendon is cut in line with the femoral neck. Then the gluteus medius and gluteus minimus tendons are reflected anteriorly. After this vastus lateralis fibers reflected. After all these steps the femoral head can be dislocated. Acetabulum exposed clearly after osteotomy of femoral neck.




**LATERAL APPROACH TO THE HIP**

A- Skin incision made with the greater trochanter at the center

B- Cutting of ilio tibial band

C- Splitting of Gluteal medius

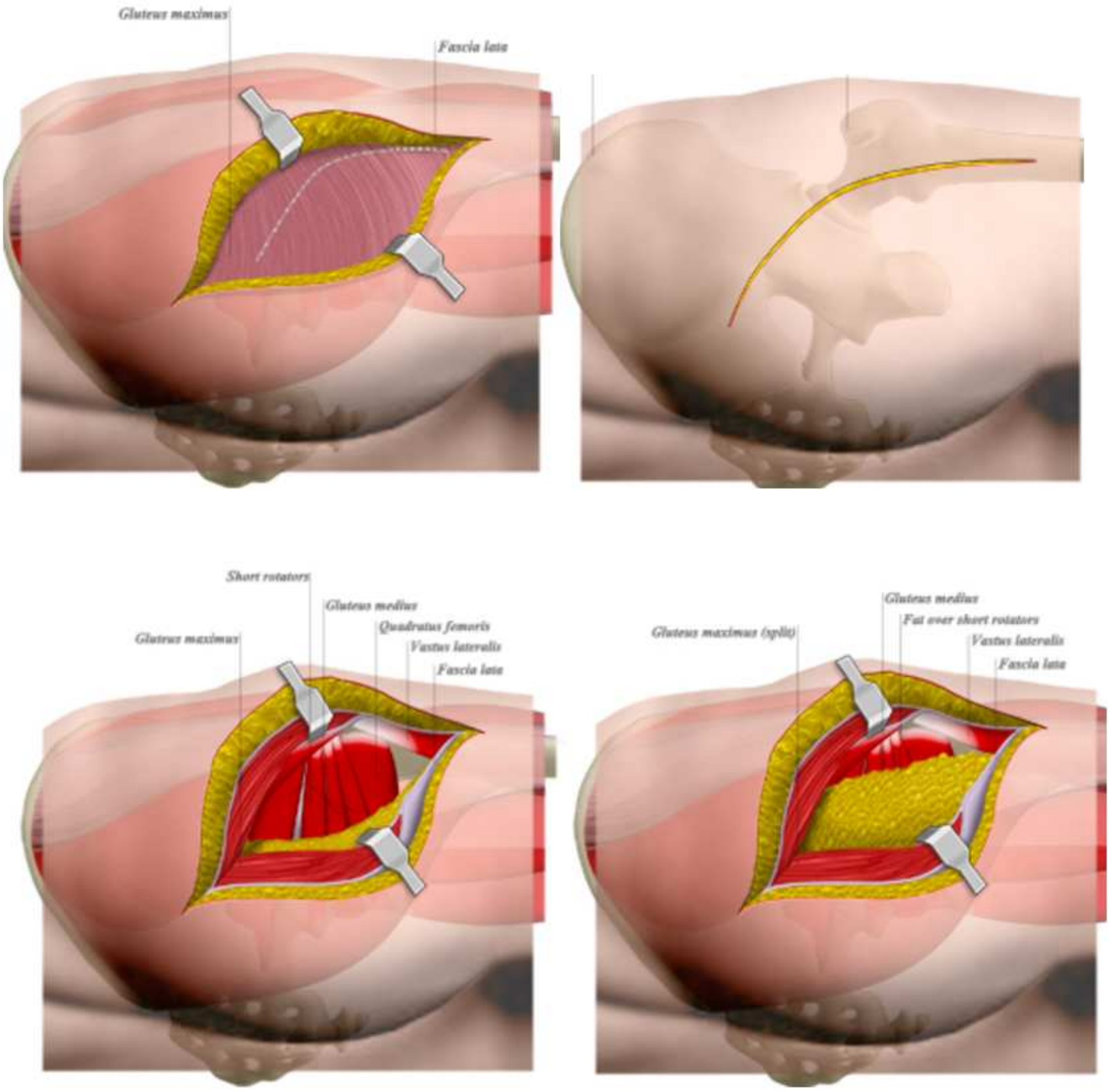
D- After cutting the gluteus minimus and capsule femoral neck is exposed.

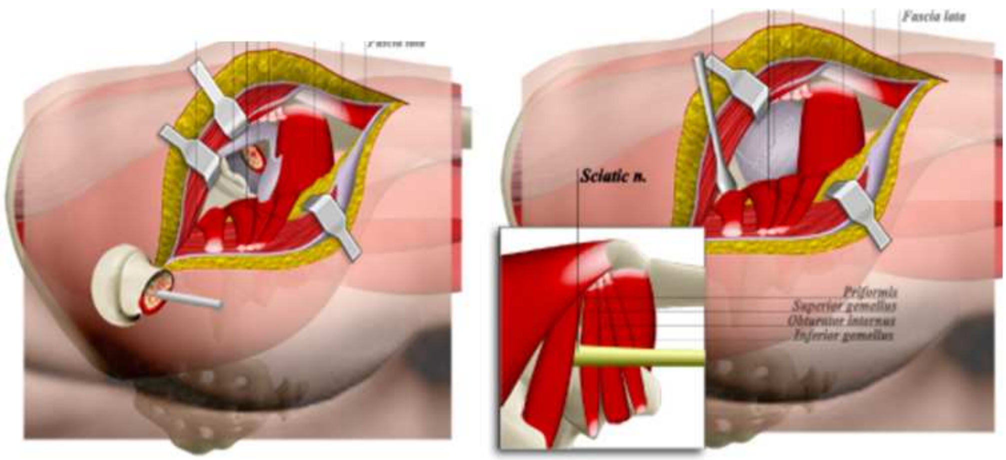
E- Dislocation of hip done.

F- Implantation of acetabular and femoral components.

After femoral neck osteotomy femoral canal is prepared with broaches. The final broach size is determined based on the stability within the femoral canal. After broaching the correct size femoral stem is implanted into the femoral canal in cementless THA and along with cement (polymethylmethacrylate) in cemented THA. Meticulous closure of capsule and cut muscle tendons is must at the end of the procedure which helps in soft tissue tensioning to reduce dislocation rates.

**POSTERIOR APPROACH:**






A curved incision is made from 8 cm inferior from the posterior superior iliac spine, which extended distally and laterally centering the shaft of femur. Then the deep fascia is incised in line with skin incision.

Gluteus maximus is divided by blunt dissection so that injury to superior gluteal vessels avoided. Then the short external rotators exposed. Stay sutures done and the rotators are cut close to their incision.

Care should be taken for sciatic nerve while retracting the short external rotators. Then the posterior capsule is exposed. T shaped incision is made over the capsule. Then the hip is flexed, adducted and externally rotated to dislocate the femoral head.

Femoral head is delivered using a head extractor. Then the acetabulum is prepared in the same manner as discussed in the lateral approach. Acetabular cup inserted. Then femoral component prepared, stem inserted in the same manner as in lateral approach. Hip reduction is carried out. Capsule and soft tissues are meticulously closed.

# MATERIALS AND METHODS

1. Study Population: 35 HIPS.

2. Method of selection: Patients admitted for total hip arthroplasty (Cemented and Uncemented) without associated lower limb fractures or other factors like arthritis knee etc.

3. All patients will undergo X ray pelvis with both hip, CT hip post operatively for clinical and radiological assessment.

4. preoperative clinical examination is recorded and Harris Hip Score is done

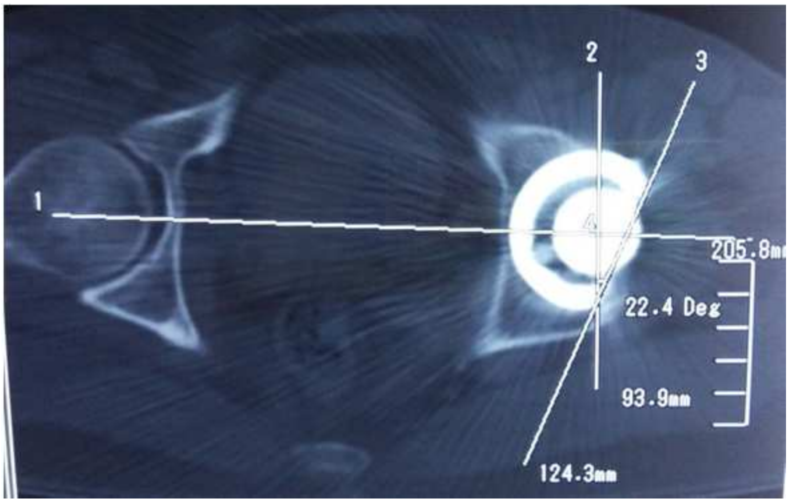
5. Patients are counselled regarding advantages, disadvantages and possible complications of this procedure and a written consent is obtained.

## METHODS

## CLINICAL EXAMINATION

All patients were assessed clinically with the latest follow up and evaluated with Harris hip score. The corresponding hip score were entered against all the parameters mentioned in the hips score proforma.

**CT EXAMINATION OF THE CUP POSITION**




After obtaining the CT picture of the hip, the version of the acetabular cup was assessed by using the Modified MURRAY method.

The acceptable range of the cup version is 15 ± 10.

**MATERIALS**

| | |
|---|---|
| Total No. of patients | 33 |
| Total No. of hips | 35 |

**SEX DISTRIBUTION**

Male 19

Female 14

| **Indications** | **No of patients** |
|---|---|
| 1. Fracture neck of femur | 23 |
| 2. Ankylosis of hip | 2 |
| 3. Avascular neck of femur | 7 |
| 4. Secondary OA of hip | 3 |

# RESULTS

**Table-1:Sex distribution**

| SEX | NUMBER | PERCENTAGE |
|---|---|---|
| MALE | 19 | 57.5 |
| FEMALE | 14 | 42.5 |
| TOTAL | 33 | 100.0 |

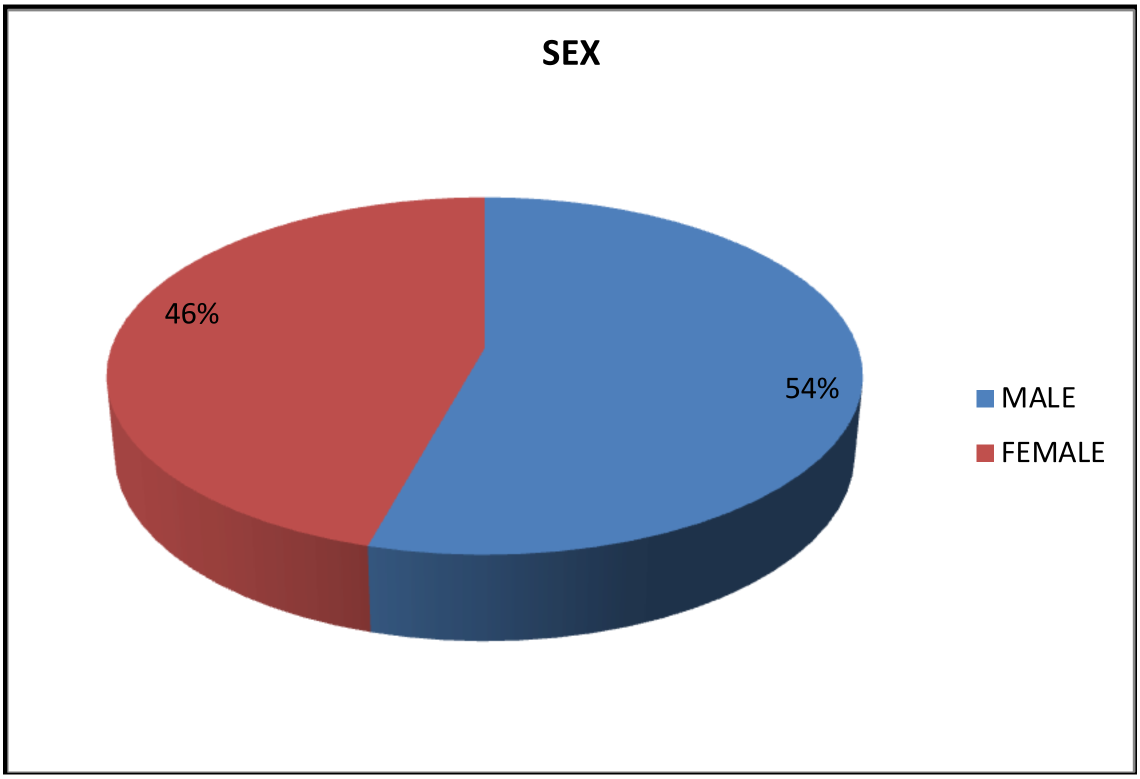


**Table-2: Age distribution**

| VARIABLE | N | MINIMUM | MAXIMUM | MEAN | STD. DEVIATION |
|---|---|---|---|---|---|
| AGE | 35 | 26.00 | 86.00 | 54.4545 | 16.14406 |

**Table-3:Harris Hip Score**

| VARIABLES | N | MINIMUM | MAXIMUM | MEAN | STD. DEVIATION |
|---|---|---|---|---|---|
| PREOP HHS | 31 | 22.00 | 53.00 | 37.2258 | 8.89835 |
| POST OP HHS | 31 | 75.00 | 94.00 | 87.4839 | 4.82266 |

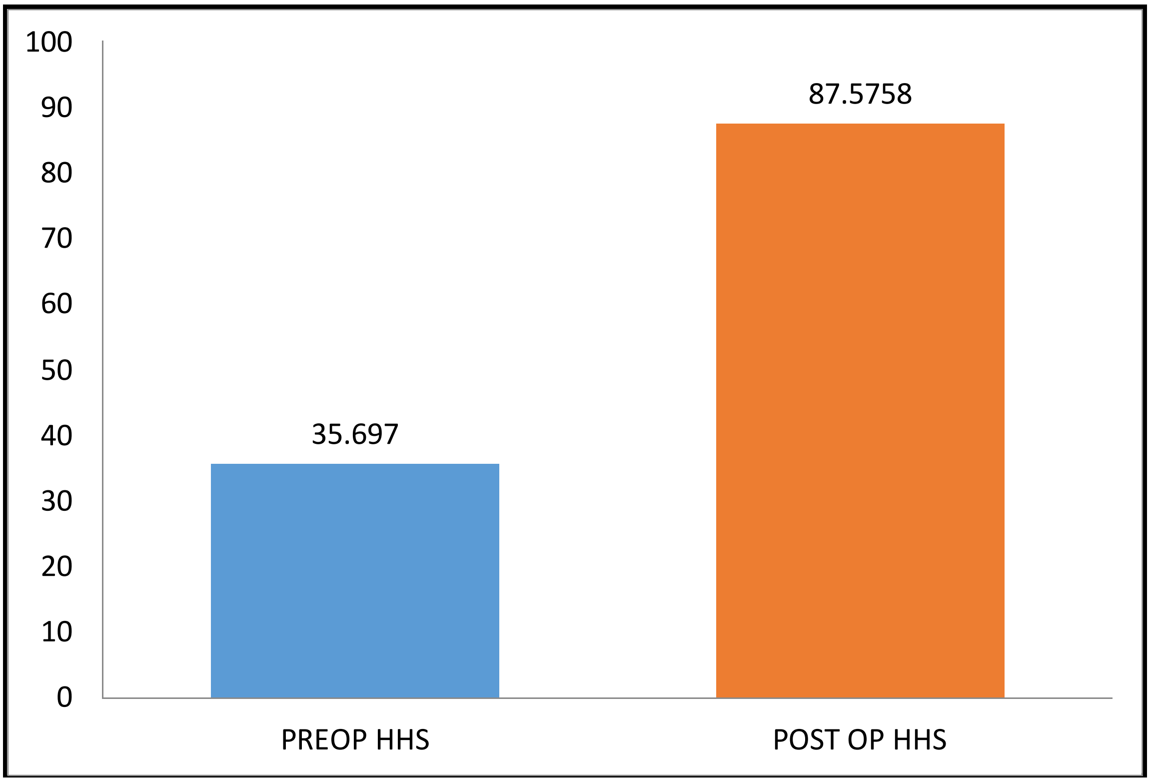


**Table-4: Acetabular cup measurements**

| VARIABLES | N | MINIMUM | MAXIMUM | MEAN | STD. DEVIATION |
|---|---|---|---|---|---|
| Acetabular cup inclination | 35 | 35.50 | 61.30 | 41.3545 | 4.31430 |
| Acetabular cup anteversion | 35 | 11.50 | 33.00 | 16.4061 | 3.81452 |
| Femoral anteversion | 35 | 21.30 | 42.00 | 34.3848 | 4.82909 |

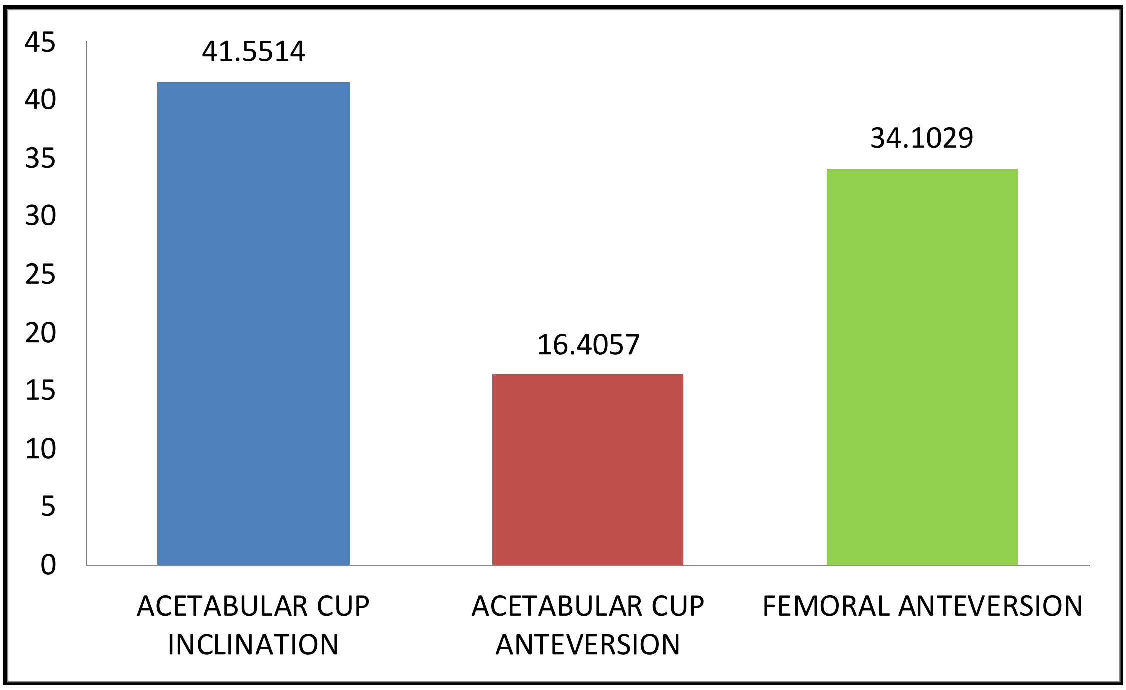


**Table-5: Comorbidities**

| COMORBIDITIES | NUMBER | PERCENTAGE |
|---|---|---|
| DIABETIC | 5 | 15.2 |
| HYPERTENSIVE | 2 | 6.1 |
| RHEUMATOID ARTHRITIS | 5 | 9.1 |
| NIL | 23 | 69.7 |
| TOTAL | 35 | 100.0 |

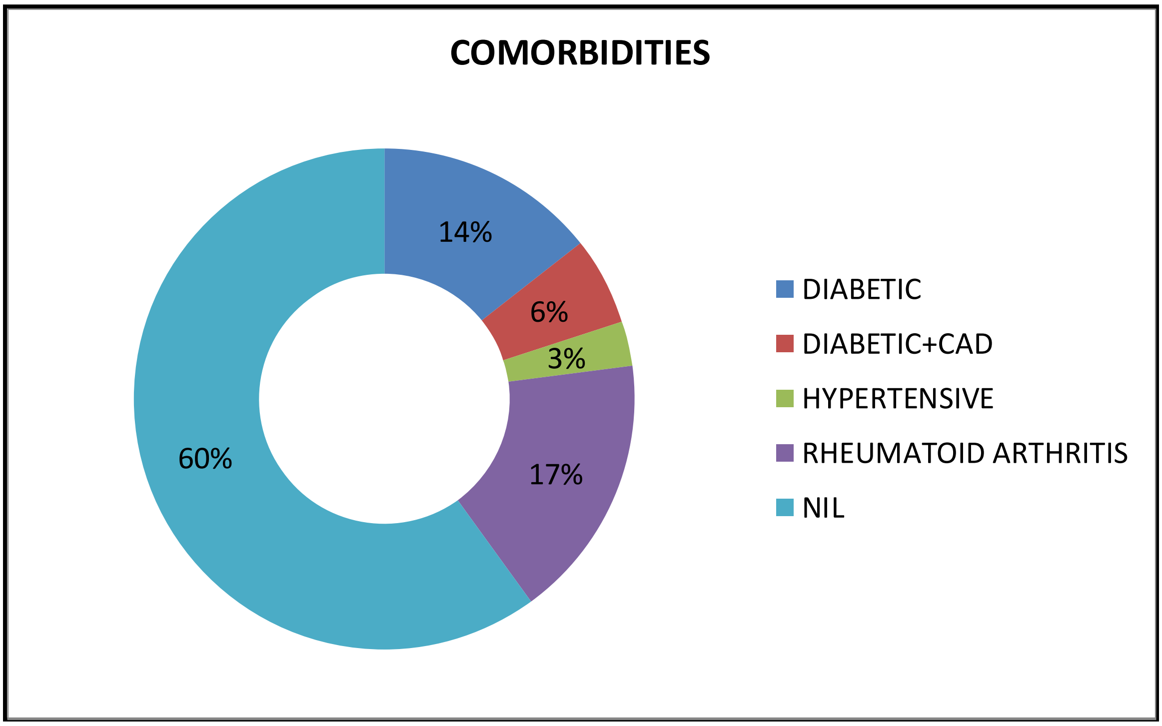


**Table-6: Approaches**

| APPROACH | NUMBER | PERCENTAGE |
|---|---|---|
| ANTEROLATERAL | 1 | 3.0 |
| LATERAL | 3 | 9.1 |
| POSTERIOR | 31 | 87.9 |
| TOTAL | 35 | 100.0 |

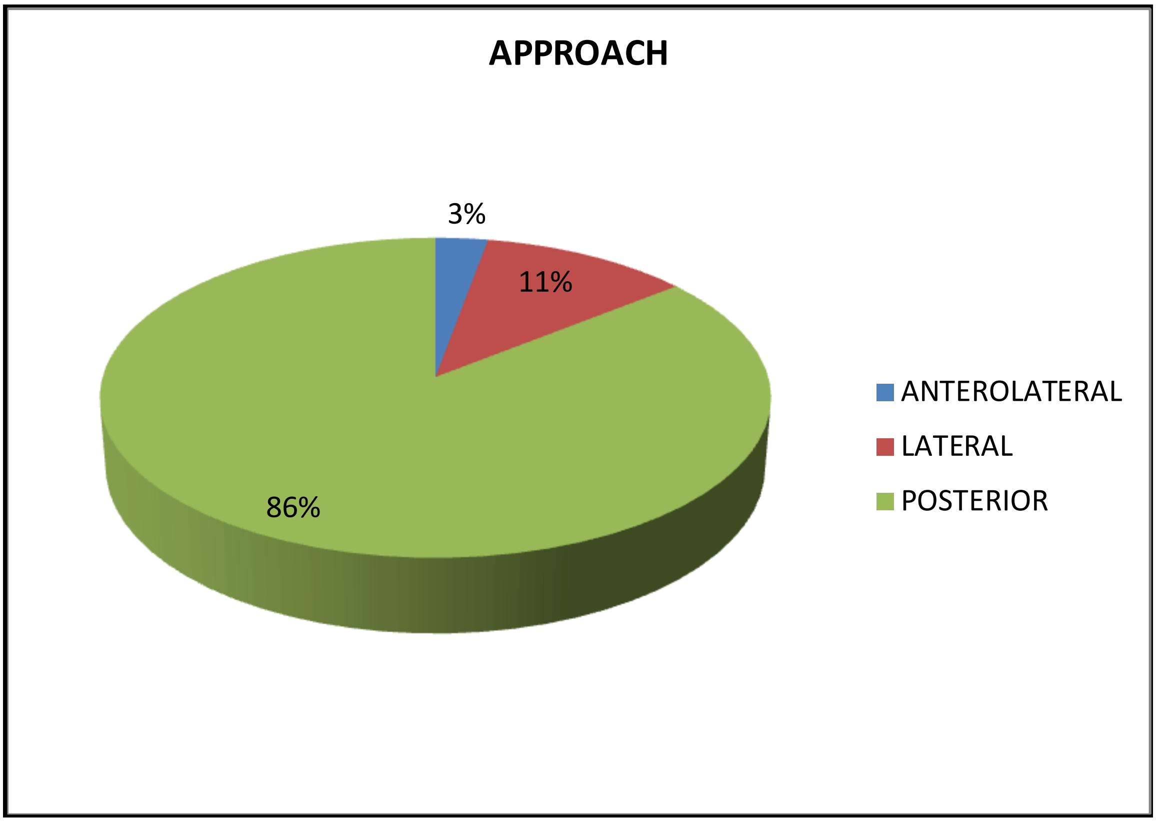


**Table-7: Complications**

| COMPLICATIONS | NUMBER | PERCENTAGE |
|---|---|---|
| DISLOCATED | 2 | 6.1 |
| NIL | 33 | 93.9 |
| TOTAL | 35 | 100.0 |

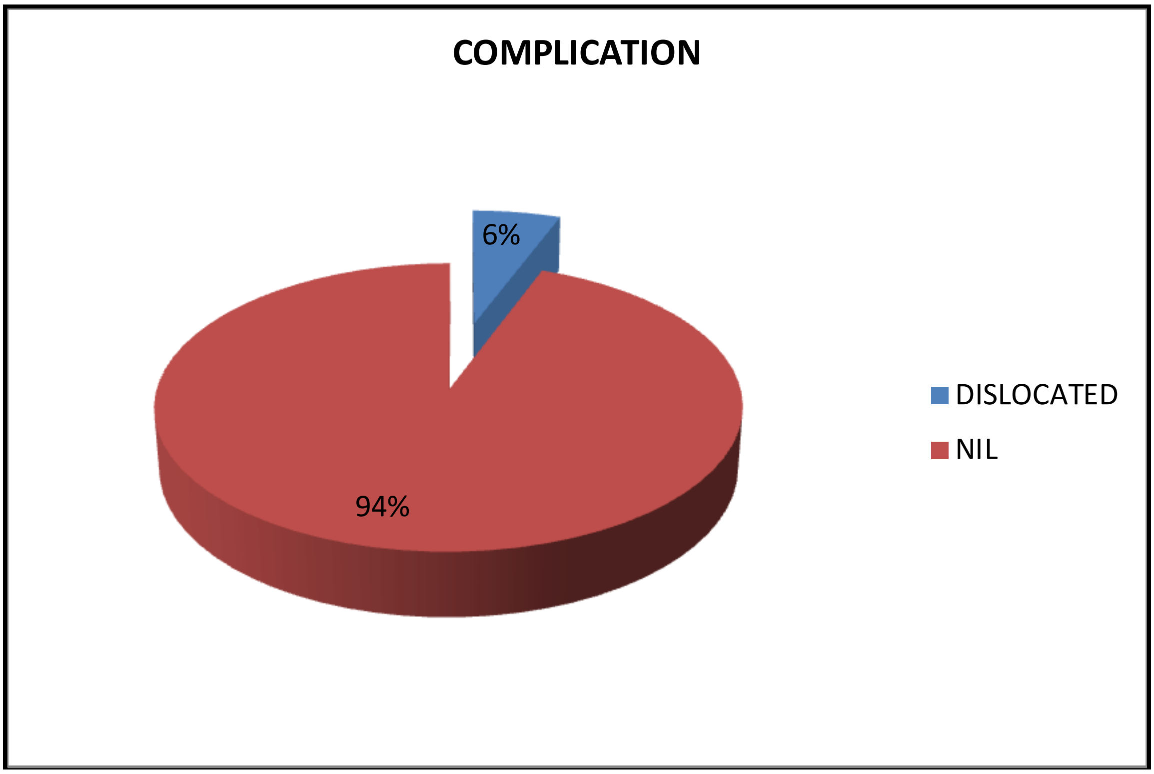


**Table-8: Outcome**

| OUTCOME | NUMBER | PERCENTAGE |
|---|---|---|
| EXCELLENT | 13 | 39.4 |
| GOOD | 17 | 48.5 |
| POOR | 4 | 12.1 |
| TOTAL | 35 | 100.0 |

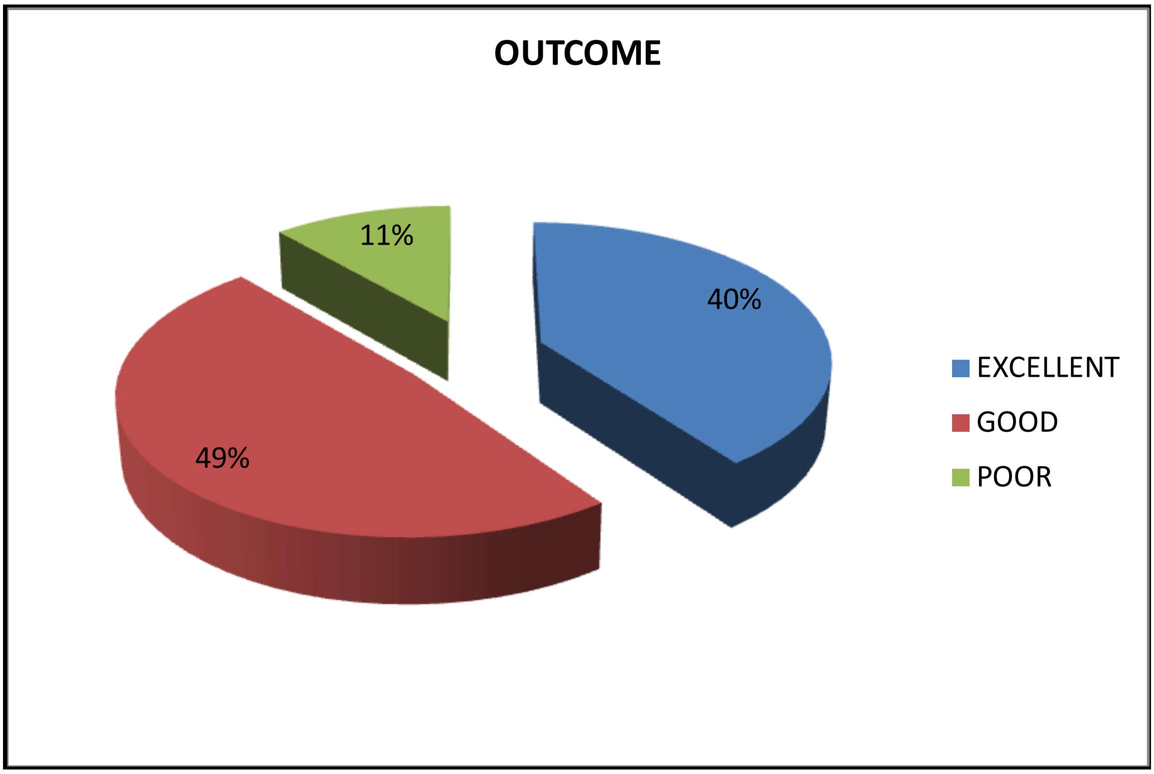


**Table-9: Indications in our study**

| DIAGNOSIS | NUMBER | PERCENTAGE |
|---|---|---|
| ANKYLOSED HIP | 1 | 3.0 |
| AVASCULAR NECROSIS | 6 | 18.2 |
| FRACTURE NECK OF FEMUR | 24 | 72.7 |
| OSTEOARTHRITIS | 2 | 6.1 |
| TOTAL | 35 | 100.0 |

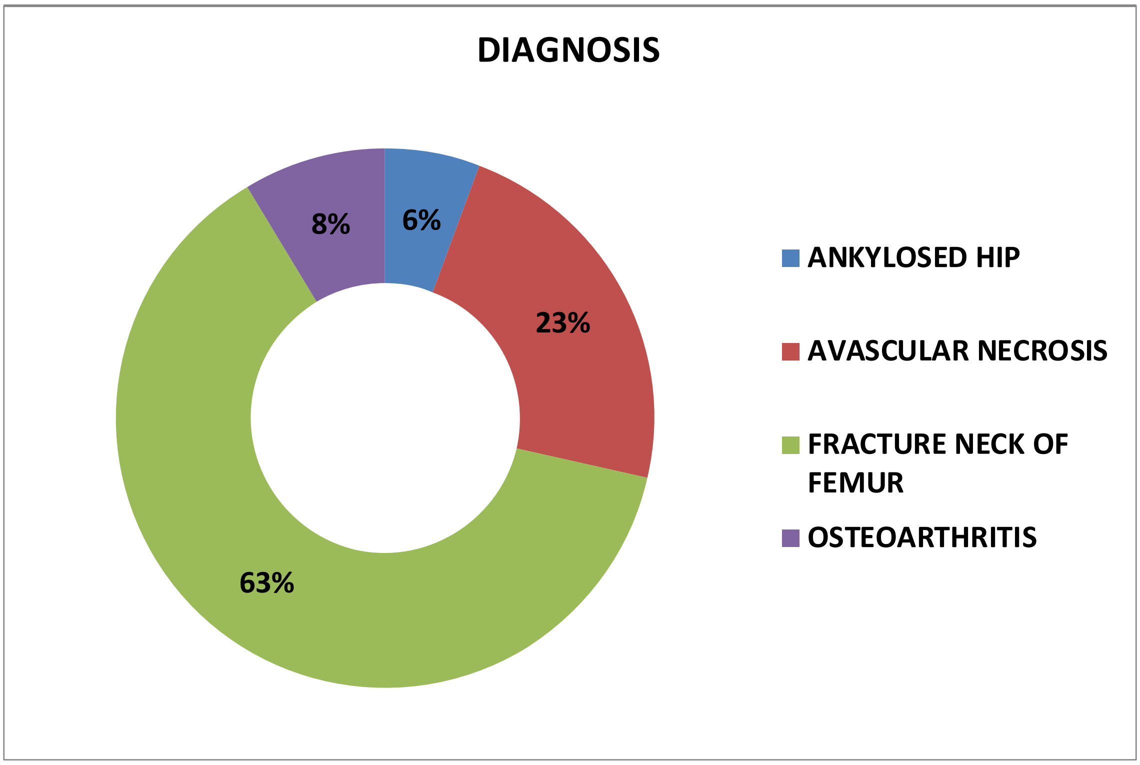


**Table-10: Preop and post op HHS**

| VARIABLES | MEAN | N | STD. DEVIATION | P VALUE |
|---|---|---|---|---|
| PRE OP HHS | 37.5172 | 31 | 8.65044 | <0.001 |
| POST OP HHS | 87.4828 | 31 | 4.94701 | |

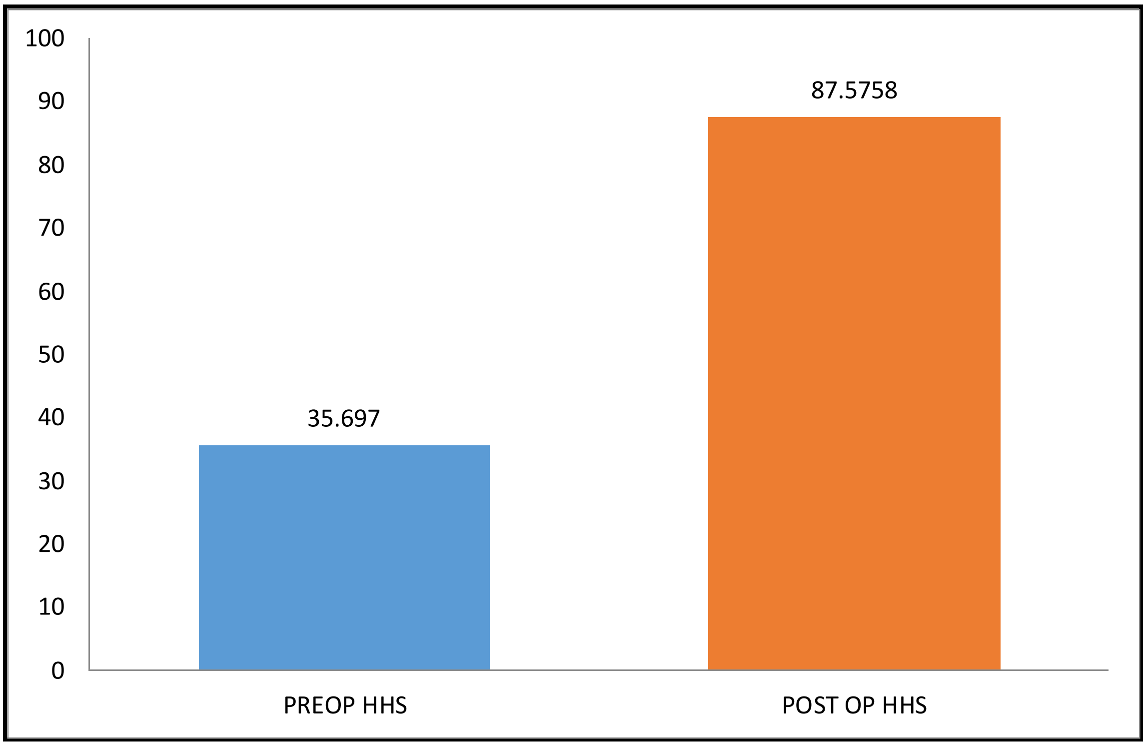
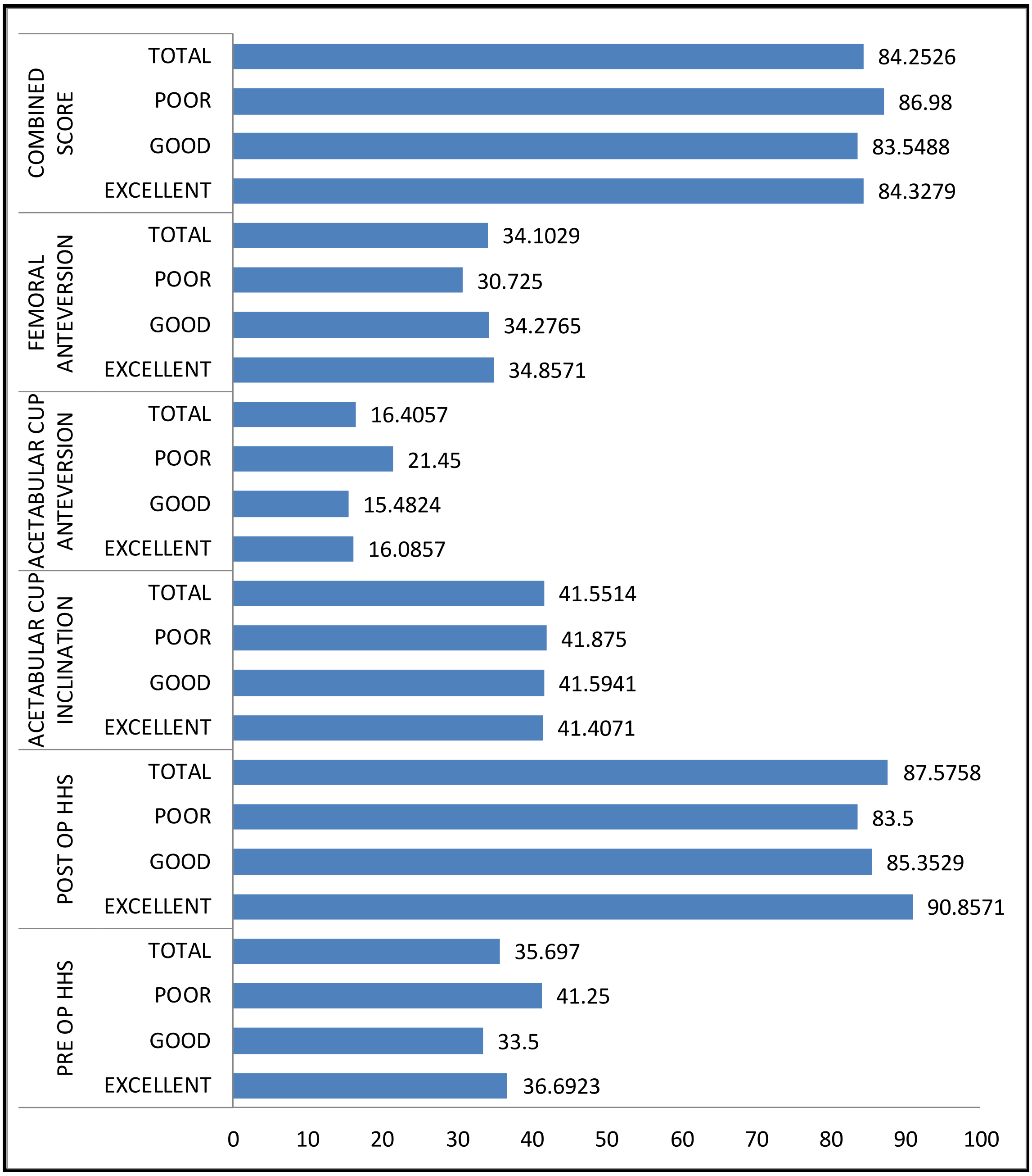


**Table-11:**

| VARIABLES | | N | MEAN | STD. DEVIATION | P VALUE |
|---|---|---|---|---|---|
| PRE OP HHS | Excellent | 12 | 36.5833 | 8.82618 | 0.640 |
| | Good | 17 | 36.6667 | 8.04156 | |
| | Poor | 4 | 41.2500 | 13.40087 | |
| | Total | 35 | 37.2258 | 8.89835 | |
| POST OP HHS | Excellent | 13 | 91.9231 | 1.38212 | <0.001 |
| | Good | 16 | 85.1875 | 2.66380 | |
| | Poor | 2 | 77.0000 | 2.82843 | |
| | Total | 31 | 87.4839 | 4.82266 | |
| ACETABULAR CUP INCLINATION | Excellent | 13 | 41.2692 | 1.59342 | 0.969 |
| | Good | 16 | 41.2938 | 5.92312 | |
| | Poor | 4 | 41.8750 | 3.54342 | |
| | Total | 35 | 41.3545 | 4.31430 | |
| ACETABULAR CUP ANTEVERSION | Excellent | 13 | 16.0231 | 2.13509 | 0.012 |
| | Good | 16 | 15.4562 | 2.60870 | |
| | Poor | 4 | 21.4500 | 7.97350 | |
| | Total | 35 | 16.4061 | 3.81452 | |
| FEMORAL ANTEVERSION | Excellent | 13 | 34.9385 | 3.96517 | 0.278 |
| | Good | 16 | 34.8500 | 5.14872 | |
| | Poor | 4 | 30.7250 | 5.74188 | |
| | Total | 35 | 34.3848 | 4.82909 | |

| VARIABLES | | N | MEAN | STD. DEVIATION | P VALUE |
|---|---|---|---|---|---|
| COMBINED SCORE | Excellent | 13 | 84.1900 | 1.17372 | 0.250 |
| | Good | 16 | 83.6694 | 3.55594 | |
| | Poor | 4 | 86.9800 | 7.24406 | |
| | Total | 35 | 84.2758 | 3.53050 | |



# DISCUSSION

Even after the decade of years, defining the optimal cup and femoral stem positions is very difficult and challenging. Understating of implant factors and pelvic anatomy is very important in optimal cup and stem positioning and to avoid impingement, dislocation, wear rates.

After Total Hip Arthroplasty 10-year survival rate is more than 95%, and 25-year implant survival is more than 80% [53]. After total hip arthroplasty quality of life is largely good to excellent at short term, mid-term and long term follow-up [55].

Post-operatively over 7-23% patients often suffer from persistent lateral thigh or hip pain [56]. Improper acetabular positioning is one of the many causes which are associated with persistent pain due to impingement [57], dislocation [61], edge loading [62] and liner fracture [58].

These unwanted outcomes lead to dissatisfaction after a total hip arthroplasty in patients.

Psoas impingement is one of the causes of persistent anterior groin pain, which requires revision surgery [64]. Retroversion or lateralization may cause an uncovered acetabular component by bone of the pelvis is one of the risk factors for iliopsoas impingement [65]. Based on these studies, proper positioning of the cup may be one of the important factors in patient satisfaction.

Lewinnek et al. originally defines safe zone for acetabular cup as 15 ± 10 degrees of anteversion and 40 ± 10 degrees of inclination after studied 9 dislocations [61].

This "safe zone" gained popularity in the literature and has since been scrutinized by many surgeons [67]. There are no studies that show any correlation of cup positioning in "safe zone" on functional outcomes of patients. The functional outcome of acetabular component positioning in Total Hip Arthroplasty on patient satisfaction has not been studied yet.

In our study the mean acetabular cup inclination is 41.36°. Mean cup anteversion is 16.4°, and mean femoral anteversion is 34.4° Modified Murray's method was used to measure the versions in CT, which was commonly used in various studies previously. We had 2 of our cases with excessive retro version of cup, which got dislocated post operatively.

To evaluate the effectiveness of our studies functional outcome measurements are very useful and very important in clinical research[68]. Functional outcome measures are the patient perspective indicators to improve our research. Disease-specific indicators such as WOMAC and Harris Hip Score allow comprehensive assessment of treatment effects [69].

In our study we used Harris Hip score for assessment of the effect of cup and femoral stem positioning in total hip arthroplasty.

The proper position of the acetabular cup is still not clear in literature. The so called proper position of acetabular component discussed in older studies and literature are mainly based on dislocation rates[70].

In our study we did not observed significant correlation with cup inclination, anteversion and femoral stem versions with patient satisfaction and functional outcome. And also in our study Lewinnek's "safe zone" does not play any significant role in patient outcome scores. Within the Cup and stem positions studied in our study patient functional outcome scores are significantly good clinically.

Anterior groin and lateral groin pain has been reported in some of our patents. These are not only associated with cup and stem positions alone. A number of causes described in literature for lateral hip pain. These include increased femoral offset and limb length discrepancy [66]. Other possible reasons for anterior groin and lateral thigh pain are iliopsoas impingement, infection, osteolysis, soft tissue damage (66). Iliopsoas impingement has been associated with 4.3% in the literature (64).The inherent limitations include variation in head sizes, inaccuracies with radiographic measurements and the exclusion of patients who had revision procedures affects the responsiveness of the functional outcomes scores used in this study. These variations may affect effectiveness positions of cup and the stem. However, this study examined patient reported satisfaction and outcomes on a 35 hips after a primary THA as dependent only on cup and femoral stem position.

# CONCLUSION

1. In extreme positions (>2SD) acetabular cup remains an important factor in the outcome of total hip arthroplasty which influences the dislocation rate, wear rate, patient outcome.

2. Pre-operative templating with acetabular and femoral offset measurements plays a major role in intra operative positioning of the cup.

3. Variation in the positions of the acetabular and femoral components has shown significant correlation radiologically. But within the studied ranges the functional outcome score difference is not clinically significant.

4. Specific intraoperative perfection of safe zones in positioning the acetabular and femoral components may be important for hip stability, but there may be no change in patient outcomes with defining such zones.

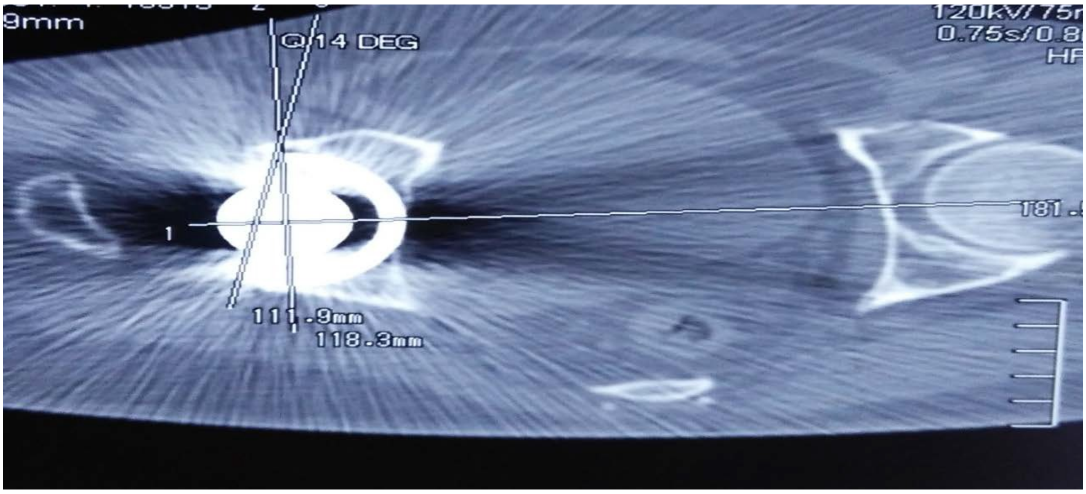
5. Apart from safe zones, meticulous closure of capsule and soft tissues are also plays an important role in immediate post op period in hip stability.

# CASE ILLUSTRATION

## CASE 1

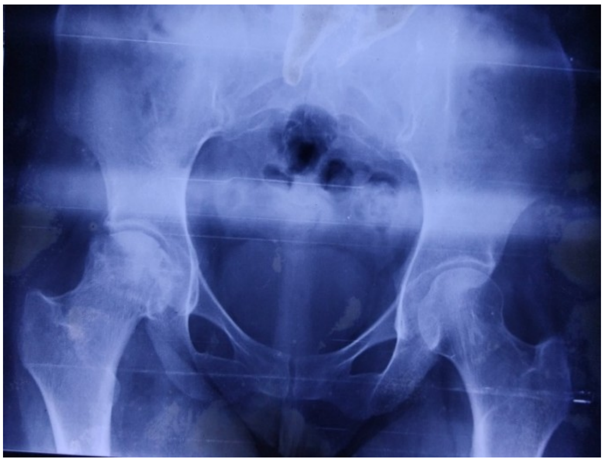
Munusamy, 55 yrs, male, diagnosed as fracture neck of femur right side

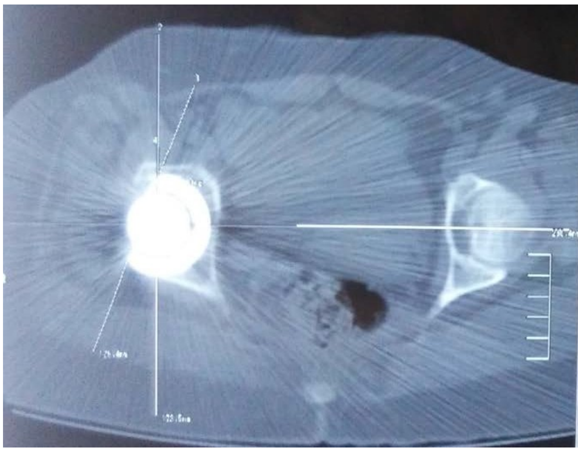


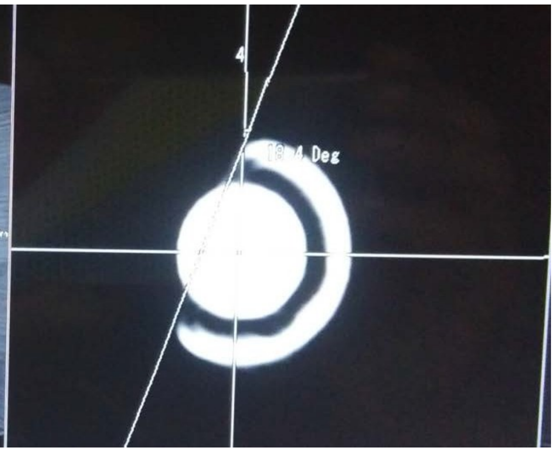


## CASE 2

Lakshmi, 35 yrs, female, diagnosed as avascular necrosis of right femoral head

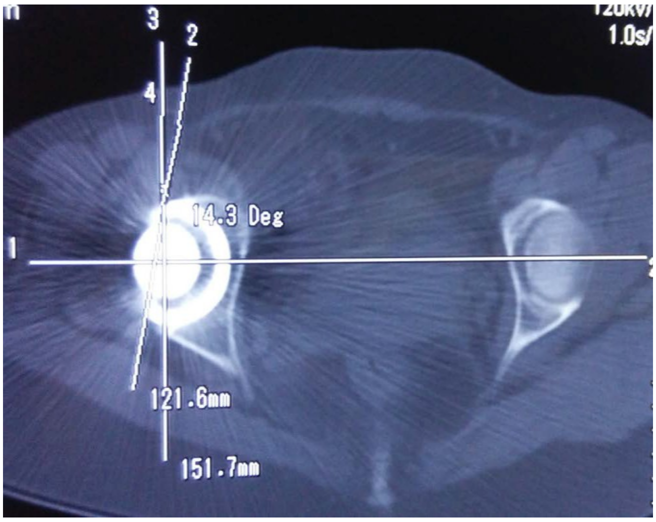




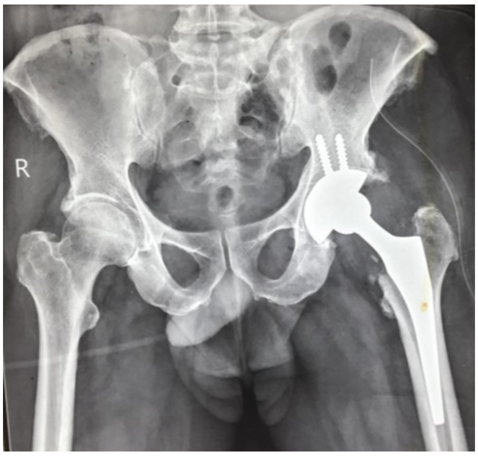
CASE-3

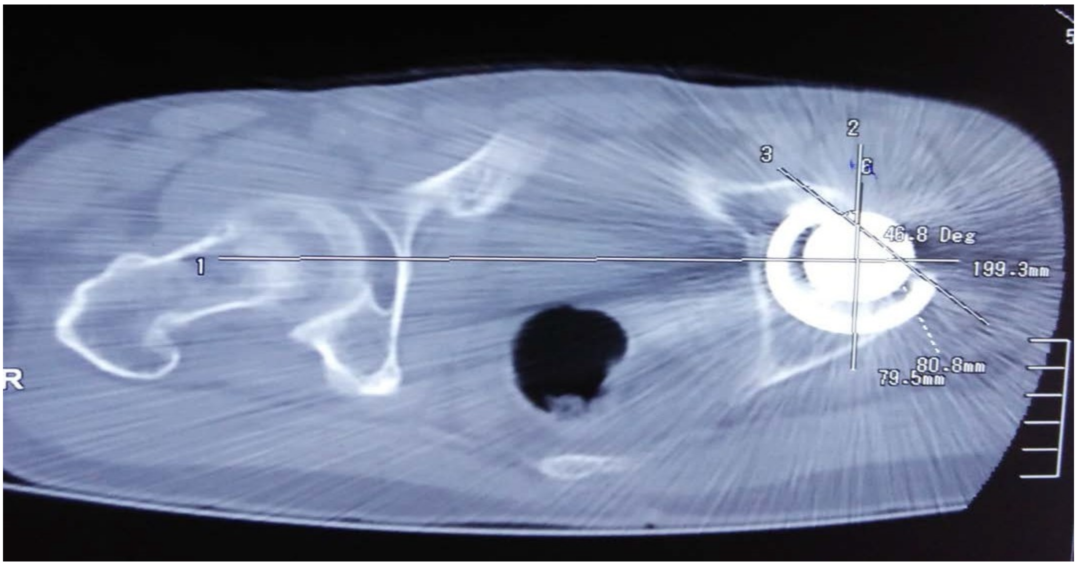
**Karupayee, 70 yrs, female, diagnosed as fracture neck of femur right side**


**CASE 4**

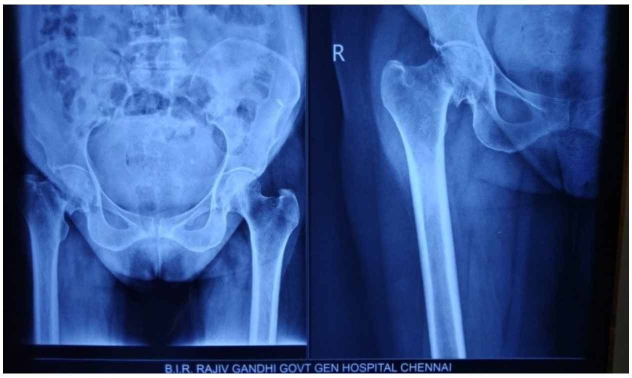
Subramani, 53 yrs, male, diagnosed as fracture neck of femur left side

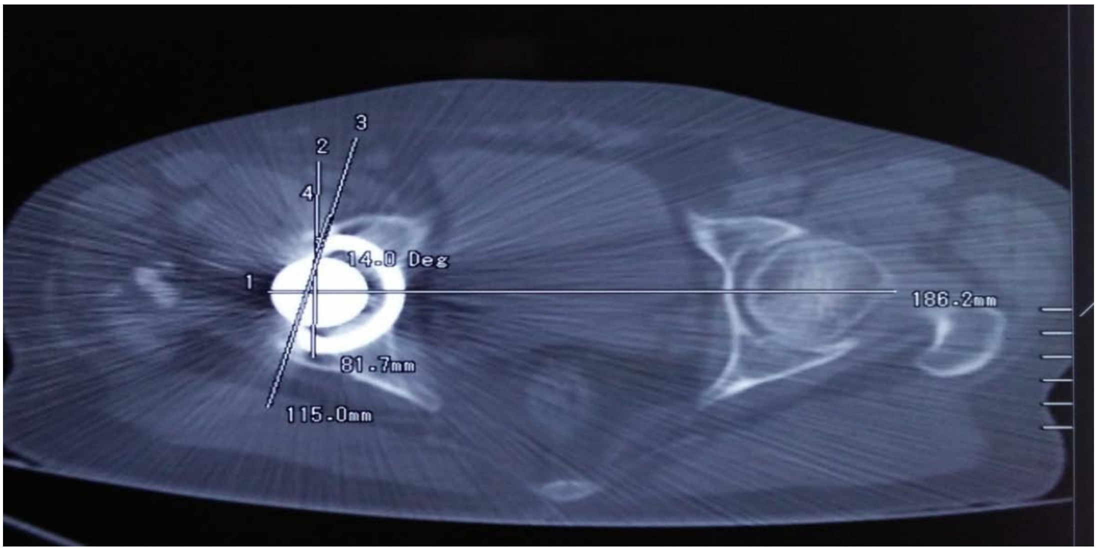




# CASE-5

Kasthuri, 54 yrs, female, diagnosed as fracture neck of femur right side





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**INSTITUTIONAL ETHICS COMMITTEE**
**MADRAS MEDICAL COLLEGE, CHENNAI 600 003**

EC Reg.No.ECR/270/Inst./TN/2013
Telephone No.044 25305301
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**CERTIFICATE OF APPROVAL**

To
**Dr.G.N.Sukumar**
PG in M.S. Orthopaedics
Institute of Orthopaedics and Traumatology
Madras Medical College
Chennai

Dear Dr.G.N.Sukumar,

The Institutional Ethics Committee has considered your request and approved your study titled **"FUNCTIONAL OUTCOME ANALYSIS WITH REGARD TO CUP INCLINATION, FEMORAL AND ACETABULAR VERSIONS IN TOTAL HIP REPLACEMENT " - NO.07042018**

The following members of Ethics Committee were present in the meeting held on **03.04.2018** conducted at Madras Medical College, Chennai 3

1. Prof.P.V.Jayashankar :Chairperson
2. Prof.R.Jayanthi,MD.,FRCP(Glasg) Dean,MMC,Ch-3 : Deputy Chairperson
3. Prof.Sudha Seshayyan,MD., Vice Principal,MMC,Ch-3 : Member Secretary
4. Prof.N.Gopalakrishnan,MD,Director,Inst.of Nephrology,MMC,Ch : Member
5. Prof.S.Mayilvahanan,MD,Director,Inst. of Int.Med,MMC, Ch-3 : Member
6. Prof.A.Pandiya Raj,Director, Inst. of Gen.Surgery,MMC : Member
7. Prof.Shanthy Gunasingh, Director, Inst.of Social Obstetrics,KGH : Member
8. Prof.Rema Chandramohan,Prof.of Paediatrics,ICH,Chennai : Member
9. Prof. Susila, Director, Inst. of Pharmacology,MMC,Ch-3 : Member
10. Prof.K.Ramadevi,MD., Director, Inst. of Bio-Chemistry,MMC,Ch-3 : Member
11. Prof.Bharathi Vidya Jayanthi,Director, Inst. of Pathology,MMC,Ch-3: Member
12. Thiru S.Govindasamy, BA.,BL,High Court,Chennai : Lawyer
13. Tmt.Arnold Saulina, MA.,MSW., :Social Scientist
14. Thiru K.Ranjith, Ch- 91 : Lay Person

We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

Member Secretary – Ethics Committee

URKUND

# Urkund Analysis Result

**Analysed Document:** Thesis final copy updated.docx (D58555565)
**Submitted:** 11/9/2019 5:38:00 AM
**Submitted By:** gnsdoc1987@gmail.com
**Significance:** 14 %

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# PLAGIARISM CERTIFICATE

This is to certify that this dissertation work titled "**FUNCTIONAL OUTCOME ANALYSIS WITH REGARD TO CUP INCLINATION, FEMORAL AND ACETABULAR VERSIONS IN TOTAL HIP REPLACEMENT"** of the candidate **Dr.SUKUMAR.G.N.** with Registration Number **221712008** for the award of degree in **M.S.** in the branch of **ORTHOPAEDICS**. I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows **14 percentage of plagiarism** in the dissertation.

**Guide & Supervisor sign with Seal**

# PROFORMA

Patient's Name:

Age and sex:

Occupation:

Address:

Contact no:

I.P. No:

Date and mode of injury:

Date of admission:

Plain X-ray AP view of hips:

CT SCAN:

Diagnosis:

Treatment:

Date of surgery:

Other co morbid conditions:

Post operative complications:

Follow up: evaluated with CT scan of affected hip

Functional assessment: graded as excellent, good, fair and poor.

# PATIENT CONSENT FORM

Study Title: **"FUNCTIONAL OUTCOME ANALYSIS WITH REGARD TO CUP INCLINATION, FEMORAL AND ACETABULAR VERSIONS IN TOTAL HIP REPLACEMENT"**

Study Center: **Institute of Orthopaedics and traumatology, Rajiv Gandhi Govt. General Hospital,**
**Madras Medical College, Chennai - 3.**

Participant Name: Age/Sex: I.P.No. :

I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask the question and all my questions and doubts have been answered to my satisfaction.

I have been explained about the pitfall in the procedure. I have been explained about the safety, advantage and disadvantage of the technique.

I understood that my participation in the study is voluntary and that I am free to withdraw at anytime without giving any reason.

I understand that investigation, regulatory authorities and the ethics committee will not need my permission to look at my health records both in respect to current study and any further research that may be conducted in relation to it, even if I withdraw from the study.

I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law.

I agree not to restrict the use of any data or results that arise from the study.

Date :
Place :

**Signature / Thumb impression**

**Patient Name :**

Signature of the investigator:

Name of the investigator: Dr.G.N.SUKUMAR.

# ஆராய்ச்சி ஒப்புதல் படிவம்

ஆராயச்சியின் தலைப்பு

**இடுப்பு மூட்டு மாற்று அறுவை சிகிச்சையில் இடுப்பு மற்றும் தொடை எலும்பில் பொருத்தப்படும் உள்வைப்பு கருவிகளின் சாய்வு கோணம் மற்றும் முன்கூட்டிய கோணங்களைப் பொறுத்து செயல்பாட்டு விளைவுகளை பகுத்தறிதல்**

ஆய்வு நிலையம் : எலும்பு மற்றும் முடநீக்கியல் துறை,
சென்னை மருத்துவக் கல்லூரி சென்னை – 3.

பங்கு பெறுவரின் பெயர் :

பங்குபெறுபவரின் எண் :

**பங்குபெறுபவர் இதனை (✓) குறிக்கவும்**

மேலே குறிப்பிட்டுள்ள மருத்துவ ஆய்வின் விவரங்கள் எனக்கு விளக்கப்பட்டது. என்னுடைய சந்தேகங்களை கேட்கவும், அதற்கான தகுந்த விளக்கங்களை பெறவும் வாய்ப்பளிக்கப்பட்டது. ☐

நான் இவ்வாய்வில் தன்னிச்சையாகதான் பங்கேற்கிறேன். எந்த காரணத்தினாலோ எந்த கட்டத்திலும் எந்த சட்ட சிக்கலுக்கும் உட்படாமல் நான் இவ்வாய்வில் இருந்து விலகி கொள்ளலாம் என்றும் அறிந்து கொண்டேன். ☐

இந்த ஆய்வு சம்பந்தமாகவோ, இதை சார்ந்த மேலும் ஆய்வு மேற்கொள்ளும் போதும் இந்த ஆய்வில் பங்குபெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகளை பார்ப்பதற்கு என் அனுமதி தேவையில்லை என அறிந்து கொள்கிறேன். நான் ஆய்வில் இருந்து விலகிக் கொண்டாலும் இது பொருந்தும் என அறிகிறேன். ☐

இந்த ஆய்வின் மூலம் கிடைக்கும் தகவல்களையும், பரிசோதனை முடிவுகளையும் மற்றும் சிகிச்சை தொடர்பான தகவல்களையும் மருத்துவர் மேற்கொள்ளும் ஆய்வில் பயன்படுத்திக்கொள்ளவும் அதை பிரசுரிக்கவும் என் முழு மனதுடன் சம்மதிக்கின்றேன். ☐

இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக்கொள்கிறேன். எனக்கு கொடுக்கப்பட்ட அறிவுரைகளின்படி நடந்து கொள்வதுடன் 'இந்த ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்று உறுதியளிகிறேன். ☐

பங்கேற்பவரின் கையொப்பம் .................. இடம்................ தேதி..............

கட்டைவிரல் ரேகை

பங்கேற்பவரின் பெயர் மற்றும் விலாசம் ..............................................

ஆய்வாளரின் கையொப்பம் ................... இடம்................. தேதி...............

ஆய்வாளரின் பெயர் ..........................................

# ஆராய்ச்சி ஒப்புதல் கடிதம்

**ஆராய்ச்சி தலைப்பு**

**இடுப்பு மூட்டு மாற்று அறுவை சிகிச்சையில் இடுப்பு மற்றும் தொடை எலும்பில் பொருத்தப்படும் உள்வைப்பு கருவிகளின் சாய்வு கோணம் மற்றும் முன்கூட்டிய கோணங்களைப் பொறுத்து செயல்பாட்டு விளைவுகளை பகுத்தறிதல்**

| | | | |
|---|---|---|---|
| பெயர் | : | தேதி | : |
| வயது | : | உள் நோயாளி எண் | : |
| பால் | : | ஆராய்ச்சி சேர்க்கை எண் | : |

இந்த ஆராய்ச்சின் விவரங்களும் அதன் நோக்கங்களும் முழுமையாக எனக்கு தெளிவாக விளக்கப்பட்டது.

எனக்கு விளக்கப்பட்ட விஷயங்களை நான் புரிந்துகொண்டு எனது சம்மதத்தை தெரிவிக்கிறேன்.

இந்த ஆராய்ச்சியில் பிறரின் நிர்பந்தமின்றி என் சொந்த விருப்பத்தின்பேரில் பங்கு பெறுகின்றேன். இந்த ஆராய்ச்சியில் இருந்து நான் எந்நேரமும் பின்வாங்கலாம் என்பதையும் அதனால் எந்த பாதிப்பும் ஏற்படாது என்பதையும் நான் புரிந்துகொண்டேன்.

நான் என்னுடைய சுய நினைவுடனும் மற்றும் முழு சுதந்திரத்துடனும் இந்த மருத்துவ ஆராய்ச்சியில் என்னை சேர்த்துக்கொள்ள சம்மதம்.

**ஆய்வாளரின் கையொப்பம்** **பங்கேற்பாளர் கையொப்பம்**

தேதி

# MASTER CHART

| S. no | Patients details | IP No./Unit | Diagnosis | Comorbidity | Pre op HHS | D.O.S | Approach | Post op HHS | Acetabular cup | | Femoral Version (FV) | CA+CI+ (0.77*FV) = | Compli cations | Results |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Inc (CI) | Ver (CA) | | | | |
| 1 | Munusamy, M/55 | 70508, II | Fracture neck of femur right side | Nil | 27 | 10/09/15 | Posterior | 92 | 42.1 | 17.6 | 28.7 | 81.79 | Nil | Excellent |
| 2 | Moorthy, M/41 | 70045, IV | Avascular necrosis right femoral head | Rheumatoid arthritis | 34 | 16/07/18 | Posterior | 89 | 38.4 | 16.4 | 35.3 | 83.59 | Nil | Good |
| 3 | Thangaraj, M/54 | 78814, IV | Fracture neck of femur left side | Nil | 24 | 15/12/18 | Posterior | 94 | 39.2 | 12.9 | 40.9 | 83.59 | Nil | Excellent |
| 4 | Kumar, M/75 | 85076, I | Fracture neck of femur Right side | Diabetic | 36 | 26/09/18 | Posterior | 92 | 39.0 | 17.4 | 35.3 | 83.58 | Nil | Excellent |
| 5 | Rani, F/60 | 88330, II | Fracture neck of femur Right side | Nil | 41 | 10/11/18 | Posterior | 89 | 41.7 | 13.5 | 36.0 | 82.71 | Nil | Good |
| 6 | Lakshmi, F/35 | 66018, IV | Avascular necrosis of femoral head right side | Nil | 46 | 09/12/17 | Lateral | 92 | 41.3 | 14.7 | 31.5 | 80.25 | Nil | Excellent |
| 7 | Mari, M/28 | 91538, IV | Secondary OA of left hip | Rheumatoid arthritis | 34 | 18/10/18 | Posterior | 92 | 39.1 | 17.6 | 34.1 | 82.95 | Nil | Excellent |
| 8 | Mukilan, M/34 | 94335, IV | Fracture neck of femur Right side | Nil | 45 | 29/09/18 | Lateral | 90 | 40.8 | 15.4 | 38.3 | 85.69 | Nil | Excellent |
| 9 | Anbalagan, M/35 | 101717, III | Fracture neck of femur left side | Nil | 24 | 27/09/18 | Anterolateral | 82 | 37.0 | 18.7 | 40.8 | 87.11 | Nil | Good |
| 10 | Venkatalakshi, F/40 | 95217, I | Avascular necrosis left femoral head | Nil | 52 | 03/10/18 | Posterior | 79 | 42.2 | 14.6 | 36.1 | 84.59 | Nil | Fair |
| 11 | Somu, M/46 | 78338, IV | Fracture neck of femur right side | Nil | 37 | 09/10/18 | Posterior | 94 | 40.7 | 12.4 | 42.0 | 85.44 | Nil | Excellent |

| S. no | Patients details | IP No./Unit | Diagnosis | Comorbidity | Pre op HHS | D.O.S | Approach | Post op HHS | Acetabular cup | | Femoral Version (FV) | CA+CI+ (0.77*FV) = | Compli cations | Results |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Inc (CI) | Ver (CA) | | | | |
| 12 | Subramani, M/53 | 82231, I | Fracture neck of femur left side | Nil | 41 | 10/10/18 | Posterior | 93 | 41.4 | 20.0 | 30.6 | 84.96 | Nil | Excellent |
| 13 | Ezhumalai, M/60 | 93535, II | Fracture neck of femur left side | Nil | 46 | 23/10/18 | Posterior | 89 | 39.4 | 16.7 | 33.6 | 81.97 | Nil | Good |
| 14 | Hemakumar, M/27 | 103408, I | Ankylosis of left hip | Rheumatoid arthritis | 44 | 23/01/18 | Posterior | Bed ridden | 40.2 | 19.4 | 34 | 85.78 | Nil | Poor |
| 15 | Adhiseshan, M/86 | 109820, I | Fracture neck of femur left side | Nil | Bed ridden | 03/11/18 | Posterior | Expired | 39.0 | 18.7 | 35.0 | 84.65 | Nil | -- |
| 16 | Rani, F/60 | 120261, I | Fracture Neck of femur left side | Nil | 32 | 12/10/18 | Posterior | 83 | 39.2 | 13.6 | 37.0 | 81.29 | Nil | Good |
| 17 | Karupayee, F/70 | 127357, I | Fracture neck of femur Right side | Diabetic | Bed ridden | 12/12/18 | Posterior | 90 | 43.4 | 15.9 | 31.4 | 83.47 | Nil | Excellent |
| 18 | Sundaravadivel, M/26 | 132492, IV | Secondary OA of left hip | Rheumatoid arthritis | 24 | 25/02/19 | Posterior | 90 | 41.0 | 18.2 | 33.8 | 85.22 | Nil | Excellent |
| 19 | Hemakumar, M/27 | 111671, IV | Ankylosis of hip right side | Rheumatoid arthritis | 18 | 08/11/17 | Posterior | 86 | 39.6 | 11.8 | 39.6 | 81.89 | Nil | Good |
| 20 | Ganga, F/38 | 94207, IV | Avascular necrosis right side | Nil | 25 | 15/03/19 | Posterior | 87 | 43.7 | 18.2 | 29.9 | 84.92 | Nil | Good |
| 21 | Selvam, M/54 | 17844, IV | Fracture neck of femur right side | Diabetic | 53 | 13/03/19 | Posterior | 75 | 47.0 | 33.0 | 22.4 | 97.24 | Dislocated | Fair |
| 22 | Poonkodi, F/38 | 142038, IV | Avascular necrosis left hip | Nil | 33 | 18/02/19 | Posterior | 84 | 61.3 | 16.3 | 21.3 | 94.01 | Dislocated | Good |
| 23 | Kasthuri, F/67 | 2648, I | Fracture neck of femur right side | Nil | 37 | 12/03/18 | Posterior | 92 | 39.9 | 18.3 | 30.4 | 81.60 | Nil | Excellent |
| 24 | Dhakshana moorthy, M/60 | 14010, II | Avascular necrosis of right hip | Diabetic, CAD | 28 | 37/01/17 | Posterior | 83 | 35.5 | 19.7 | 33.1 | 80.68 | Nil | Good |

| S. no | Patients details | IP No./Unit | Diagnosis | Comorbidity | Pre op HHS | D.O.S | Approach | Post op HHS | Acetabular cup | | Femoral Version (FV) | CA+CI+ (0.77*FV) = | Compli cations | Results |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Inc (CI) | Ver (CA) | | | | |
| 25 | Adhilakshmi, F/63 | 23612, IV | Fracture neck of femur right side | Nil | 52 | 12/11/18 | Posterior | 87 | 44.2 | 15.9 | 33.8 | 86.12 | Nil | Good |
| 26 | Kannamal, F/68 | 25903, IV | Fracture Neck of femur left side | Nil | 43 | 18/03/19 | Posterior | 83 | 38.5 | 11.5 | 39.6 | 80.49 | Nil | Good |
| 27 | Saroja, F/76 | 14419, III | Fracture Neck of femur right side | Nil | 27 | 21/03/19 | Posterior | 74 | 36.2 | 13.2 | 38.9 | 79.35 | Nil | Fair |
| 28 | Kathirvel, M/57 | 26737, II | Fracture Neck of femur right side | Nil | 46 | 27/04/19 | Posterior | 93 | 41.4 | 14.9 | 35.1 | 83.32 | Nil | Excellent |
| 29 | Thahira, F/68 | 59572, I | Fracture neck of femur left side | Nil | 27 | 31/08/18 | Posterior | 84 | 41.0 | 12.8 | 40.7 | 85.13 | Nil | Good |
| 30 | Thiripurasundari, F/80 | 16231, I | Fracture Neck of femur left side | Hypertensive | 37 | 10/03/19 | Posterior | 86 | 43.4 | 13.6 | 37.3 | 85.72 | Nil | Good |
| 31 | Thahira, F/68 | 59572, I | Fracture neck of femur left side | Diabetic | Bed ridden | 31/8/18 | Lateral | 85 | 44.7 | 17.1 | 20.3 | 77.43 | Nil | Good |
| 32 | Kaliyaperumal, M/67 | 77589, II | Avascular necrosis left femoral head | Nil | 40 | 14/8/18 | Posterior | 92 | 41.9 | 15.2 | 36.8 | 85.43 | Nil | Excellent |
| 33 | Somu, M/70 | 42572, III | Fracture Neck of femur left side | Diabetic | 33 | 02/05/19 | Posterior | 91 | 44.3 | 16.2 | 31.1 | 84.44 | Nil | Excellent |
| 34 | Mari, M/28 | 91538, IV | Secondary OA of left hip | Rheumatoid arthritis | 38 | 28/03/19 | Lateral | 90 | 43.2 | 16.9 | 33.8 | 86.12 | Nil | Excellent |
| 35 | Dhakshana moorthy, M/60 | 94817, II | Avascular necrosis of left hip | Diabetic, CAD | 32 | 23/23/18 | Posterior | 88 | 43.4 | 15.9 | 35.1 | 86.32 | Nil | Good |