COMPARISON OF VARUS MALALIGNMENT IN UNSTABLE EXTRACAPSULAR PROXIMAL FEMUR FRACTURE BETWEEN PROXIMAL FEMORAL NAIL ANTIROTATION (PFNA) AND PROXIMAL FEMORAL LOCKING PLATE (PFLCP): A RETROSPECTIVE STUDY

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Abstrak

Kepatahan tulang peha yang tidak stabil merangkumi bahagian ‘pertrochanteric’ dan ‘subtrochanteric’ adalah mencabar dan sukar kerana terdapat aliran bebanan yang tinggi di bahagian yang terlibat ke sendi peha. Pemilihan implant adalah kontroversial tetapi banyak kajian memihak kepada implan ‘intramedullary’ untuk rawatan kepatahan. Sifat tulang ditambah dengan pengaruh kuat dari otot sekeliling dan bebanan tinggi yang bertindak di sebelah ‘medial’ adalah penyebab kepada komplikasi and kerumitan yang berlaku semasa dan selepas pembedahan. ‘Varus malalignment’ adalah salah satu komplikasi yang utama dijumpai di dalam kes kepatahan tulang peha proksimal. Kajian ini adalah bertujuan untuk menilai insiden ‘varus malalignment’ di dalam kepatahan proksimal femur yang tidak stabil.

TATACARA: 60 pesakit yang mengalami kepatahan proksimal femur yang tidak stabil melibatkan bahagian ‘pertrochanteric’ dan ‘subtrochanteric’ ditempatkan ke dalam 2 kumpulan yang berlainan dari segi implan dan dinilai secara retrospektif. Terdapat 30 pesakit yang telah dibedah untuk kumpulan ‘proximal femoral nail antirotation’ (PFNA) dan ‘proximal femoral locking plate’ (PFLCP). Insiden ‘varus malalignment’ sebaik sahaja selepas pembedahan, kualiti reduksi kepatahan sebaik sahaja selepas pembedahan dan keupayaan mengekalkan reduksi kepatahan 6 bulan selepas pembedahan dianalisa untuk kedua-dua kumpulan implan.

KEPUTUSAN: Sebaik sahaja selepas pembedahan tulang kepatahan, insiden 'varus malalignment' adalah lebih tinggi di dalam kumpulan PFLCP (23.3%) berbanding kumpulan PFNA group (13.3%). Walaubagaimanapun, tiada perbezaan yang ketara secara statistik di antara kedua-dua kumpulan apabila perbandingan kualiti reduksi kepatahan sebaik sahaja selepas pembedahan dan keupayaan mengekalkan reduksi kepatahan 6 bulan selepas pembedahan dibuat.

KESIMPULAN: PFLCP menawarkan keputusan yang setanding dengan PFNA untuk rawatan kepatahan di dalam kes kepatahan extrakapsular tulang peha proksimal yang tidak stabil dari segi 'varus malalignment' sebaik sahaja selepas pembedahan dan 6 bulan selepas pembedahan.

Kata kunci: varus malalignment, PFNA, PFLCP, kepatahan proksimal femur yang tidak stabil

Abstract

Unstable fractures of proximal femur of the pertrochanteric and subtrochanteric region are challenging injuries due to the high loads transmission across the affected part of the bone to the hip joint. The selection of the implants remained controversial but many studies favouring intramedullary implants for fractures' fixation. The nature of the bone with strong muscular action with high compressive forces acting medially are responsible for intraoperative and postoperative complications and difficulties. Varus malalignment is one of the commonest complication found in proximal femur fractures. This study was done to evaluate the incidence of varus malalignment in unstable extracapsular proximal femur fracture.

METHODS: 60 patients with closed unstable fracture of proximal femur involving pertrochanteric and subtrochanteric region were subjected into 2 groups of fixation and retrospectively evaluated. 30 patients each for proximal femoral nail antirotation (PFNA) and proximal femoral locking plate (PFLCP) group were operated. Incidence of varus malalignment immediately post operation, quality of fracture's reduction immediately post operation and implant's sustainability of fracture's reduction at 6 months post operation were analyzed for both groups.

RESULTS: Immediately after fracture's fixation, incidence of varus malalignment was higher in PFLCP group (23.3%) compared to PFNA group (13.3%). However the quality of fracture's reduction immediately post operation and implant's sustainability of fracture's reduction at 6 months between both implants were not statistically significant.

CONCLUSIONS: PFLCP offered comparable result as PFNA for osteosysnthesis of unstable extracapsular proximal femur fracture in term of varus malalignment on immediate and 6 months post operation.

Keywords: varus malalignment, PFNA, PFLCP, unstable extracapsular proximal femur fracture

CHAPTER 1: INTRODUCTION

Road traffic accident is one of major causes of mortality and morbidity in South East Asia countries. Increasing trends of road traffic accident resulting musculoskeletal trauma contributes to major burdens to our health care system as it is one of the leading causes requiring admission to hospital. Long bones are mostly affected with lower limb had higher incidence of fracture compared to upper limb which accounted for 72% and 28% respectively.(1)

The incidence of proximal femoral fractures has increasing in recent decades and most probably the trends will continue due to long life expectancy of the population.(2) Proximal third femoral fracture has bimodal distribution of incidence which involved young and elderly population with the age of 20-40 years old and over 60 years old respectively. High energy mechanism are commonly involved in young age population in contrast to elderly group which associated with low energy fracture.(3)

Proximal femoral fracture can be divided into intracapsular and extracapsular fracture with the latter involving pertrochanteric and subtrochanteric region which can be treated with either intramedullary or extramedullary implant. The selection of implant remained controversial especially in unstable fracture. Intramedullary implant has been known to have several advantages biologically and biomechanically which includes load sharing ability, percutaneous insertion and short moment arm.(4)

Screw cut out, implant migration and varus malalignment of femoral neck are several complications that can occur from both intramedullary and extramedullary devices in fixation of proximal femoral fractures. The emerging of angular stable proximal femoral locking plate (PF-LCP) in 2007 has given surgeon an alternative for proximal femoral fractures' fixation. Nevertheless, several studies have showed mixed results including biomechanical and clinical trial.(5)(6)(7)

CHAPTER 2: LITERATURE REVIEWS

2.1 Relevant Anatomy

Bone consists of 70% mineral, 22% organic matrix and 8 % water. The main functions of the bone are body structural support and mobility. Other than that, bone helps to protect internal organs, store fat and minerals and involved in blood cells production.(8) Main composition of organic and inorganic matrix are type 1 collagen and calcium phosphate respectively. The combination makes bone stiff and tough material to maintain the shape of the body. The hardness of the bone is contributed by the mineral component. Elasticity and viscoelasticity are attributed to organic matrix and water component respectively.(9)

Bones can be divided into long, flat, short and irregular based on their shape. Their function are also different for each type; long bones for carry compressive loads and resist bending forces, short bones to counter primarily with compressive loads, flat bones to provide origin of muscles and to protect organs. The long bones mainly consists of cortical bone, conversely, cancellous bone in short bone. Overall, about 80% of bones in human body consists of cortical bone and the remaining 20% are made from cancellous bone. There are variations of distribution of cortical and cancellous bone between individual bones. Cortical bone can be found on the outer layer of all bones and cancellous bone on the inner side.(9)

The femur is the longest and heaviest bone in the body. It transmits body weight from the hip bone to the tibia when a person is standing. Its length is approximately a quarter of the person's height. The femur consists of a shaft and two ends, superior or proximal and inferior or distal. The superior (proximal) end of the femur consists of a head, neck, and two trochanters (greater and lesser). The round head of the femur makes up two thirds of a sphere that is covered with articular cartilage, except for a medially placed depression or pit, the fovea for the ligament of the head. In early life, the ligament gives passage to an artery supplying the epiphysis of the head. The neck of the femur is trapezoidal, with its narrow end supporting the head and its broader base being continuous with the shaft. Its average diameter is three quarters that of the femoral head.(10)

The head of femur projects superomedially and slightly anteriorly when articulating with the acetabulum. The head is attached to the femoral shaft by the neck of the femur. The head and neck are at an angle (115 to 140°, averaging 126°) to the long axis of the shaft of the femur. This is known as neck shaft angle and it is widest at birth and diminishes gradually until the adult angle is reached. It is less in females because of the increased breadth of the lesser pelvis and the greater obliquity of the shaft of the femur. When the femur is viewed superiorly, it is apparent that the two axes lie at an angle (the torsion angle, or anteversion angle), the mean of which is 7° in males and 12° in females.(10)

Where the neck joins the femoral shaft are two large, blunt elevations- the trochanters. The rounded, conical lesser trochanter extends medially from the posteromedial part of the junction of the neck and shaft. The greater trochanter is a large, laterally placed bony mass that projects superiorly and posteriorly where the neck joins the femoral shaft. The site where the neck joins the shaft is indicated by the intertrochanteric line- a roughened ridge running from the greater to the lesser trochanter. A similar but smoother ridge, the intertrochanteric crest, joins the trochanters posteriorly. The rounded elevation on the crest is the quadrate tubercle. The greater trochanter is in line with the femoral shaft and overhangs a deep depression medially- the trochanteric fossa.(10)

The shaft of the femur is slightly bowed anteriorly. Most of the shaft is smoothly rounded, except for a broad, rough line posteriorly- the linea aspera. This vertical ridge is especially prominent in the middle third of the femoral shaft, where it has medial and lateral lips (margins). Superiorly, the lateral lip blends with the broad, rough gluteal tuberosity, and the medial lip continues as a narrow, rough spiral line. The spiral line extends toward the lesser trochanter and then passes to the anterior surface of the femur, where its end in the intertrochanteric line. A prominent intermediate ridge- the pectineal line- extends from the central part of the linea aspera to the base of the lesser trochanter. Inferiorly, the linea aspera divides into medial and lateral supracondylar lines that leads to the spirally curved medial and lateral condyles. The condyles are separated inferoposteriorly by an intercondylar fossa.(10)

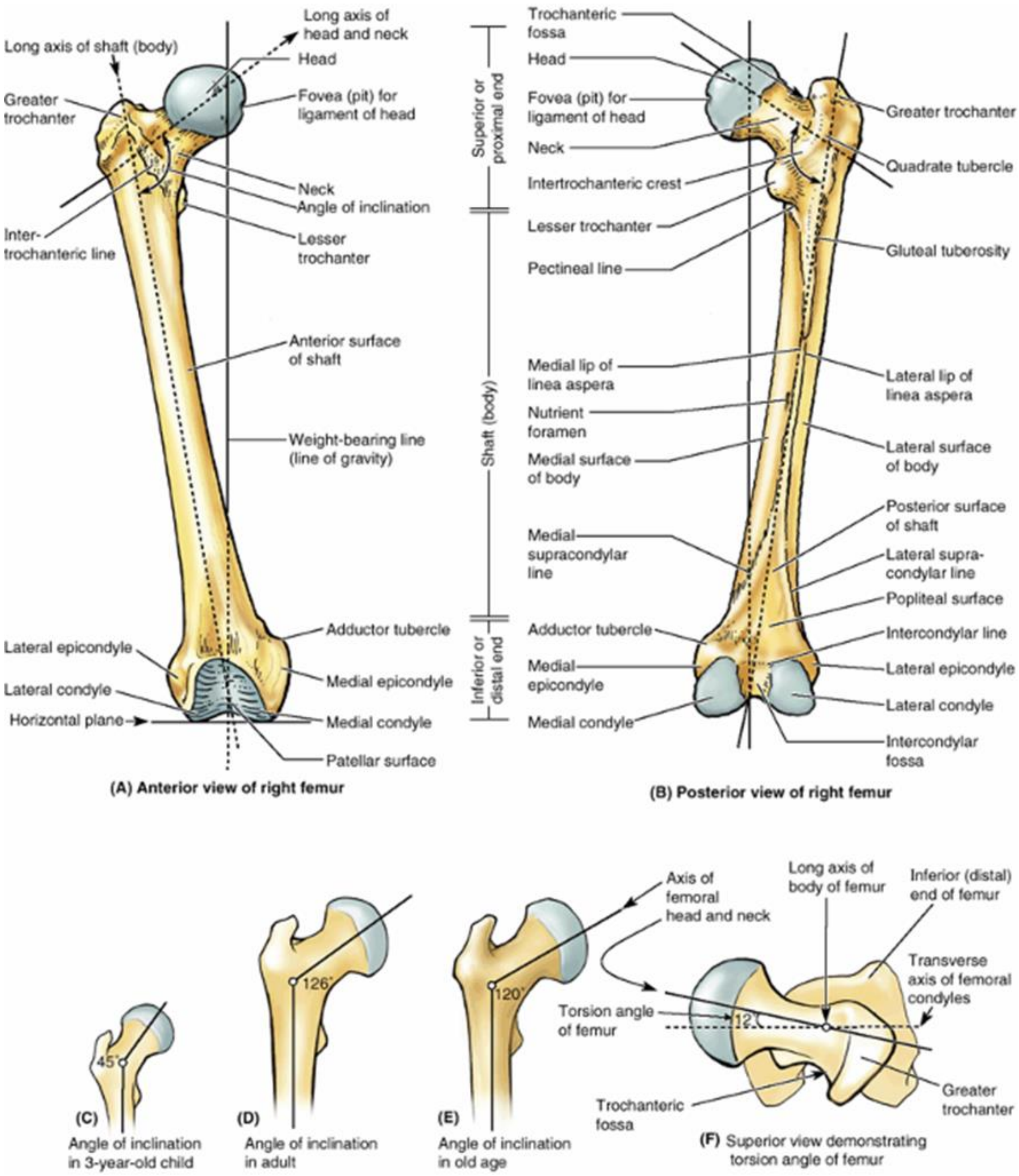

Figure A and B. The bony features of an adult femur are shown.

Figure C, D and E. The angle of inclination decreases with age.

Figure F. The axis of the head and neck of the femur forms a 12° angle with the transverse axis of the femoral condyles (angle of torsion/ anteversion angle).

Ward has described the internal trabecular system of the femoral head which oriented along lines of stress. The thickest come from the calcar region and radiate into the lower part of the femoral head. The calcar femorale is a dense vertical plate of bone extending from the posteromedial portion of the femoral shaft under the lesser trochanter radiating to the greater trochanter and reinforcing the posteroinferior portion of the femoral neck.

The presence or absence of trabecular lines form the basis of the classification of osteoporosis described by Singh. It is a method of estimating the degree of osteoporosis by fitting the pattern of proximal femoral trabecular lines into six separate categories. Singh Index grades osteopenia from normal (grade 6; all trabecular groups are visible) to definite (grade 3; thinned trabeculae with a break in the principal tensile group) to severe (grade 1; only the primary compressive trabeculae are visible, and they are reduced) based on the ordered reduction in trochanteric, tensile, and ultimately primary compressive trabeculae. The grade is determined from a true AP projection of an intact proximal femur.(11) Incidence of fragility fractures of the hip secondary to osteoporosis increased from the age 65 years old onwards where substantial bone loss occurred.(12)

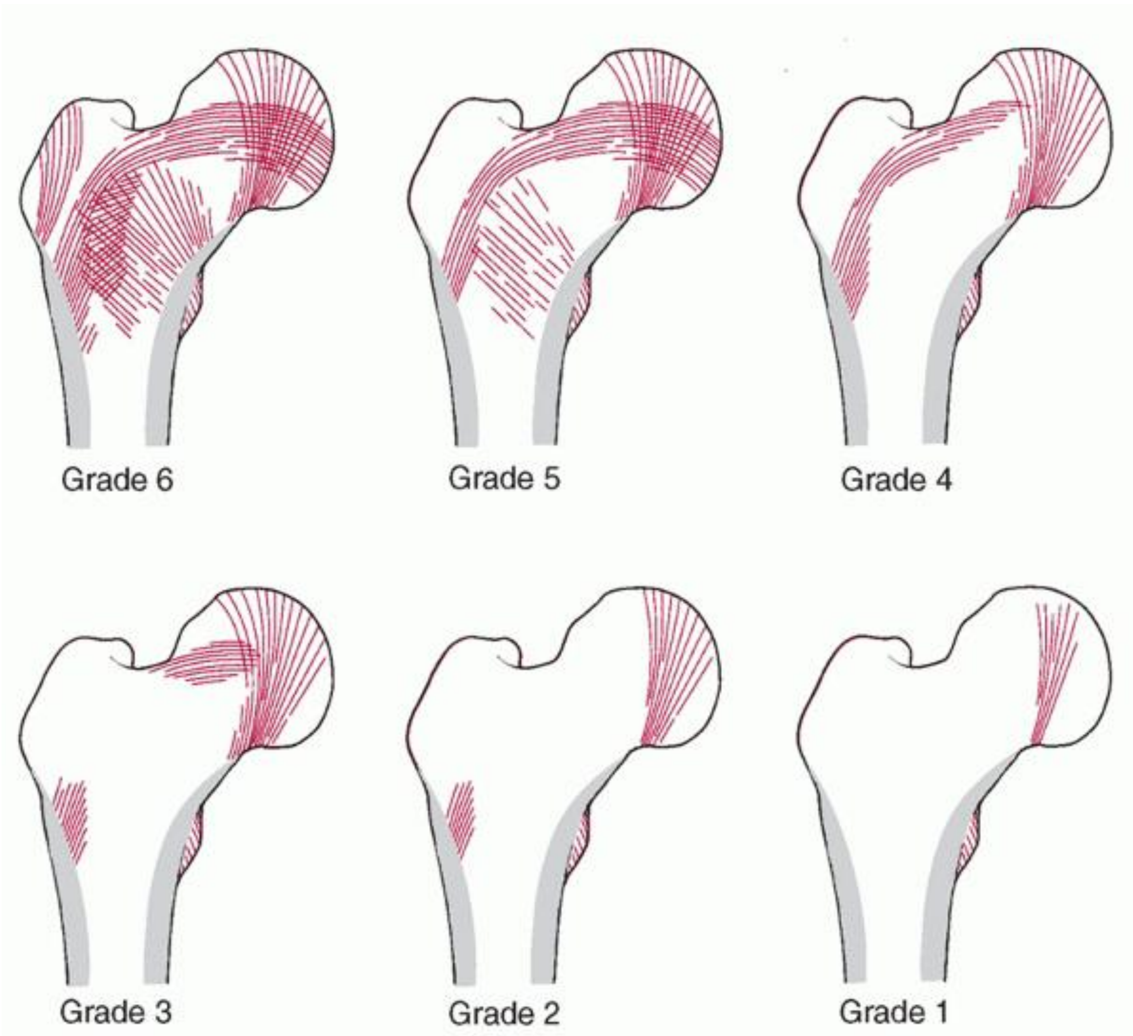

Figure G: Singh index

2.2 Epidemiology of trauma and proximal femoral fractures

Trauma is defined as an injury (as a wound) to living tissue caused by an extrinsic agent. It is a serious problem to all societies and becomes one of the leading cause of morbidity and mortality in developing and developed countries. Approximately 55 million peoples died worldwide with road traffic accident (RTA) as the ninth leading cause of the mortality with 1.3 million death in 2011 according to World Health Organization (WHO).

The number was increasing, with increment of 300,000 more deaths compared to year 2000 and road traffic accident was predicted to become as fifth leading cause of death by 2030. 50% of RTA occurred in adult with age ranging from 15 to 44 years old and three times greater in males rather than females. The sequalae of injuries from RTA often results in chronic and debilitating health problems.(13)

While in Malaysia in 2011, trauma is the third leading cause, accounted 8.98 % of hospital admissions in Kementerian Kesihatan Malaysia after maternity causes and diseases from respiratory system. 72.6% from total 123,916 patients that were registered in Malaysia National Trauma Database (MNTD) 2006 were from RTA with 64.9% involving motorcyclist and pillion rider.(14)

Proximal femoral fractures are quite common with incidence of 250000 cases per year with mortality rate ranging from 4.5% to 22% in the Unites states of America.(15) Extracapsular proximal femur fracture including intertrochanteric and subtrochanteric fractures accounted for approximately half of all fractures in the proximal femur.(16) Subtrochanteric fracture of femur is the least common compared to other proximal femur fractures with incidence ranging from for 2-10%.(17)(18)(19)(20)(21)

2.3 Extracapsular proximal femoral fractures

Extracapsular proximal femoral region is defined as an area starting from base of neck till 5cm distal to the lesser trochanter including pertrochanter and subtrochanter region. Pertrochanter region is an area extending from extracapsular part of femoral neck till lesser trochanter before development of medullary canal. On the other hand, subtrochanter region is located from lesser trochanter to 5cm distally.(11) Subtrochanter region can also be defined an area from lesser trochanter to the junction of proximal third and middle third of femoral shaft.(7)

Generally subtrochanteric fracture occur in two age group, either young or elderly population with the former often involves high energy fracture while the latter with low energy fracture in relatively osteopenic bone.(11) The fractures can be complex fracture and extending proximally into piriformis fossa and greater trochanter. This region consists mainly from cortical bone with relatively slower healing process compared to metaphyseal bone of intertrochanteric region. Fixation with intramedullary device can be difficult due to wide intramedullary canal and short segment of proximal femur.(22)

Pertrochanteric region consists of variable amount of cancellous and cortical bones and depends mainly on structural integrity of laminated cancellous bone arcade extending from femoral head, Ward's triangle to the lesser trochanter. When fractures occurred in proximal femur, the displacement depends on the attachment of musculotendinous to the fracture fragments. The proximal fragment will be abducted, externally rotated and flexed. The displacements are contributed by the action of gluteus medius, short external rotators and iliopsoas muscles. Distally, the shaft is displaced medially and posteriorly due to action of hamstrings and hip adductors. The combination of above forces will results in shortening and coxa vara in affected femur as shown in figure (H) below.(11)

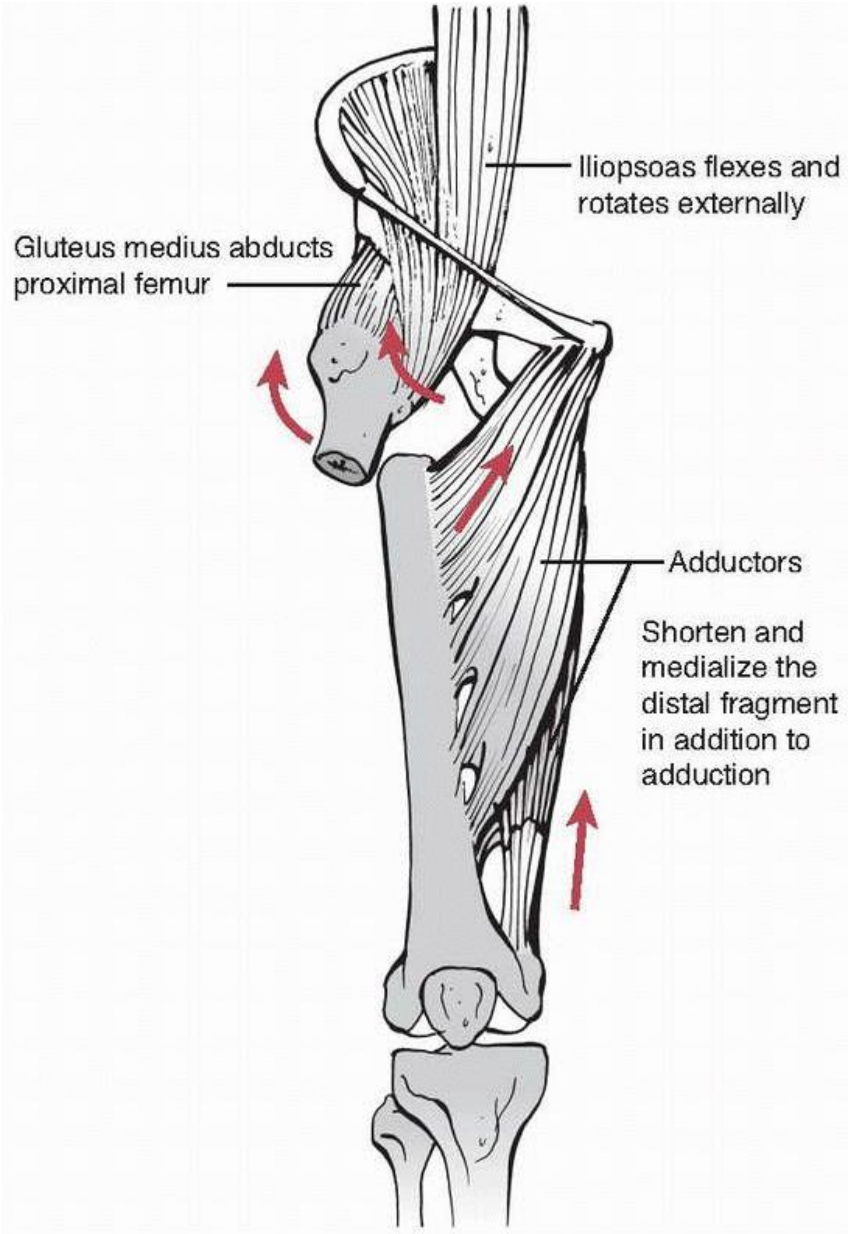

Figure H: Typical displacement of subtrochanteric fracture of femur with abduction, external rotation and flexion of proximal part with adducted and posteriorly displaced of distal part.

Unstable fracture patterns such as large posteromedial fragment separation, reverse obliquity pattern, basicervical fracture, displaced greater trochanteric fragment and irreducible fracture prior to internal fixation are associated with increase complexity of surgeries and recovery.(11)

2.4 Classification of extracapsular proximal femoral fractures

Many classifications of hip or proximal femur fractures have existed with the first was introduced by Astley Cooper in 1822 which classify into extracapsular and intracapsular fracture. Other classifications for intertrochanteric fracture are introduced subsequently by Boyd and Griffin (1949) and Evans (1949). Most articles used the OTA/AO classification (Figure I) which is based on anteroposterior radiograph. Fractures were classified into three groups (31-A1, 31-A2 and 31-A3) with subtype based on fractures comminution and fracture line obliquity. In 31-A1, the fractures are two part with fracture line extending obliquely from greater trochanter to medial cortex of proximal femur. In 31-A2 the fractures are comminuted with a posteromedial fragment. In 31-A3, the features are reverse obliquity pattern with fracture line extending across medial and lateral cortices. Overall there are nine types in OTA classification with 31-A1 fracture being the most stable fracture and 31-A3 as most unstable fracture.(11)

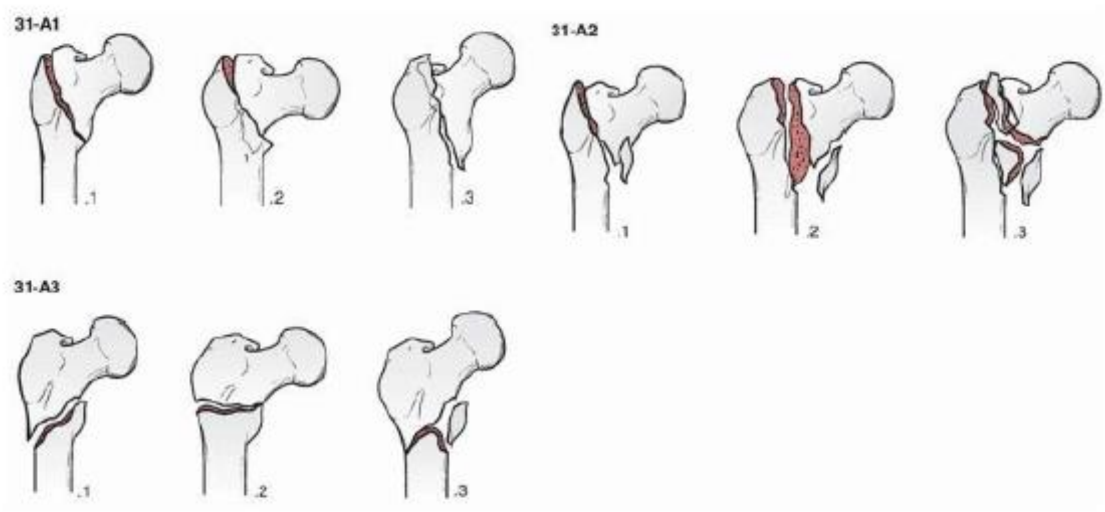

Figure I: OTA/AO classification of intertrochanteric fracture of femur

Several classifications for subtrochanteric fracture such as Russell-Taylor, Seinsheimer and Orthopedic Trauma Association (OTA) were introduced to guide surgeon for implants selection. Generally the classifications made were based on integrity of proximal fragment, fracture geometry and comminution. Seinsheimer classification is more detailed than Rusell Taylor and the classification as shown in Figure J.(23)

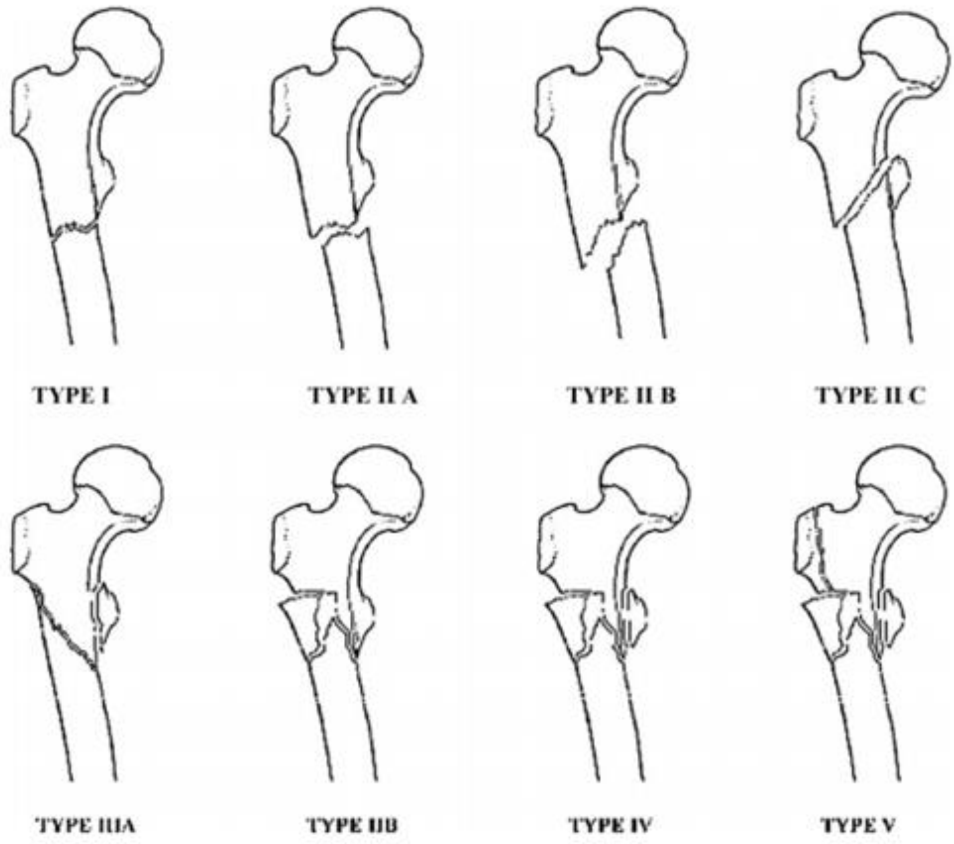

Figure J: Seinsheimer classification of subtrochanteric fractures

Type I is undisplaced fracture with less than 2 mm displacement. Type II fractures consist of displaced two-part fracture that can be further subdivided into type II A (transverse fracture pattern), type II B (spiral fracture with lesser trochanter attached to proximal fragment) and type II C (spiral fracture with lesser trochanter attached to the distal fragment. Type III is three-part fracture which includes type III A (spiral fracture with lesser trochanter as a butterfly fragment and type III B (spiral fracture with lesser trochanter as part of the third fragment). Type IV fracture includes four or more fragment and type V involve subtrochanteric–intertrochanteric fractures.(23)

2.5 Treatment

Generally most of the cases of pertrochanteric and subtrochanteric femoral fracture are treated with surgery. Rarely, nonoperative treatment can be opted in selected patient with unstable medical comorbidities, active infection, non-ambulatory, dementia and terminal illness with life expectancy less than 6 weeks. Care must be taken in non-operative treatment to prevent complications of bed bound and sufficient analgesia must be given to ease the pain. Usually by six weeks, as callus formed around the fracture site that reduced motion related pain, most of the patient can be lifted into wheel chair.(11)

The operative treatment offers various selection of implant in extracapsular proximal femoral fractures. Intramedullary implants are generally superior biologically and biomechanically with the ability of percutaneous insertion, short moment arm and load sharing property. However, it has its own technical difficulty and complications. Thus, the selection of implant is debatable for stabilization of extracapsular proximal femoral fracture especially in unstable fracture. Basically the implants can be divided into two major categories namely the extramedullary plate-screw system and intramedullary nail. Extramedullary implant such as dynamic compression hip screw (DHS), dynamic condylar screw (DCS) and fixed angle plate were commonly used in both pertrochanteric and subtrochanteric fractures. The popular extramedullary implant used is DHS which is a load sharing device that can provides compression along femoral neck in stable fracture. DHS is trochanteric stabilizing plate which prevent medial displacement of distal part. In unstable fracture, the fracture may angulate into varus with screw cut out, loosening or broken implant with secondary limb shortening on weight bearing due to medialization of distal fragment.(24) The complication rate ranging from 3-15% in cases of unstable fracture treated with DCS and DHS.(25)

Intramedullary implants such as cephalomedullary nail including proximal femoral nail antirotation (PFNA) and gamma nail are useful in unstable fracture due to superior biomechanic profile compared to extramedullary implant. When comparing with DHS, there were no significant different in term of operating time and intraoperative complication.(5) Several complications can be seen, for an instance gamma nail can result in higher risk of fracture at distal tip, intraarticular penetration of screw and screw's backout compared to DHS.(26) Cephalomedullary nail may delay fractures' healing by blocking the proximal fragment to the lateral wall by lying between fracture fragments.(27)

One of the commonly used cephalomedullary device is PFNA which was the third generation intramedullary device designed by AO in 2004 and consists of helical blade rather than screw for better purchase in femoral neck. (Figure K)

Figure K: Proximal femoral nail antirotation (PFNA) by Synthes Inc 2006