INTRODUCTION

Although fractures of femoral neck can be seen in all ages and both sex groups. It is more devastating injury commonly sustained by elderly people. The history of the development of a treatment rationale for femoral neck fractures parallels the historical development of orthopaedic surgery itself. Specific milestones have included the principle of reduction by dynamic traction, the importance of anatomic reduction and maintenance in plaster, the development of stable internal fixation devices and finally the development of implant arthroplasty, which led to the era of total joint replacement.

Before the operative management of the fracture neck of femur, when the fractures were managed conservatively, the fracture meant a terminal event in the old and frail patients. Conservative management led to the complications of prolonged immobilization namely bed-sores, DVT, thrombo-embolic phenomena, aspiration pneumonia etc. and there was considerable truth to the phrase "we come into the world under the brim of pelvis and go out through thence of femur".[1]

Ambrose Pare,[2] the famous French surgeon recognized existence of hip fractures more than 400 years ago. But it was Sir, Astley Cooper in 1823 differentiated intra-capsular fractures from extra-capsular fractures.[3] Extra-capsular fractures unite readily because of rich blood supply of fractures surface whereas intra-capsular fractures undergoes nonunion and avascular necrosis because of precarious blood supply. The fracture of the femoral neck gained notoriety and attracted curiosity due its two commonest complications-AVN and Nonunion. In a classic treatise on femoral neck fractures, Speed,[4] branded them "the unsolved fracture". Barnes,[5] added another note of pessimism by calling them "the unsolvable fracture".

The conservative methods which were adopted by Phillips,[6] as a longitudinal and lateral traction to be used in the treatment of femoral neck fractures to eliminate "shortening or other deformity" as well as spica cast which was introduced by Royal Whitman in 1902,[7] were accompanied by problems of immobilization and proved fatal to many ill and elderly patients. Conservative methods were soon replaced by surgical treatment so that patient could be mobilized early. Internal fixation of the femoral neck fractures was started first of all by Von Langenbeck.[8] Several designs of nails followed, ordinary wood screw,[9] triflange nails,[10] cannulated nails,[11] telescoping nails or screws.[12] At present compression screws of various types like dynamic hip screws, multiple threaded pins, screws, garden screws are used for internal fixation.Internal fixation is commonly used in young patients with fracture neck of femur in whom bony union of the fracture is aimed at. But inadequate reduction of the fracture and distraction of the fragments during internal fixation may lead to non-union and AVN. Garden,[13] showed primary displacement and the quality of reduction.After internal fixation there is possibility of non-union, AVN and late segmental collapse of the head, prolonged hospital stay and late weight bearing which in elderly patients can lead to complications of immobilization like bed sores, DVT and thrombo-embolic phenomena etc.Removing the fractured portion of head & neck of femur and substituting it with a prosthesis offers advantage of early mobilization of patients which reduces the period of hospitalization and avoids non-union and AVN seen with internal fixation.

The era of arthroplasty had its beginning, when John Murray Carnochan reported interposing a small block of wood in an attempt to mobilize a patient's ankylosed jaw. Several surgeons had used Inter-positional arthroplasty. Thin platinum plates were attempted by Jules Emile Pean and John Benjamin Murphy reported use of gold foil for covering femoral head. Mould arthroplasty was used by a

Boston Surgeon in 1982,[14] which became forerunner of later designs. The development of an alloy, vitallium (consisting of 30% chromium, 5% molybdenum and 65% cobalt) by Charles Vanable & Walter Stuck which was chemically inert, and strong to meet the prosthesis requirements was a major break-through. J. Austin Tolley Morre & Harold Ray Bohlman,[15] inserted the first endoprosthesis of vitallium after resecting 30 cm of upper end of femur in a patient with recurrent giant cell tumor.Judet Brothers of Paris,[16] developed a new endoprosthesis made of acrylic bound to a chromium steel rod which was a failure due to rapid wear and breakage. Frederick R. Thompson,[17] introduced a chromium-cobalt femoral endoprosthesis with a non-fenestrated intra-medullary stem that curved to fit the upper shaft of femur. Austin-Moore,[15] introduced his "Self-locking" endoprothesis with a wider fenestrated stem.

Since then several modifications of endoprosthesis were designed but, only the Thompson's & Austin-Moore prosthesis stood the test of time.The common complications noted following insertion of "unipolar' endoprosthesis of Thompson or Austin-Moore type are aseptic loosening of stem, Supereo-Medial migration of prosthesis, acetabular erosion and protrusio-acetabuli. The development of acrylic bone cement, Methyl Metha Acrylate by Follacci and Charnley,[18] for stabilization of prosthetic hemi-arthroplasty reduced the incidence of loosening of the stem, although they noted that incidence of acetabular erosion and sepsis were increased by the use of bone cement owing to lack of motion of prosthesis-bone interface.A two- part endoprosthesis or a 'Bipolar' endoprosthesis was designed to reduce the problem of acetabular erosion and according to Bowman et al,[19] the trend was started by Bateman.[20] These implants consist of a femoral component that articulates with snap fit into the high density polyethylene liner of a metallic cup that moves freely within the patient's acetabulum. The design is aimed at reducing the friction and impact force at the

prosthesis-acetabular cartilage that are noted in conventional hemi-arthroplasty by allowing additional motion at the femoral head-polyethylene bearing interface.[21] But several authors, Cabanela & Van Demark,[22] and recently Raja et al observed that bipolar prosthesis offers no advantage over conventional hemi-arthroplasties in elderly patients with the only advantage of potential ease for converting it into a total hip replacement. Hemi-arthroplasty of hip advanced and the attention was centered on the acectabular component specially, when it was diseased by arthritis etc, which led to the era of total hip replacement. Sir, John Charnely,[23] pioneer of total hip replacement first used Teflon for the acetabular cup and later changed it to high density polyethylene.[24] The various merits, demerits, indications and contra -indications of arthroplasty of hip are as follows.[25]

Advantages of prosthetic replacement

1. Immediate weight bearing.

2. Eliminate complications like AVN & Non-union.

3. Reduces the incidence of Re-operation.

Disadvantage

1. Salvage procedures become complicated when there is infection or Mechanical failure.

2. Operation is generally more extensive-with more blood loss, large exposure & greater post-operative mortality rates.

3. Late complication – Septic or aseptic loosening of the stem of the prosthesis, proximal resorption of the femoral neck.

Indications

Absolute

1. A Fracture that cannot be reduced or fixed satisfactorily or severally comminuted.

2. Femoral neck fractures that loose fixation, weeks after operation.

3. Preexisting lesions of hip like AVN of head of femur from previous dislocation or irradiation etc.

4. In Malignancy: Fracture whether traumatic or pathological is candidates for PHR since patients already have a short life expectancy.

5. Patients with uncontrolled Seizures, those undergoing ECT, and with uncontrolled Parkinsonism.

6. Undiagnosed, untreated displaced fracture of femoral neck more than 3 weeks old.

7. Fracture of the neck of femur with complete dislocation of the femoral head.

8. A patient who probably cannot withstand two operations due to other Medical problems.

9. Patients with psychosis or mental Retardation or who are blind as they need rapid mobilization.

Relative

1. Advanced physiological age-generally accepted lower age limit is 70, with a life expectancy of 10-15 years.

2. Fracture dislocation of hip in an elderly individual (pip kin type II).

Contra-Indications

1. Pre-existing sepsis.

2. An active young patient in whom alternative procedures for salvaging femoral head are possible.

3. Several disease in acetabular articular cartilage secondary to osteo-arthritis, Rheumatoid-arthritis or failed internal fixation devices.

The human hip joint is extremely complex on account of the functional demands on it by the body. On account of its complex biomechanics and important function, a stable painless hip is required for normal locomotion.

Although hip surgery dates back to 19th century, but its greatest period of growth and development has occurred in 20th century. An ever growing population of chronic joint disease demanding relief of pain and disability has lead to development of operations such as osteotomy and arthroplasty. The original intent of arthroplasty was to restore motion to an ankylosed joint. This concept has been expanded to include the restoration, as far as possible, of the integrity and functional power of the diseased joint. While resection restores motion, arthroplasty must not only restore motion but also provide stability to the joint.

Total hip replacement is implanting an artificial femoral head and socket to replace the degenerated hip joint that will relieve pain, while preserving motion and stability and correcting deformity, if any.

During the last four decade of its inception, Charnley's low friction arthroplasty, at present remains the best reconstruction procedure. It was major turning point in the history of orthopaedics, since major hip disability could be treated with excellent results.

Total hip arthroplasty has been in constant changes since its inception. Polymethylmethacrylate (bone cement) introduced by Haboush as a mechanism for achieving rigid internal fixation, has lost its popularity due to problems of loosening of stem and cup. Materials involved in fixation of the implant to bone have also evolved. The choices are press-fit, porous coated, and hydroxyapatite coated stems and cups. They are being investigated as ways to eliminate the use of cement and to use bone ingrowths or outgrowths as a means of achieving durable skeletal fixation. These non-cemented implants have proven to be reliable and highly effective in the hands of expert surgeons.

With the development of modular system, a vast array of implants size can be assembled from a modest inventory of individual components. But the durability of modular implant

is of concern and the optimum method for the mating of parts has to be determined.

The results of Charnley's total hip arthroplasty were evaluated by different surgeons using hip score such as Merle d'Aubigne and Postel modified by Charnley, Harris, Lowa, Mayo, Hospital for special surgery etc. The results varied with each score.

So far, no ideal scoring system has been reported for the follow up studies in patients of Indian origin. This follow-up study by using Merle d'Aubigne hip score will make an attempt to report comparative assessment of the widely practiced cemented total hip arthroplasty and bipolar in India.

The study will be useful to the community, as it will throw light on the results and complications of Charnley's low friction arthroplasty in Indian patients. Besides, it will be useful for further improvement in the technique of the low friction arthroplasty. We, in the Department of Orthopaedics, Rajindra Hospital and Government Medical College, Patiala are doing "**Follow-up study of Total hip arthroplasty and Bipolar in intra-capsular fracture neck of femur in elderly people**" – A study of 25 cases each.

SURGICAL ANATOMY OF THE FEMORAL NECK AND HEAD

Anatomically, proximal femur consists of femur head, femur neck and trochantric region of large multiaxial ball and socket type synovial joint, enclosed by thick articular capsule which permits free movements of hip joint. Femoral neck projects superiorly, anteriorly and medially from the upper femoral shaft. It is broader at its base laterally and narrower just below and lateral to the origin of the femoral head. Vascular foramina are present on the antero-inferior aspect of the neck.

The surface of the femoral head is covered with articular cartilage, about 4 mm in thickness over the superior portion and 3mm at the equator. Medial to the axis of the femoral head is fovea centralis, a small area devoid of articular cartilage where the ligamentum teres is attached and articulates with cup like acetabulum.

The fibrous capsule encloses the joint and is attached to acetabular labrum medially. Laterally it is attached to the inter-trochantric line of the femur in front and half way along the posterior aspect of the neck of the bone behind and thickens to form three ligaments of hip joint. At its attachment to the inter-trochantric line in front, some of its fibers, accompanied by blood vessels, are reflected upwards along the neck as bands, called retinacula, supplying the head and neck of the femur.

The internal architecture of the proximal end of the femur has been a subject of considerable investigation, discussion and controversy. Internal trabecular system of the femoral head was first described by Ward, who recognized two groups of trabeculae as under:-

Compression Group

This group arises from the medial portion of shaft upward into the head, which is again divisible into primary and secondary groups.

Tensile group

This arises from the lateral portion of the shaft and curving upwards, ending in the upper portion of the neck and inferior portion of the head.These two systems intersect each other at a right angle. There is a third group which connects these two principle groups.There is structurally weak triangular area in the neck of the femur which is comprised of rather loosely arranged thin trabeculations. This was described by Ward and is known as 'Ward's Triangle' or the 'trigonum internum femoris'. It is well delineated in the aged, particularly in the female with osteoporosis. This area is of importance; as through it majority of the fractures of the femoral neck occur. According to Harty,[26] and Griffin,[27] the calcar femoral is a dense vertical plate of bone extending from the posterior medial portion of the femoral shaft under the lesser trochanter and radiating, laterally forwards the greater trochanter, reinforcing the femoral neck postero-inferiorly. This was considered as the true neck of femur.

Vascular Anatomy

Femoral neck fractures have all the problems associated with healing of intra-capsular fracture elsewhere in the body. The portion of femoral neck which is intra-capsular all of the anterior and posterior two-thirds have no cambium layer in the periosteum that could participate in the peripheral callus formation, so that healing of fracture is dependent on endosteal callus formation alone,[28] unless fracture fragments are carefully impacted, synovial fluid can lyses blood clot formation . Union of the fracture can occur in spite of an avascular fragment, although the incidence of nonunion is increased.Crock,[29] described the blood supply to the proximal end of the femur, which was divided into three major groups:-

1. An extra-capsular arterial ring located at the base of the femoral neck.

2. Ascending cervical branches of the arterial ring on the surface of the femoral neck.

3. Arteries of the ligamentum teres.

The extra-capsular arterial ring is from posteriorly by a large branch of the medial femoral circumflex artery and anteriorly by branches of the lateral femoral circumflex artery. The superior and inferior gluteal arteries also have minor contributions to this ring.These ascending cervical branches arise from the extra-capsular arterial ring and can be divided into four groups (anterior, medial, posterior and lateral). The lateral group provides most of the blood supply to the femoral head and neck.At the margin of the articular cartilage on the surface of the neck of femur, these vessels form a second ring termed the sub-synovial intra articular arterial ring. Once these arteries from the sub-synovial intra-articular ring penetrate the femoral head, they are termed the epiphyseal arteries. The artery of the ligamentum teres is a branch of the obturator or the medial femoral circumflex artery. The functional presence of this artery has been variably reported in the literature. Howe and his associates found that, although the vessels of the ligamentum teres did supply vascularity to the femoral head, they were often inadequate to assume the major nourishment of the femoral head after a displaced fracture. Trueta and Harrison,[30] believed that the femoral epiphyseal blood supply in the adult arose largely from the lateral epiphyseal arteries that enter the head postero-superiorly and secondarily from the medial epiphyseal artery entering through the ligamentum teres. Smith demonstrated that extreme valgus reduction or rotation of the capital fragment occluded the vessel in ligamentum teres. In fracture of the femoral neck with displacement, only the vesselsof ligamentum teres remain uninjured, hence the high association of the avascular necrosis of the femoral head

seen in fracture occurring in this area.

Classification of femoral neck fractures:

Sir, Astley Cooper on the basis of capsular attachment was first to classify these femoral neck fractures in treatise of 1822,[31] as intra-capsular and extra-capsular.

* Intra-capsular: that is within the capsular attachment

* Extra-capsular: that is outside the capsule attachment

Intracapsular fracture:

This is also called high fracture neck of femur in which proximal fragment often loses part of blood supply, hence union is difficult. This is divided according to level of fracture line in the neck as follows:

1. Sub capital

2. Trans cervical

3. Basal

Pauwel's classification

Pauwel,[32] divided femoral neck fracture into three types based on the direction fracture line across femoral neck in the AP X-Ray projection.

Type-I has a fracture obliquity 0- 30° from the horizontal.

Type-II has a fracture obliquity 30-50° from the horizontal.

Type-III has a fracture obliquity 50- 70° from the horizontal.

Pauwel attributed non-union in type III fracture to the increased shearing force of this vertical fracture.

Garden's Classification

Garden,[13] proposed a classification system based on degree of displacement of the fracture noted on pre-reduction X-rays.

The Garden type-I fracture is an incomplete or impacted fracture. In this fracture, the trabeculae of the inferior neck

are still intact. This group includes the "abducted impaction fracture".

A garden type-II fracture is a complete fracture without displacement. The X-ray demonstrates that the weight-bearing trabeculae are interrupted by a fracture line across the entire neck of the femur.

A Garden type-III fracture is a complete fracture 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.

A Garden type -IV is a complete fracture with total displacement of the fracture fragments. In this fracture, all continuity between the proximal and distal fragments is disrupted. The femoral head assumes its normal relationship in the acetabulum. Therefore, trabecular pattern of the femoral headlines up with the trabecular -pattern of the acetabulum.

A.O. Classification system

Fractures of the femoral neck are classified as:-

Type BI: - Sub capital with no or minimal displacement.

BI.1. Impacted in valgus of 15 degree or more

BI.2. Impacted in valgus of less than 15 degrees.

BI.3. Non- impacted.

Type B2:- Trans- cervical fracture

B2.1. basicervical fracture

B2.2. midcervical with adduction

B2.3. midcervical with shear

Type B3:- Displaced sub capital fractures

B3.1. moderately displaced in varus and external rotation

B3.2. moderately displaced with vertical transation and

external rotation.

B3.3. markedly displaced.

Whatever classification system is used, impacted fracture must be distinguished from undisplaced fractures of the neck femur. The impacted fracture must be distinguished from undisplaced fractures of neck femur. The impacted fractures are stable and do suggest a conservative or non-operative approach. Undisplaced fractures of the femoral neck are entirely different. There is no impaction and therefore no inherent stability in this fracture. It is believed that almost 100% of these will subsequently displace if they are not internally fixed.

Incidence and Mechanism

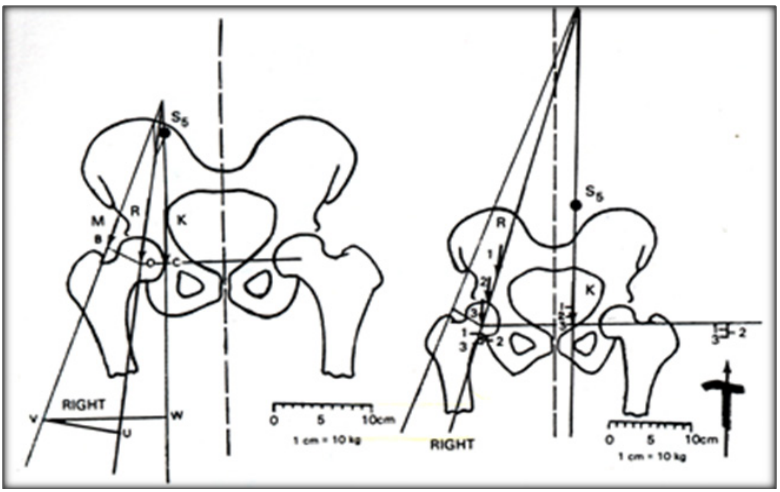
Post-menopausal women are more liable to sustain them owing to senile osteoporosis, in which 90% of hip fractures can result from trivial trauma or even spontaneously and may remain un-detected for weeks.[33] The incidence of these fractures has increased due to increased expectancy of life,[34] and by the year 2050 there will be an increase of 135% from year 2000 with advancement in medical technology.[35] In post-menopausal woman, due to lack of protective effect of estrogen, hip fracture is more common as compared to males in the ratio of M: F 1: 4 to that of simple senile osteoporosis,[36] and fracture of femoral neck presents epidemically in elderly people,[37] as this fracture is relatively rare in young people in which, it occurs due to high energy trauma.[38] Women are even more prone to this injury due to greater osteoporosis secondly to lack of adequate ambulation or antigravity activities as well as decreased hormone levels in postmenopausal age.[39] As per Zuckerman functional outcome score of good (80-100), Chinese people has better functional outcome, with Malasyians as second and Indians as third.[40] Epidemiological studies in Sweden has revealed that 28% risk of fracture neck femur with life expectancy of 14 years in a 75 years old Swedish lady as in contrast to 14% in UK with life expectancy

of 11 years in 75 years old woman.[41]

Despite the tremendous advances made in the field of operative techniques, anesthesia, and manufacture of implants. Fracture of the femoral neck remains an "unsolved fracture" with a variety of treatment options and the ideal rationale still unsettled. The surgeon is faced with Dilemma of whether to go for internal fixation or arthroplasty (total or hemi) especially in elderly patients. It is generally accepted that primary internal fixation be used in young adults, since in them best option is to heal the fracture by osteo-genesis, whereas arthroplasty is the best answer in old people. As the controversy regarding the ideal management of the fracture neck femur still exists, the purpose of the present study is to evaluate our own results of total hip arthroplasty and bipolar cases in intra-capsular fracture neck of femur among elderly people.

The primary aim of treatment should be to perform a surgery that provides to an individual greatest opportunity for early ambulation.[42] This requirement is fulfilled to a great extent by use of primary prosthetic replacement implant with or without cement. This technique allows early ambulation, thus avoids recumbency associated complications. Over the years orthopaedic surgeons has come to recognize the value of primary arthroplasty rather than other methods of fixation in elderly patients.[43] Arthroplasty is free from problems like fracture site nonunion and AVN. Salvage treatment with hip arthroplasty is being increasingly considered for selected older patients with poor bone quality, bone loss, osteoarthrosis or articular cartilage damage,[44] and other use is being extended for fractures.

Mechanism of Hip Joint



Body weight and abductor muscle pull act on the hip joint. Body weight acts through the lever arm from body's center of gravity to the center of the femoral head. The abductor musculature acts on a lever arm extending from the lateral aspect of the greater trochanter to the center of the femoral head. It exerts an equal moment to hold the pelvis level in one leg stance and a greater moment to tilt the pelvis on the same side when walking or running. Since the length of the lever arm of the body weight to the abductor muscle is 2.5:1, the abductor muscles must exert force 2.5 times the body weight to maintain the pelvis level when standing on one leg. Thus, the expected load on the femoral head in the stance phase of gait is equal to the sum of the forces created by the abductors and the body weight and is at least 3 times the body weight. Various experiments measuring forces about the hip joint using instrumented prosthesis have recorded contact forces of up to 3 times the body weight during single – limb stance phase of gait, increasing to up to 10 times the body weight during lifting, running or jumping.

The ratio of the two lever arm is important in the generation of the total forces acting on the hip joint. The shorter the horizontal distance from the center of gravity of the body to the hip joint, the less the muscle force is required to balance it. Conversely, the greater the horizontal distance from the hip joint to the center of the gravity, the more muscle force is required. These forces act not only in the coronal plane, but also act in the saggital plane. These forces are increased when the loaded hip is flexed, as when arising from the chair, ascending or descending stairs or lifting. Rotational stability of the stem can be increased by increasing the width of the proximal portion of the stem to better fill the metaphysis, retaining a longer segment of the femoral neck and having a rounder, rectangular cross- section of distal portion of the femoral stem.

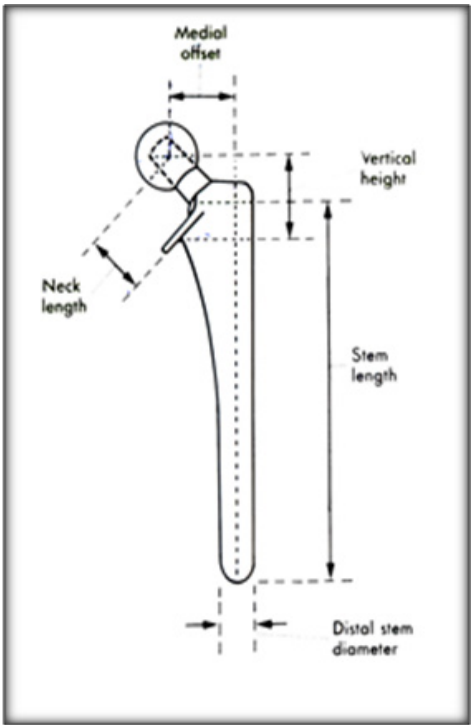
Centralization of head and lengthening of abductor lever arm

Charnley's concept of total hip arthroplasty was to shorten the lever arm of the body weight by deepening the acetabulum (centralization of the femoral head) and to lengthen the lever arm of the abductor mechanism by reattaching the osteotomized greater trochanter laterally. This greatly reduced the force exerted by the abductor musculature to counter balance the body weight. The abductor lever arm is shortened in arthritis to as high as 4:1. Changing surgically the lever arms to 1:1 reduces the total load on the hip by as much as 30%.

However, the principle of centralization has given way to preserving as much subchondral bone in the pelvis as possible. Also, the abductor lever arm can be altered relative to the offset of the head to the stem in case an osteotomy of the trochanter is not done.

Offsets: Ideal femoral reconstruction reproduces the normal center of rotation of the femoral head. This location is determined by three factors:

1. Vertical height (vertical offset)
2. Medial offset
3. Anterior offset (version of femoral neck)



Vertical height of the femoral head is measured as the distance from a fixed point, such as the lesser trochanter, to the center of the head. Restoring this distance is essential for correcting leg length. Using stems with variable neck length adjusts this distance.Medial offset is the distance from the center of the femoral head to a line through the axis of the distal part of the stem. Inadequate restoration of this offset shortens the moment arm of the abductor musculature and results in increased joint reaction force, limp and bony impingement. Conversely, an increase in the offset results in increased stresses with in the stem and cement mantle that may lead to stem fracture

or loosening. Medial offset is primarily a function of stem design. Most of the femoral stem is produced with the neck shaft angle of 135 degree. Normal anterior offset (version) is 10-15 degree of ante version. A stem fixed in retroversion can lead to posterior dislocation of the head.