"CLINICAL STUDY OF FIXATION OF UNSTABLE PERI-TROCHANTERIC / SUB-TROCHANTERIC FEMORAL FRACTURES WITH 95^0 ANGLE BLADE PLATE"

By

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SDUAHER

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ABSTRACT

BACKGROUND:

Peri-trochanteric and Sub-Trochanteric hip fractures account for approximately half of the hip fractures in the elderly. By definition, these include any fracture from the extracapsular part of the neck of the femur to a point 5cm distal to the lesser trochanter. A bimodal age distribution is seen- old patients, usually females with osteoporotic low energy fractures and young patients, usually males with high energy injuries. Intertrochanteric fractures unite with conservative management, but this method is associated with high rate of complications. Hence, stable reduction and rigid internal fixation is the treatment of choice for these fractures. In this study, we have attempted to evaluate the results of surgical management of unstable peri-intertrochanteric and sub-trochanteric fractures with a 95 degrees angle blade plate.

MATERIALS AND METHODS:

This study is a hospital based prospective study centered in Department of Orthopaedics at R.L Jalappa Hospital and Research Centre, Kolar, from October 2012 to October 2014 in which 30 patients with Unstable Peritrochanteric and Sub-trochanteric fractures are treated with open reduction and internal fixation with 95 degrees angle blade plate.

RESULTS:

Patients were regularly followed-up post-operatively. Thirty cases were available for follow up. Excellent results were seen in 21 patients, good results in 7 patients, fair results in 2 patients and poor results in none.

INTERPRETATION AND CONCLUSION:

This study shows that the 95 degrees angle blade plate offers a reliable and effective alternative for the treatment of trochanteric fractures. The 95 degrees angle blade plate can be used for both stable and unstable intertrochanteric fractures, but the final outcome is dependent on various factors such as the type of fracture, the condition of the medial wall, the bony architecture, and the co-morbid conditions of the patient, the operative technique, implant position and post-operative care. The position of the implant should be such that the tip of the blade should be in the lower half of the femoral head and the blade should pass below the superior cortex of the neck. The 95 degrees angle blade plate is a stable and acceptable implant for the treatment of intertrochanteric fractures.

KEY WORDS:

Peri-trochanteric and Sub-trochanteric fractures; hip fractures; 95 degrees angle blade plate; condylar blade plate

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INTRODUCTION

Intertrochanteric fractures are seen more commonly in the elderly. They occur commonly in osteoporotic bone [1]. Most of them result from a simple fall from standing height [2]. They are 3-4 times more common in women than in men [3]. Though the energy is low, comminution of the fracture is usually seen due to osteoporosis [4].

Although relatively uncommon, intertrochanteric fractures also occur in the young, most commonly in men after high energy injuries [5]. A cadaver study has shown that the energy required to break this tough bone is very high in young adults [2].

By definition, Intertrochanteric fracture includes any fracture from the extra capsular part of the neck of the femur to a point 5 cm distal to the lesser trochanter [6].

Osteoporotic hip fracture is increasingly recognized as a growing problem in Asia as per the Asian Audit Report, 2009 [7, 8]. It is estimated that the incidence of hip fracture will rise from 1.66 million in 1990 to 6.26 million by 2050. Also by 2050, more than 50% of all osteoporotic fractures will occur in Asia.

Among elderly patients, hip fractures are associated with an in-hospital mortality of 7-14 % [9, 10]. In the earlier days, intertrochanteric fractures were treated conservatively as these fractures unite invariably. But this method is associated with high mortality and morbidity rates, 30% of elderly patients die within 1 year of fracture. After 1 year, patients resume their age-adjusted mortality rate [11].

Current guidelines recommend that surgeons perform hip fracture surgery within 72 hours of injury as observational studies suggest earlier surgery is associated with better functional outcome and lower rates of non-union, shorter hospital stays and duration of pain and lower rates of complication and mortality [12, 13, 14].

Internal fixation of trochanteric fractures is a life saving measure in the elderly [15]. Proper precautions are to be taken during surgery to prevent complications like coxa vara deformity, shortening, limited hip movements and secondary osteoarthritic changes in the hip.

Post-fracture rehabilitation is equally necessary. Early post-operative ambulation and physiotherapy is crucial and the best approach for the patient. The overall goal is returning of patient to pre-morbid level of function.

OBJECTIVES

- To determine the rate of union and functional outcomes of surgical treatment of unstable peri-trochanteric and sub-trochanteric fractures with 95° angle blade plate.
- To determine operative risks and intraoperative and post-operative complications of surgical treatment of unstable peri-trochanteric and sub-trochanteric fractures.

REVIEW OF LITERATURE

Prior to the year 1930, trochanter fracture management was conservative treatment basically [3].

In the year 1907, Fritz Steinmann, of Bern, devised a method to apply skeletal traction. He inserted two pins into the femoral condyles and applied traction [4].

In the year 1909, Martin Kirschner, of Greifswald, introduced small diameter stainless steel wires, which were inserted through and through to apply skeletal traction. But they were insufficiently rigid [3, 4].

In the year 1916, Steinmann introduced the Steinmann pins, which were rigid stainless steel pins of 9 inches length and 3-5 mm diameter [5].

In the year 1929, Bohler of Austria developed a special stirrup that could be attached to the Steinmann pin and helped in varying the direction of traction without rotating the pin in the bone [3, 4, 5].

In the year 1930, Jewett introduced the nail, which came to be known as Jewett nail (Figure 14), which could be inserted into the fracture through the greater trochanter to provide stability of fragments [4, 5].

In the year 1931, Smith-Peterson introduced the triflanged nail (Figure 16) for treatment of fracture neck of femur and trochanter fractures [3, 4, 5].

In the year 1932, Roger Anderson described a traction method where skeletal traction was applied to the injured leg while the well leg was employed for counter traction [3, 5].

In the year 1932, Johansson introduced the cannulated hip nail which was later modified by West Cott. This helped in more accurate placement of the nail in the femoral head. This was the precursor of guide pins used currently [16].

Since the year 1934, Austin T.Moore started studying proximal femoral fractures in detail. He began treating intertrochanteric fractures with nailing [16, 17].

In the year 1937, Lawson Thornton modified the Smith-Peterson nail by attaching a plate to the nail. This plate came to be known as Thornton plate [17].

In the year 1940, Austin Moore developed an implant which held the trochanteric fracture by a blade through the fracture into the head of the femur and a plate fixed to the shaft of the femur held with screws. It was made of steel, was 8 inches long and angled at 135° to correspond to the neck-shaft angle of the femur. Milwaukee suggested its use for the proximal femoral osteotomies at 95° angle also and it was named 'blade plate' [16, 17].

In the year 1941, Jewett developed a new implant modifying the Jewett nail by devising a single piece angled nail plate for an open reduction and internal fixation of intertrochanteric fractures [18].

In the year 1944, Austin Moore published a report about internal fixation of intertrochanteric fractures with blade- plate. He advocated the operative treatment stating that it decreased convalescence, hospital and nursing care expenses and improved functional recovery. He also stated that the length and shape of the blade plate could be altered to suit different needs in various conditions of proximal femur fractures [19].

In the year 1947, Irwin A. Jaslow published a case report of blade-plate fixation for trochanter fracture and advocated the use of blade-plate and mentioned about peri-prosthetic fracture and its management [20].

In the year 1947, McLaughlin introduced an adjustable nail plate combination (Figure 17). He used a triflanged nail with its lateral end having a slot to which a plate was fixed with a washer and bolt [21].

In the year 1949, Harold B.Boyd and Lawrence L.Griffin presented a paper regarding their study of 300 intertrochanteric fractures of femur in which they gave a classification based on prognosis and the difficulty of securing and maintaining reduction. They concluded that internal fixation results were comparable to results following non-operative management [6].

In the year 1949, Mervin Evans presented 123 cases of which 101 were treated conservatively and 22 cases were treated with internal fixation with Capener Neufeld nail plates. He suggested that operative management had the advantages of early mobility and decreased mortality. He also devised a classification system (Figure 7) in which he divided the trochanteric fractures into stable and unstable types [22].

In the year 1949, RC Murray and JFM Frew published a report based on their review of 100 cases of trochanteric fractures in which they concluded that conservative treatment should be the routine and internal fixation should be reserved for cases where traction is inadequate. They stated that the operative complications of shock, infection and haemorrhage outweigh all advantages [23].

In the year 1950, GP Arden and GJ Walley studied a series of 37 intertrochanteric fractures treated by internal fixation. They opined that operative treatment had the advantages of early ambulation, fewer general complications, shorter hospital stay and earlier return to normal function [24].

In the year 1955, Taylor GM, Neufeld AJ and Nickel VL published a report about the complications and failures in the operative treatment of intertrochanteric fractures of the femur based on their study of 1500 trochanteric fractures of which 123 fractures showed marked complications such as infection, embolism and implant failure [25].

In the year 1959, Cleveland M et al published a report based on their ten year analysis of intertrochanteric fractures of the femur. They concluded that the treatment of trochanteric fractures of the femur has become that of surgical fixation. The presence of associated geriatric pathologies and complications demand team work [1].

In the year 1960, the USA based ‘Richards manufacturing company’ produced dynamic compression screw. Hence, it came to be known as ‘Richards screw’. Clawson made several modifications and in its current form, the device is known as Richards Compression Screw [26].

In the year 1967, Dimon and Hughston evolved a new method of fixation termed primary medial displacement osteotomy [PMDO]. This prevented the cut-out of the implant and the collapse of the fracture in varus position [27].

In the year 1970, Singh et al described the trabecular pattern of the upper end of the femur (Figure 5) and the changes noted in the trabecular pattern as an index of osteoporosis [28].

In the year 1973, Mann RJ published his study on the avascular necrosis of the femoral head following intertrochanteric fractures and concluded that though the risk of avascular necrosis was very small, it was definite and needed a high degree of clinical suspicion and should be diagnosed as early as possible for better outcomes [29].

In the year 1973, Augusto Sarmiento emphasized that the reduction of the medial cortex determines the efficiency of the metallic appliances. After accurate reduction of the medial cortex, fracture can withstand great stresses, while improper reduction of medial cortex resulted in collapse into varus with implant failure. He also stated that osteotomy gives maximal stability and changes the angle of inclination of the fracture to a less vertical degree introducing a valgus attitude to the proximal femur [30, 34].

In the year 1978, Whatley JR et al published a report based on their review of twenty-three trochanteric fractures of the femur treated with the Association for the Study of Internal Fixation (ASIF) blade plate fixation. They found that there were 17 primary unions (0 to 6 months), two delayed unions (6 to 12 months), and two nonunions with device failure, requiring reoperation and bone grafting before healing. There were two deaths, but only one was due to postoperative complications. They concluded that ASIF blade plates provide adequate stabilization and fixation with a high rate of union in trochanteric fractures of the femur [31].

In the year 1980, Jacobs RR, McClain O, Armstrong HJ published a report based on their review of one hundred seventy-three cases of intertrochanteric fractures treated by internal fixation, 72 treated with the Jewett nail and 101 with the Richards compression hip screw. Both devices maintained adequate reduction in the majority of cases. Treatment failure in the form of loss of fixation, symptomatic joint penetration, aseptic necrosis, malunion and nonunion occurred in 25% of the Jewett nail cases and 6% of the Richards screw cases. They also found that the compression screw is subjected to less bending stress by acting as a lateral "tension band" in stable reductions and by allowing sliding, thus shortening the bending movement lever arm in unstable reductions. They concluded that the compression hip screw is valuable in the treatment of intertrochanteric hip fractures [32].

In the year 1989, Kinast C, Bolhofner BR, Mast JW, Ganz R published a report based on their retrospective analysis of 47 trochanteric fractures of the femur treated with a 95 degrees condylar blade-plate to establish whether two different surgical techniques yielded different results. Twenty-four fractures were treated by extensive visualization of the fracture lines, permitting anatomic reduction of all fragments, stable internal fixation with the blade-plate, and optional autologous bone grafting and constituted Group I of this study. Twenty-three patients were treated by an indirect reduction technique to gain optimal alignment and stability without aiming at anatomic reduction, visualization of the fracture lines was abandoned, especially at the medial cortex and bone grafting was discontinued. They constituted Group II of the study. Average time to bony union for those fractures that healed primarily was 5.4 months in Group I and 4.2 months in Group II. Delayed or nonunion was 16.6% in Group I and 0% in Group II, and the infection rate was 20.8% versus 0% in the two groups. The functional end result was comparable for both groups. The authors concluded that the use of the indirect reduction technique that preserves the vascularity of the medial fragments and osseous compression were the two most important pre-requisites for a successful outcome using a 95 degrees condylar blade-plate [33].

In the year 1991, Brien WW, Wiss DA, Becker V Jr, Lehman T published a report based on their study of seventy-nine patients with peritrochanteric femur fractures. Group I consisted of 21 patients treated with a Zickel nail, Group II comprised 25 patients treated with a 95 degrees blade plate, and Group III included 33 patients treated with an interlocking nail. The average operating times for Groups I, II, and III were 212, 272, and 181 min, respectively, while blood loss averaged 900, 1,500, and 600 ml for each group, respectively. Group I had one infection, ten malunions, and one nonunion. Group II had one infection, six malunions, and two nonunions. Group III had no infections, two malunions, and one non-union. They concluded that closed interlocking nailing is the treatment of choice for acute non-pathologic peritrochanteric femur fractures in adults as there is decreased blood loss, reduced operating time, and fewer complications than with either the Zickel nail or the 95 degrees blade plate, regardless of the fracture pattern or the degree of fracture comminution [35].

In the year 1994, Curtis MJ, Jinnah RH, Wilson V, Cunningham BW conducted a biomechanical study to compare intramedullary and extramedullary fixation in proximal femoral fractures. Their study assessed the rigidity and strength of fixation provided by internal fixation with the Gamma nail for intramedullary and internal fixation with the Richards 135 degrees classic hip-screw for extramedullary fixation for proximal femoral fractures. They concluded that the fixation of trochanteric fractures with the intramedullary Gamma nail was significantly stronger and more rigid than that with the extramedullary screw plate devices. Also, the 95 degrees condylar screw plate provided more rigid fixation than did the 135 degrees hip screw [36].

In the year 1995, Vanderschot P, Vanderspeeten K, Verheyen L, Broos P published a retrospective review of 161 peritrochanteric fractures of the femur of which 107 cases were treated by a 95 degrees angular blade plate, 25 cases were treated by dynamic condylar screw and 29 cases were treated by a gamma nail. The mean operating times for the 95 degrees angled blade plate, the dynamic condylar screw and the gamma nail were 86, 85 and 74 min, respectively. 18 required a revision operation, of which 8 were initially treated using a 95 degrees condylar blade plate, 2 with a dynamic condylar screw and finally 8 with insertion of a gamma nail. The authors concluded that type IIIA fractures were the most unstable type and treatment of peritrochanteric fractures of the femur with 95 degrees condylar blade plate was superior to that of dynamic condylar screw and gamma nail [37].

In the year 1996, van Meeteren MC, van Rief YE, Roukema JA, van der Werken C described their experiences in 40 patients with trochanteric fractures treated with an AO 95 degrees condylar blade plate. Three cases developed deep postoperative wound infection which healed eventually. One patient developed a delayed union which ultimately resulted in repeated plate fractures due to fatigue. Three patients died early due to multiple injuries. Based on their favourable results, they considered the condylar blade plate fixation of trochanteric fractures to be an excellent method, especially if an image intensifier and/or fracture table were not available [38].

In the year 1998, Siebenrock KA et al studied 15 patients with intertrochanteric fractures treated by indirect reduction using a condylar blade plate. Union was achieved in 14 cases (93%) with full weight-bearing after a mean of 3 months (1-4 1/2 months). Malunion was seen in two cases (13%) without the need for further surgery. Non union occurred in one patient (7%) with a III B open injury due to early infection. After repeated debridements, bone grafting and decortication, the fracture was stabilized with a replacement condylar blade plate and healed uneventfully [39].

In the year 1999, Skoták M, Behounek J, Krumpl O summarized their long term outcomes of the use of 130 degrees angled blade plate in intertrochanteric fractures. The group comprised 110 patients. The analysis of the results proved that this technique was justified in stable fracture classification according to AO/ASIF - A1.1 A1.2. In other fractures A1.3 A2.1 A2.2 A2.3 there occured after 6 months a varus position and in extreme cases the internal fixation failed. In the second part of the article, Harris hip score was satisfactory in a group of 24 patients 3 to 6 years after surgery [40].

In the year 1999, Lundy DW, Acevedo JI, Ganey TM, Ogden JA, Hutton WC conducted a study to determine the stiffness and strength characteristics of certain plate-composite femur models designed to simulate unstable trochanteric femur fractures (OTA 31-A2.3). The femora were fixed with either the Synthes 95 degree angled condylar blade plate, a 95 degree dynamic condylar screw plate (DCS), or a 135 degree dynamic compression hip screw (DHS). The DHS-femur model was the stiffest (586 Newtons/ millimeter), followed by the 95 degree DCS (404 Newtons/millimeter) and the 95 degree condylar blade plate (260 Newtons/ millimeter). The DHS also had the highest ultimate load-to-failure [41].

In the year 1999, Chinoy MA, Parker MJ conducted a meta-analysis of 14 studies comparing the fixed nail plates versus sliding hip systems for the treatment of trochanteric femoral fractures. It involved a total of 3069 patients. Results showed an increased risk of cut-out (13% versus 4%), non-union (2% versus 0.5%), implant breakage (14% versus 0.7%) and re-operation (10% versus 4%) and higher mortality and morbidity rates for fixed nail plates in comparison with the sliding implants [42].

In the year 2001, Haidukewych GJ, Israel TA and Berry DJ published a report based on their study of 49 patients with a reverse oblique fracture of the intertrochanteric region of the femur. They found that 68% of fractures treated with internal fixation healed without an additional operation. 15 fractures failed to heal or had a failure of fixation. The failure rate was nine of sixteen for the sliding hip screws, two of fifteen for the blade-plates, three of ten for the dynamic condylar screws, one of three for the cephalomedullary nails, and zero of three for the intramedullary hip screws. 46% of non-anatomically reduced fractures failed while only 17% of anatomically reduced fractures had a failure of treatment. 26% of ideally placed implants failed while 80% non-ideally placed implants had a failure of treatment. In those who required revision surgery, functional results were poor and their two-year mortality was 33%. They concluded that ninety-five-degree fixed-angle internal fixation devices performed significantly better than did sliding hip screws [43].

In the year 2002, Sadowski C et al published the results of their prospective, randomized study for treatment of reverse oblique and transverse intertrochanteric fractures with use of either an intramedullary nail or a 95° screw-plate. Thirty-nine elderly patients with AO/OTA 31-A3 intertrochanteric fractures of the femur were randomized into two treatment groups and were followed for a minimum of one year. The nineteen patients in Group I were treated with a 95° fixed-angle screw-plate (Dynamic Condylar Screw), and the twenty patients in Group II were treated with an intramedullary nail (Proximal Femoral Nail). Patients treated with an intramedullary nail had shorter operative times, fewer blood transfusions, and shorter hospital stays compared with those treated with a 95Â° screw-plate. Implant failure and/or nonunion was noted in seven of the nineteen patients who had been treated with the 95Â° screw-plate. Only one of the twenty fractures that had been treated with an intramedullary nail did not heal. The results of their study supported the use of an intramedullary nail rather than a 95° screw-plate for the fixation of reverse oblique and transverse intertrochanteric fractures in elderly patients [44].

In the year 2004, Suriyajakyuthana W studied 69 patients with closed intertrochanteric femoral fractures who were treated using the 95 degrees Condylar Blade Plate. 13 patients were lost to follow up. 56 of them met the minimum 10 months follow up requirement. 53 patients (94%) healed after the procedure. There were 3 patients (7%) requiring surgical intervention. One patient developed post-operative infection, one patient had delayed union and broken implant, and one patient had cut through of the implant. The author concluded that open reduction and internal fixation using the 95 degrees Condylar Blade Plate was effective in treating patients with intertrochanteric femoral fractures. The surgical time and blood loss were minimized. Early patient rehabilitation was initiated, and the complications were decreased [45].

In the year 2005, Yoo MC, Cho YJ, Kim KI, Khairuddin M, Chun YS reported their retrospective, clinical study of thirty-nine consecutive patients with peritrochanteric femoral fractures. . There were 29 subtrochanteric fractures and 10 intertrochanteric fractures (reverse obliquity pattern). They were treated with open reduction and internal fixation using a 95 degrees angled blade plate. They found that the average time to osseous union for those fractures that healed primarily was 19 (range, 13-28) weeks. Two of 39 fractures united with 10 degrees varus deformity, but no corrective surgery was warranted. Limb length discrepancy more than 1.5 cm did not occur. Implant failure before solid bony union occurred in 1 case with a severely comminuted subtrochanteric fracture. Postoperative infection or osteonecrosis of the femoral head did not occur any time throughout the follow-up period. They concluded that a 95 angled blade plate can be a useful alternative fixation device for the treatment of unstable peritrochanteric femoral fractures [46].

In the year 2005, Kregor PJ, Obremskey WT, Kreder HJ, Swiontkowski MF published a report based on their analysis of the relatively rare 31-A3 fracture, which has also been referred to as an "intertrochanteric femur fracture with subtrochanteric extension," "reverse obliquity intertrochanteric femur fracture," "unstable intertrochanteric femur fracture," or a "subtrochanteric femur fracture.". Possible fixation constructs include compression hip screws, intramedullary hip screws, trochanteric intramedullary nails, cephalomedullary antegrade intramedullary nails, and 95 degrees plates. They determined the effect of fixation technique for the AO/OTA 31-A3 fracture on rates of union, infection, risk of reoperation, and functional outcomes [47].

In the year 2006, Giannoudis PV, Schneider E published a report on the principles of fixation of osteoporotic fractures. They found that the fixed-angle devices, such as the angled blade plate, are very useful as they resist angular deformation and torsion, and the strain is reduced because the blade has a large surface area. Initial success with fixed-angle implants such as the blade plate has led to the development of screws which are rigidly fixed to the plate [48].

In the year 2007, Rahme DM et al compared closed intramedullary nailing to open reduction and internal fixation using a fixed angle blade plate for the management of subtrochanteric femoral fractures. They concluded that internal fixation using a fixed angle blade plate for subtrochanteric femoral fractures has higher implant failure and revision rates, compared to closed intramedullary nailing [49].

In the year 2009, Yong CK et al compared the outcome of 57 consecutive unstable intertrochanteric fragility fractures treated with Dynamic hip screw (DHS) fixation and fixed angled 95° condylar blade plate (CBP). They found that CBP instrumentation is more difficult requiring longer incision, operating time and higher surgeon reported operative difficulty. The six month post-operative mortality rate is 16%. Post-operative Harris hip scores were comparable between the two methods. Limb length shortening more than 20 mm was 6-fold more common with DHS. They concluded that, in elderly patients with unstable intertrochanteric fragility fractures, fixed angled condylar blade plate appears to be a better choice than dynamic hip screws for preventing fixation failures [50].

In the year 2010, Kesemenli CC et al published their study on treatment of intertrochanteric femur fractures fixation with a 95° fixed-angle blade plate in elderly patients. Fifty-eight patients with intertrochanteric femoral fractures were treated with 95º fixed-angle blade plate. Shortening greater than 2 cm was noted in these patients at last follow-up as a result of varus malunion, plate bending developed only in 3 patients, and the loss of reduction developed in two patients, but reoperation was not needed. According to AAOS criteria, results were poor in 2 patients, fair in 6, good in 16 and excellent in 31 patients. The authors concluded that the 95° fixed-angle blade plates could be thought as a proper alternative technique due to their easy applicability, low learning curve and complication rates [51].

In the year 2012, Muhammad Ayoob Laghari et al published a study of the result of A.O. condylar blade plate for the treatment of trochanteric fractures and to assess the union of the fractures after the definitive surgical management. They conducted a prospective study of 56 trochanteric femoral fractures treated by 95° A.O condylar blade plate. The union time ranged between 3.5 to 12 months (average time 4.6 months). The rate of non-union in this study was 12.5%. In this series 5 cases were complicated by malunion, of which unacceptable varus angulation of more than 15 degree was noted in 3 patients, and in remaining 2 cases varus of less than 15 degree was noted. Malunion rate in this study was 8.92%. The authors concluded that the choice varies from place to place, and depends on fracture morphology, expertise available, and whether it is cost effective and that the condylar plate will find its use in selected cases and certain situation for many years to come [52].

In the year 2013, Parker MJ and Das A published their study conducted to assess the relative effects of different types of extramedullary fixation implant, as well as external fixators, for treating extracapsular proximal femoral (hip) fractures in adults. Randomised or quasi-randomised controlled trials comparing extramedullary implants or external fixators for fixing extracapsular hip fracture in adults were included. The authors concluded that the markedly increased fixation failure rate of fixed nail plates compared with the Sliding Hip Screw (SHS) is a major consideration and thus the SHS appears preferable. There was insufficient evidence from other comparisons of extramedullary implants or on the use of external fixators to draw definite conclusions [53].

SURGICAL ANATOMY [54, 55, 56]

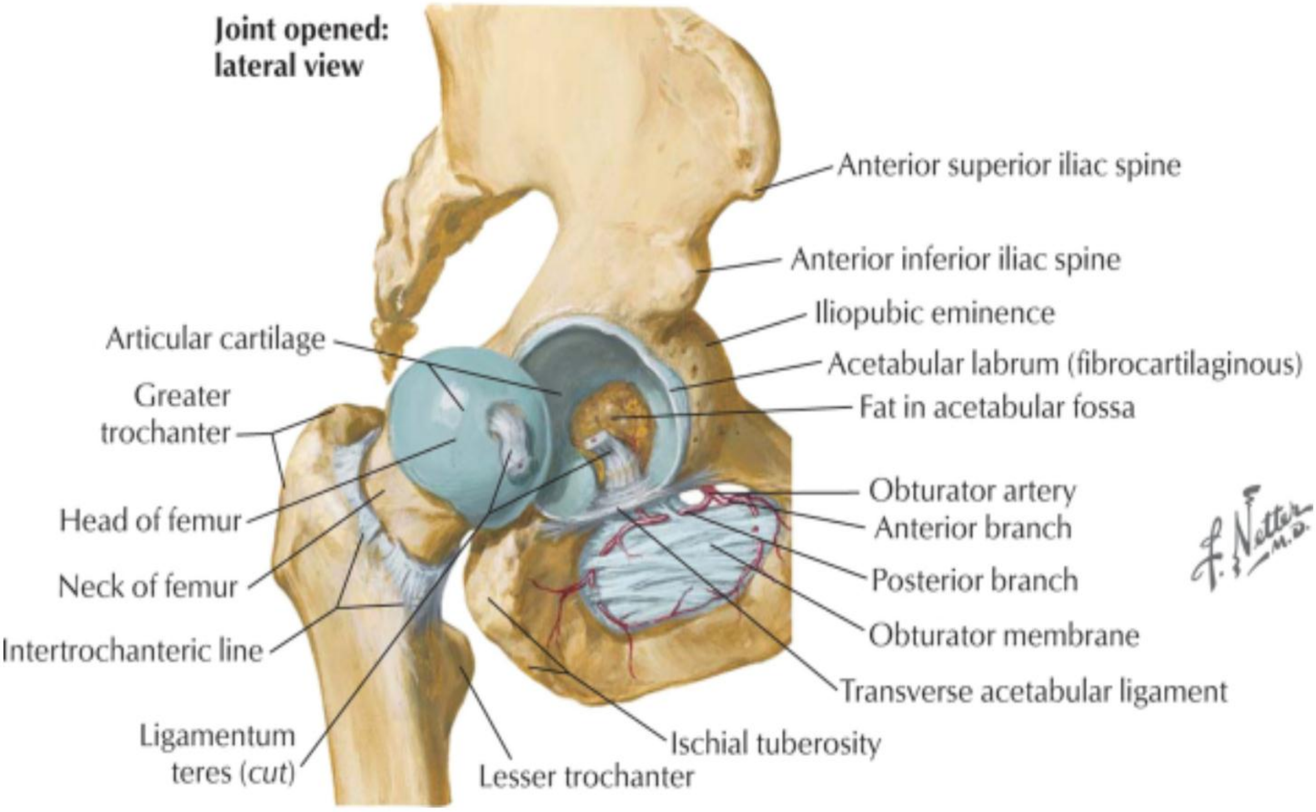


Figure 1: Anatomy of hip joint

Hip joint:

It is a ball and socket variety of synovial joint.

It is formed by the articulation of the head of the femur with the acetabulum of the hip bone.

The hip joint is unique in having a high degree of stability as well as mobility.

The stability depends upon:

- The depth of the acetabulum and the narrowing of its mouth by the acetabular labrum.
- Tension and strength of the ligaments.
- Strength of the surrounding ligaments.
- Length and obliquity of the neck of the femur.

The wide range of mobility is due to the fact that the femur has a long neck which is narrow than the equatorial diameter of the head.

Acetabulum:

The acetabulum is a deep cup shaped hemispherical cavity on the lateral aspect of the hip bone, about its centre. It is directed laterally, downwards and forwards. The inferior margin of the acetabulum is deficient, known as the acetabular notch, which is bridged by the transverse ligament. The non-articular roughened floor is called the acetabular fossa and contains a mass of fat lined by the synovial membrane. The articular surface is horse-shoe shaped and present on the anterior, superior and posterior parts of the acetabulum. The fibro cartilaginous acetabular labrum is attached to the margins of the acetabulum and deepens the acetabular cavity.

Femur:

The femur is the longest and strongest bone of the body. It has an upper end, a shaft and a lower end. The upper end of the femur includes the head of the femur, the neck of the femur, the greater trochanter, the lesser trochanter, the intertrochanteric line and the intertrochanteric crest.

Head of femur:

The head of the femur forms more than half a sphere. It is directed medially, upwards and slightly forwards. Just below and behind the centre of the head, a roughened pit called the fovea is situated which gives attachment to the ligament of the head of the femur (Ligamentum Teres).

Neck of femur:

The neck of femur is about 4 cm long. It makes an angle of about 125° with the shaft in adults. This angle is less in females due to their wider pelvis. This angle facilitates the movements at the hip joint. It also enables the lower limbs to swing clear of the pelvis. The neck has two borders, upper and lower, and two surfaces, anterior and posterior. The upper border is concave and horizontal, and meets the shaft at the greater trochanter. The lower border is straight and oblique, and meets the shaft near the lesser trochanter. The anterior surface is flat, entirely intracapsular and meets the shaft at the intertrochanteric line. The posterior surface is convex from above downwards and convex from side to side, and meets the shaft at the intertrochanteric crest. Here, the capsular ligament does not reach the intertrochanteric crest. The neck of femur does not lie in the same plane as the shaft. Hence, the transverse axis of the head of the femur makes an angle with the transverse axis of the lower end of the femur, which is about 15° and is known as the angle of anteversion or angle of femoral torsion.

Greater trochanter:

The greater trochanter is a large quadrangular prominence located at the upper end of the junction of the neck with the shaft. The upper border of the trochanter lies at the level of the centre of the head of the femur. The greater trochanter has an upper border with an apex, and three surfaces, anterior, medial and lateral. The apex is the in turned posterior part of the posterior border and gives attachment to the piriformis. The anterior surface is rough in its lateral part and gives attachment to the gluteus minimus. The medial surface presents a rough impression above, to which the obturator internus and the superior and inferior gemelli get inserted, and a deep trochanteric fossa below, where obturator externus gets inserted. The lateral surface is crossed by an oblique ridge directed downwards and forwards to which the gluteus medius gets inserted. The trochanteric bursa of the gluteus medius lies in front of the ridge, while the trochanteric bursa of the gluteus maximus lies behind the ridge.

Lesser trochanter:

The lesser trochanter is a conical eminence directed medially and backwards from the junction of the postero-inferior part of the neck with shaft. It has an apex and a roughened anterior surface to which the psoas major gets inserted. The posterior surface is smooth and is covered by a bursa that lies deep to the upper horizontal fibres of the adductor magnus. The base of the trochanter is expanded, and its medial and anterior surfaces give attachment to the iliacus, which extends downwards for a short distance behind the spiral line.

Intertrochanteric line:

It marks the junction of the anterior surface of the neck with the shaft of the femur. It is a prominent roughened ridge, which begins above at the anterosuperior angle of the greater trochanter as a tubercle, and is continuous below with the spiral line in front of the lesser trochanter. The spiral line winds round the shaft below the lesser trochanter to reach the posterior surface of the shaft. The intertrochanteric line provides attachment to the capsular ligament of the hip joint, upper band of the iliofemoral ligament in its upper part and lower band of iliofemoral ligament in its lower part. The highest fibres of the vastus lateralis take origin from the upper end of the line, while the highest fibres of the vastus medialis take origin from the lower end of the line.

Intertrochanteric crest:

It marks the junction of the posterior surface of the neck with the shaft of the femur. It is a smooth rounded ridge, which begins above at the posterosuperior angle of the greater trochanter and ends at the lesser trochanter. A little above its middle, it has a rounded elevation called the quadrate tubercle. The tubercle receives the insertion of the quadratus femoris.

Shaft of femur: upper 1/3rd

The shaft is cylindrical in shape. It is narrowest in the middle, and is expanded superiorly and inferiorly. It is convex forwards and is directed obliquely downwards and medially, because the upper ends of the femora are separated by the width of the pelvis and their lower ends are close together. The upper one-third of the shaft has four surfaces, anterior, medial, lateral and posterior and four borders, medial, lateral, spiral line and the lateral lip of the gluteal tuberosity. The medial and lateral borders are the distinct medial and lateral lips of the linea aspera which enclose the posterior surface.

Capsule:

The fibrous capsule is attached on the hip bone to the acetabular labrum including the transverse acetabular ligament, and to bone above and behind the acetabulum; and on the femur to the intertrochanteric line in front, and 1cm medial to the intertrochanteric crest behind. Antero-superiorly, the capsule is thick and firmly attached. Postero-inferiorly, the capsule is thin and loosely attached. The capsule is made of two types of fibres. The outer fibres are longitudinal, and reflected along the neck of the femur to form the retinacula. The inner fibres are circular and called as zona orbicularis.

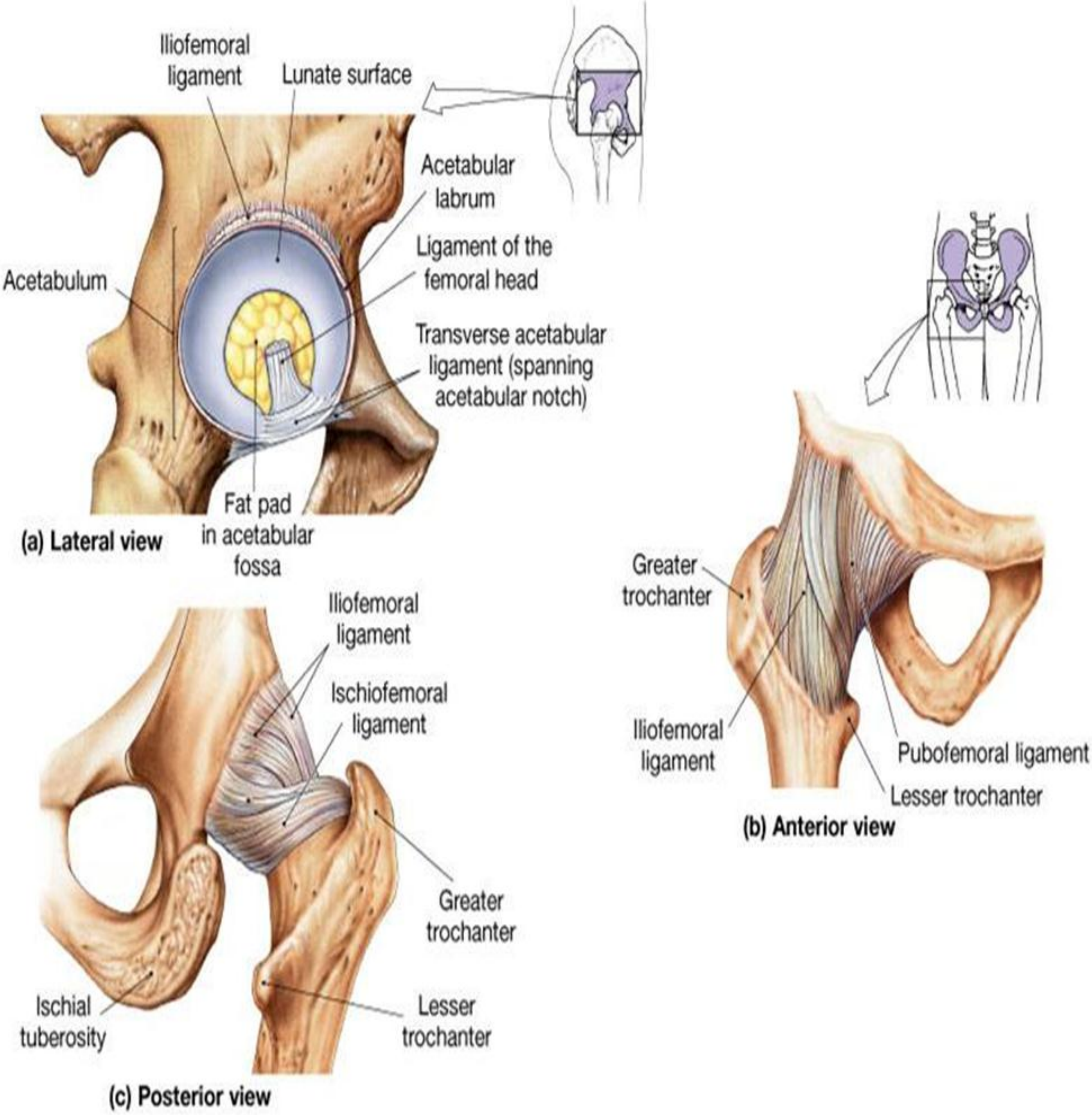


Figure 2: Ligaments around the hip joint

Synovial membrane:

The synovial membrane lines the fibrous capsule, the intracapsular portion of the neck of the femur, both surfaces of the acetabular labrum, the transverse ligament, and fat in the acetabular fossa. It also invests the round ligament of the head of the femur.

Iliofemoral ligament:

It is also known as the ligament of Bigelow. It is triangular or inverted-Y shaped. It lies anteriorly in the front of the joint. It is one of the strongest ligaments in the body. It requires a stress of more than 250-750 lb to get ruptured. It prevents the trunk from falling backwards in the standing posture. Its apex is attached to the lower half of the anterior inferior iliac spine; and the base is attached to the intertrochanteric line. The upper oblique and lower vertical fibres form thick and strong bands, while the middle fibres are thin and weak. It rarely gets torn in dislocation of the hip joint and the surgeon can use it as a stay in levering the head of the femur back into the acetabulum.

Pubofemoral ligament:

The pubofemoral ligament supports the joint inferomedially. It is also triangular in shape. Superiorly, it is attached to the iliopubic eminence, the obturator crest and the obturator membrane. Inferiorly, it merges with the anteroinferior part of the capsule and the lower band of the iliofemoral ligament. This ligament limits extension and abduction of the hip joint.

Ischiofemoral ligament:

It is comparatively weak. It covers the joint posteriorly. Its fibres are twisted and extend from the ischium to the acetabulum. The fibres of the ligament form the zona orbicularis. A few fibres get attached to the greater trochanter. This ligament limits extension.

Ligament of the head of the femur (Ligamentum Teres):

It is a flat and triangular ligament. The apex is attached to the fovea capitis, and the base to the transverse ligament and the margins of the acetabular notch. It may be very thin, or even absent. It transmits arteries to the head of the femur from the acetabular branches of the obturator and medial circumflex femoral arteries.

Acetabular labrum:

It is a fibrocartilaginous rim attached to the margins of the acetabulum. It narrows the mouth of the acetabulum. This helps in holding the head of the femur in position.

Transverse ligament of the acetabulum:

It is a part of the acetabular labrum which bridges the acetabular notch. The notch is thus converted into a foramen which transmits acetabular vessels and nerves to the hip joint.

Ossification of upper end of femur:

The femur ossifies from one primary and four secondary centres. The primary centre for the shaft appears in the seventh week of intrauterine life. Among the secondary centres, one appears for the lower end at the end of ninth month of intrauterine life, one appears for the greater trochanter during the fourth year and appears for the lesser trochanter during the twelfth year. The three epiphyses at the upper end, one at the lesser trochanter, greater trochanter and the head, fuse with the shaft at about 18 years. The lower epiphysis fuses by the twentieth year.

VASCULAR ANATOMY OF THE PROXIMAL END OF FEMUR [57, 58]

The hip joint is supplied by

• Obturator artery through artery of ligamentum teres

•Medial circumflex femoral artery which divides into superior and inferior metaphyseal artery

• Superior and inferior gluteal arteries.

The Femoral Head:

Crock described the blood supply to the proximal end of the femur, dividing it into three major groups.

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

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

c. Arteries of ligamentum teres.

The extra capsular ring is formed posteriorly by a large branch of the medial femoral circumflex artery and anteriorly by a branch from the lateral femoral circumflex artery.

The ascending cervical branches ascend on the surface of the femoral neck in anterior, posterior, medial and lateral groups. Their proximity to the neck surface makes them vulnerable to injury in femoral neck fractures. The posterior group are the most important. Injury to these vessels during surgeries on the hip via the posterior approach increases the risk of avascular necrosis of head of the femur. As the articular margin of the femoral head is approached by the ascending cervical vessels, a second less distinct ring of vessels is formed, referred to by Chung as the subsynovial intra-articular arterial ring. It is from this ring that vessels penetrate the head and are called the epiphyseal arteries. These are joined by the superior metaphyseal vessels and vessels from the ligamentum teres, which are branches of the obturator and medial circumflex femoral arteries.

The artery of the ligamentum teres is a branch of the obturator artery or rarely from the medial femoral circumflex artery.

The ascending branches of the lateral femoral circumflex artery lie lateral to the iliopsoas muscle to reach the femur at the intertrochanteric line. The lateral femoral circumflex artery also supplies two or three trochanteric branches to the anterior and lateral surfaces of the greater trochanter, which pierce the posterior surface of the trochanter along with the branches from the first perforating artery.

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

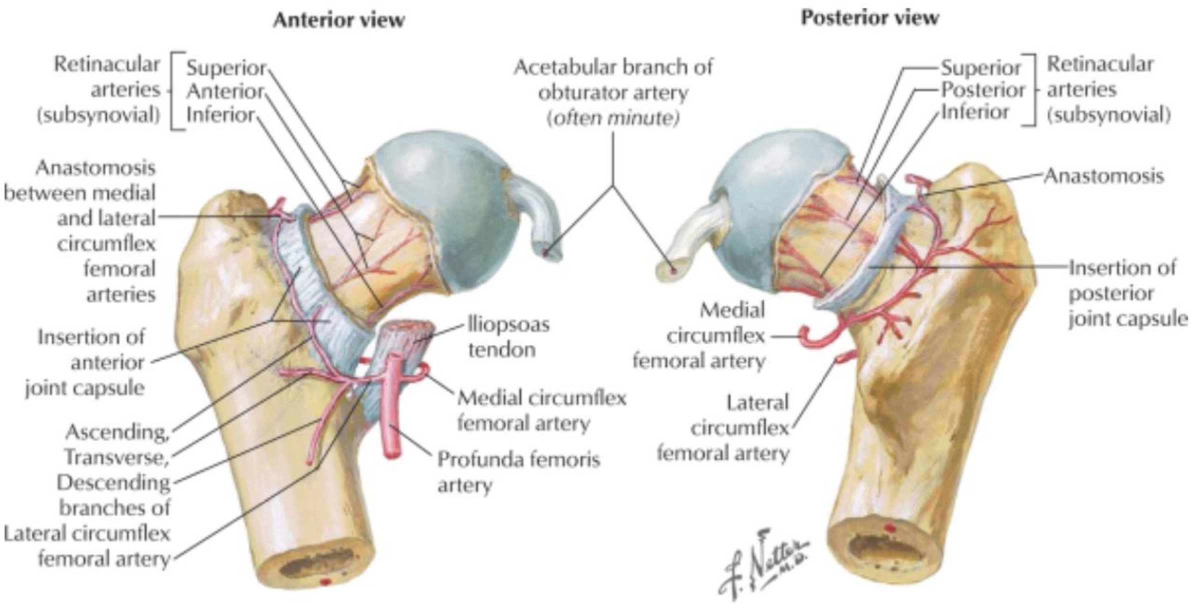


Figure 3: Vascular anatomy of the proximal femur

NERVE SUPPLY:

The hip joint is supplied by

- Femoral nerve or its muscular branches.
- Obturator nerve.
- Accessory obturator nerve.
- Nerve to Quadratus femoris.
- Superior gluteal nerve.

MOVEMENTS:

Flexion: 0° to 90°-100° with knee extended

0° to 130° with knee flexed

Extension: 0° to 10°- 20°

Abduction: 0° to 30°- 45°

Adduction: 0° to 30°- 40°

Medial rotation: 0° to 30°

Lateral rotation: 0° to 30°- 40°

KINESIOLOGY OF THE HIP:

MOVEMENT	MUSCLES (Prime Movers and Assisted by)	AXIS
Flexion	Psoas major, Iliacus, Pectineus, Rectus femoris, Sartorius, Adductor Longus (in early flexion from full extension)	Along the centre of femoral neck (pure spin)
Extension	Gluteus maximus, Posterior hamstrings	Along the centre of femoral neck (pure spin)
Abduction	Gluteus medius and minimus Tensor fasciae latae, sartorius	Antero-posterior through femoral head
Adduction	Adductors longus, brevis and magnus, Gracilis, Pectineus	Antero-posterior through femoral head
Medial Rotation	Tensor fasciae latae and Anterior fibres of Gluteus, medius and minimus	Vertical axis through centre of femoral head and lateral condyle with foot stationary on the ground
Lateral Rotation	Obturator Externus and Internus, Gemelli, Quadratus femoris, Assisted by Piriformis, gluteus maximus and Sartorius.	Vertical axis through centre of femoral head and lateral condyle with foot stationary on the ground.
This mechanical axis of the hip is not dynamic relative to the femur. It is stationary during pure spins. It moves relative to its co-articular surface in chordal or arcuate paths during pure or impure swings respectively.		

Table 1: Muscles involved in Hip Movements

TRABECULAR PATTERN OF THE PROXIMAL FEMUR:

The cancellous bone of the upper-end of the femur is composed of two distinct systems of trabeculae. In the frontal section these trabeculae are seen to form two arches, one arising from the medial (or inner) cortex of the shaft of the femur and the other taking origin from the lateral (or outer) cortex. The trabeculae forming these arches are called compressive and tensile trabeculae respectively because they are disposed along the lines of maximum compression and tension stresses produced in the bone during weight bearing. These trabeculae have been divided into following five groups:

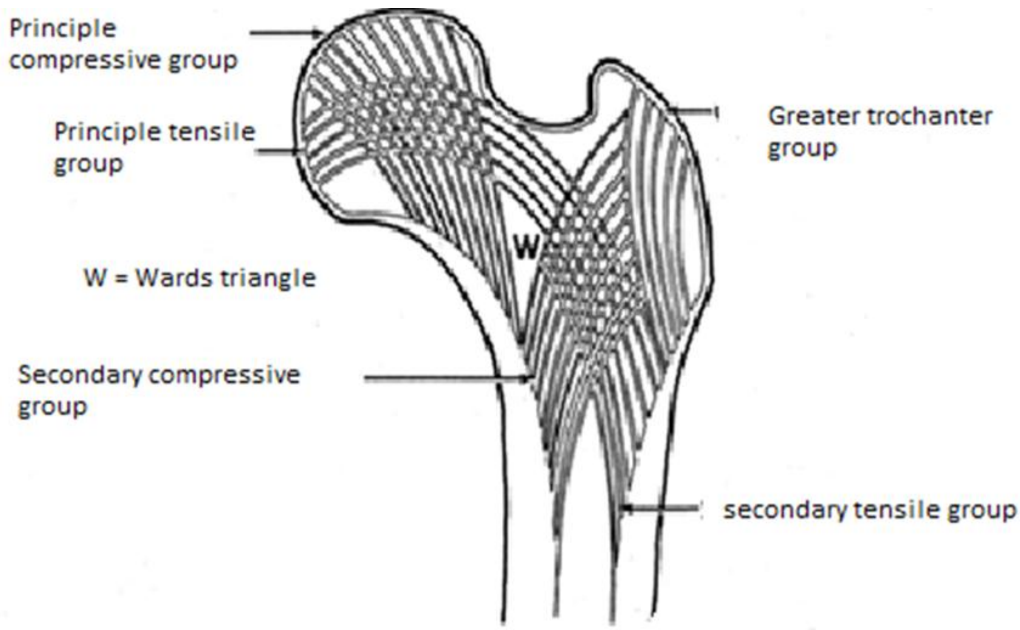


Fig 4: Trabecular pattern of proximal femur.

a) **Primary compressive group**: The upper most compression trabeculae extend from the medial cortex of the shaft to the upper portion of the head of the femur run in slightly curved radial lines. Some of these are thickest and most closely packed.

b) **Secondary compressive group**: The rest of the compression trabeculae which arise from the medial cortex of the shaft constitute the secondary compressive group. These arise below the principle compressive group and curve upwards and laterally towards the greater trochanter and the upper portion of the neck. The trabeculae in this group are thin and widely spaced.

c) **Primary tensile group**: The trabeculae which spring from lateral cortex immediately below the greater trochanter group. These trabeculae are thickest among the tensile group curve upwards and inwards across the neck of the femur to end in the inferior portion of the femoral head.

d) **Secondary tensile group**: The trabeculae which arise from the lateral cortex below the principle tensile trabeculae. The trabeculae of this group arch upwards and medially across the upper end of the femur and more or less irregularly after crossing the midline.

e) **Greater trochanter group**: Some slender and poorly defined tensile trabeculae arise from the lateral cortex just below the greater trochanter and sweep upwards to end near its superior surface.

In the neck of femur, the principle compressive, the secondary compressive and primary tensile trabeculae enclose an area containing some thin and loosely arranged trabeculae. This area is called "Ward's Triangle".

The trabeculae of the upper end of the femur can be studied by making roentgenograms of the hip region using an exposure sufficient to delineate the macroscopic details of the internal architecture of bones. The thick trabeculae appear as dense continuous lines while the delicate ones are not visible. Thus the areas like Ward's triangle appear empty while rest of the trabeculae are delineated depending on their density.

SINGH AND MAINI'S INDEX: [28]

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

Grade VI: All the trabeculae groups are visible. Upper end of the femur is completely cancellous.

Grade V: Principle (Primary) tensile and compressive trabeculae are accentuated. Ward's triangle is prominent. Secondary trabeculae are absent.

Grade IV: Principle tensile trabeculae are reduced. But still can be traced from the lateral cortex to the upper end of the femur.

Grade III: Break in the tensile trabeculae opposite the greater trochanter.

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

Grade I: Even principle compressive trabeculae are markedly reduced.

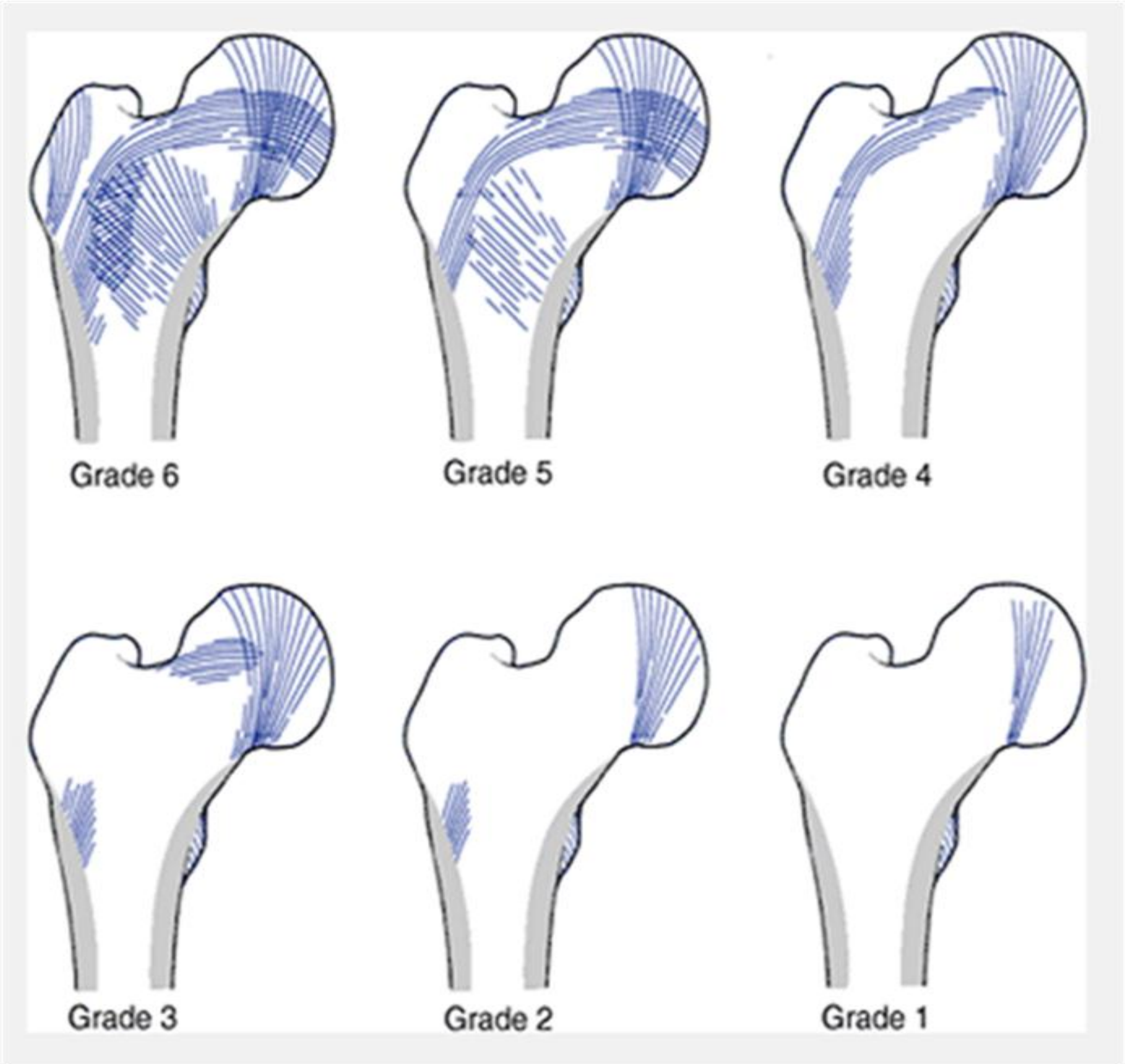


Fig 5: Singh's index

BIOMECHANICS OF HIP JOINT: [59]

The ball and socket configuration of the hip joint allows movements about all the three axes of motion: flexion-extension, abduction-adduction and internal rotation-external rotation.

The most frequent motion required for walking is from 30° flexion to 10° extension accompanied by about 80° of pelvic rotation.

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

Static forces refer to the application of external loads or forces so that they are balanced out and the joint is not subjected to acceleration.

Dynamic forces refer to unbalanced loads or forces associated with acceleration or deceleration in the lower extremity. These forces include gravity and forces generated by muscle activity.

The forces on the hip joint result from stabilising the centre of gravity of the body during stance and locomotion. The centre of gravity of the body is located just anterior to the second sacral vertebra. The horizontal distance from the centre of gravity of the body to the centre of the hip joint is 8.5 to 10 cm. Vertically, the centre of gravity is about 3 cm above the hip joint axis and during stance, the centre of gravity is in the same frontal plane as the common hip joint axis.

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

The estimated load on the femoral head in the stance phase of gait and during straight leg raising is about 3 times the body weight. Crowninshield et al. calculated peak contact forces across the hip during gait as ranging from 3.5 to 5 times the body weight. When lifting, running or jumping the load may be up to 10 times the body weight.

Intra-vital measurements of hip joint forces:

When a person stands on one leg, the force on the hip joint is 2 to 6 times the body weight.

During slow walking, the maximum weight is 1.6 times the body weight.

If the walking speed is increased, the force increases to 3.3 times the body weight in the stance phase and 1.2 times the body weight in swing phase.

During running, the force increases up to five times the body weight during the stance phase and up to three times the body weight in swing phase.

When crutches are used, the joint forces are reduced to about 0.3 times the body weight.

TROCHANTERIC FRACTURES [63]

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

Mechanism of injury:

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

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

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

A) The fall must be oriented such that the person lands on or near the hip.

B) Protective reflexes must be inadequate to reduce the energy of the fall below a certain critical threshold.

C) Local shock absorbers [e.g.: muscle and fat around the hip] must be inadequate.

D) Bone strength at hip must be insufficient.

Biomechanics of Trochanteric Fracture:

Trochanteric fractures primarily involve cortical and compact cancellous bone. Because of the complex stress configuration in this region and its non-homogenous osseous structure and geometry, fractures occur along the path of least resistance through the proximal femur. The amount of energy absorbed by the bone determines whether the fracture is a simple [2 part] fracture or is characterized by a more extensively comminuted pattern.

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

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

Deformity:

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

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

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

Radiography:

The diagnosis of an intertrochanteric fracture should always be confirmed by a radiograph.

Standard radiographic views of the hip include-

- Anteroposterior view of the pelvis including both hip joints
- Anteroposterior view of the involved proximal femur
- Cross table lateral view of the involved proximal femur

The AP view of the pelvis allows comparison of the involved side with the contralateral side and can help identify undisplaced and impacted fractures.

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

The cross table lateral view helps in assessing the posterior comminution of the proximal femur.

CLASSIFICATION OF TROCHANTERIC FRACTURES:

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

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

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

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

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

BOYD AND GRIFFIN CLASSIFICATION:

Type 1: Fractures that extend along the intertrochanteric line from the greater trochanter to the lesser trochanter.

Type 2: Comminuted fractures with the main fracture line along the intertrochanteric line but with multiple secondary fracture lines.

Type 3: Fractures that are basically subtrochanteric, with at least one fracture line passing across the proximal end of the shaft, just distal to or at the level of the lesser trochanter.

Type 4: Fractures of the trochanteric region and the proximal shaft, with fractures in at least two planes.

RUSSELL-TAYLOR CLASSIFICATION:

Type 1: Fractures do not extend into the piriformis fossa.

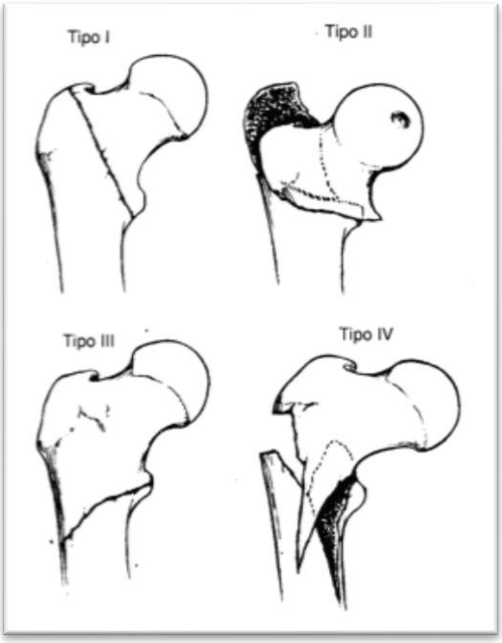
1A: Lesser trochanter is intact.

1B: Lesser trochanter is not intact.

Type 2: Fractures extend into the piriformis fossa.

2A: Lesser trochanter is intact.

2B: Lesser trochanter is not intact.



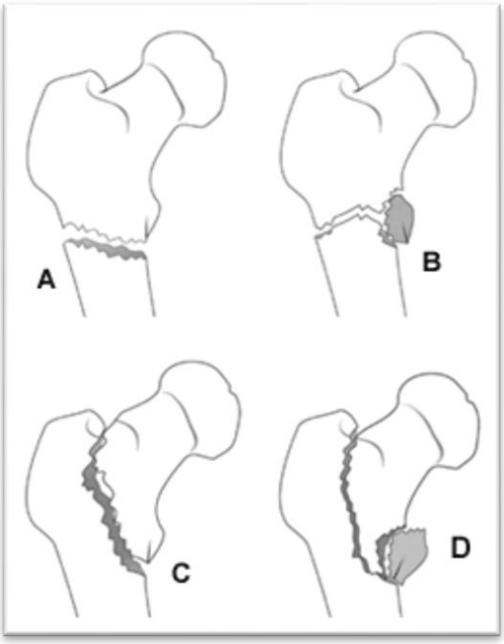


Figure 6: Boyd and Griffin Classification **Figure 7: Russell Taylor Classification**

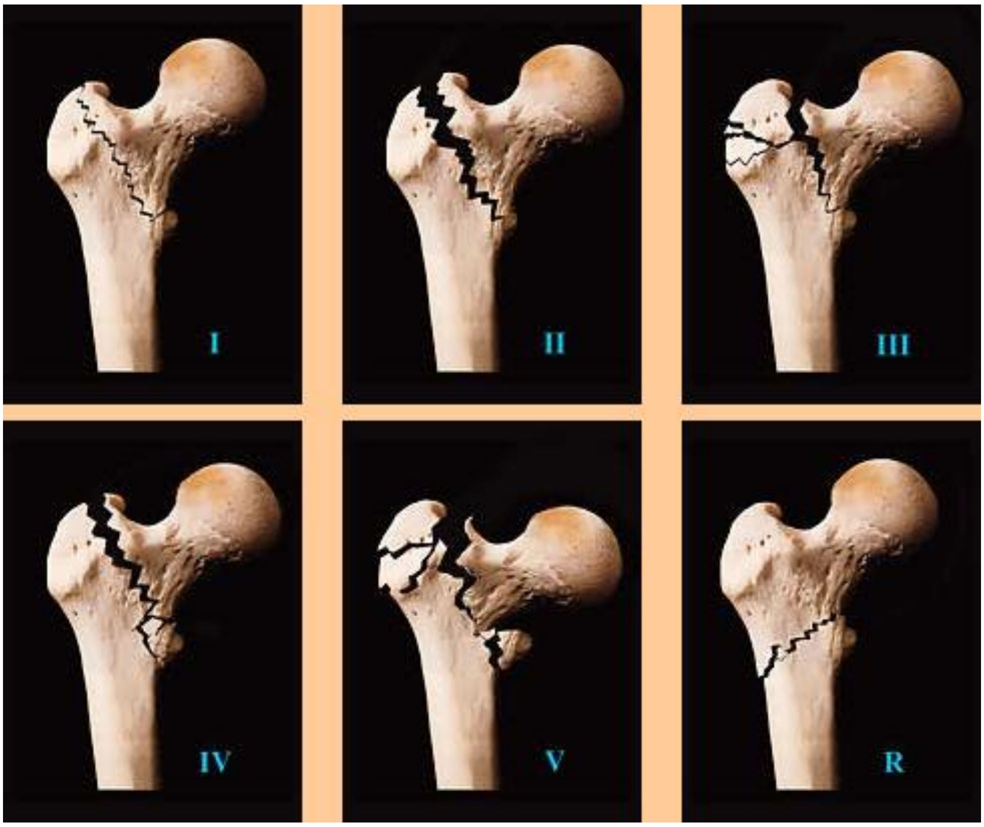


Figure 8: Evans classification

EVANS CLASSIFICATION:

Type I: Undisplaced 2-fragment fracture

Type II: Displaced 2-fragment fracture

Type III: 3-fragment fracture without posterolateral support

Type IV: 3-fragment fracture without medial support

Type V: 4-fragment fracture without posterolateral and medial support

Type R: Reverse Obliquity Fracture

AO CLASSIFICATION:

A1: Simple two-part fracture

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

A2: Fracture extends over two or more levels of medial cortex

- A2.1 With one intermediate fragment (lesser trochanter)
- A2.2 With two intermediate fragments
- A2.3 With more than two intermediate fragments

A3: Fracture extends through lateral cortex of femur

- A3.1 Simple, oblique
- A3.2 Simple, transverse
- A3.3 With a medial fragment

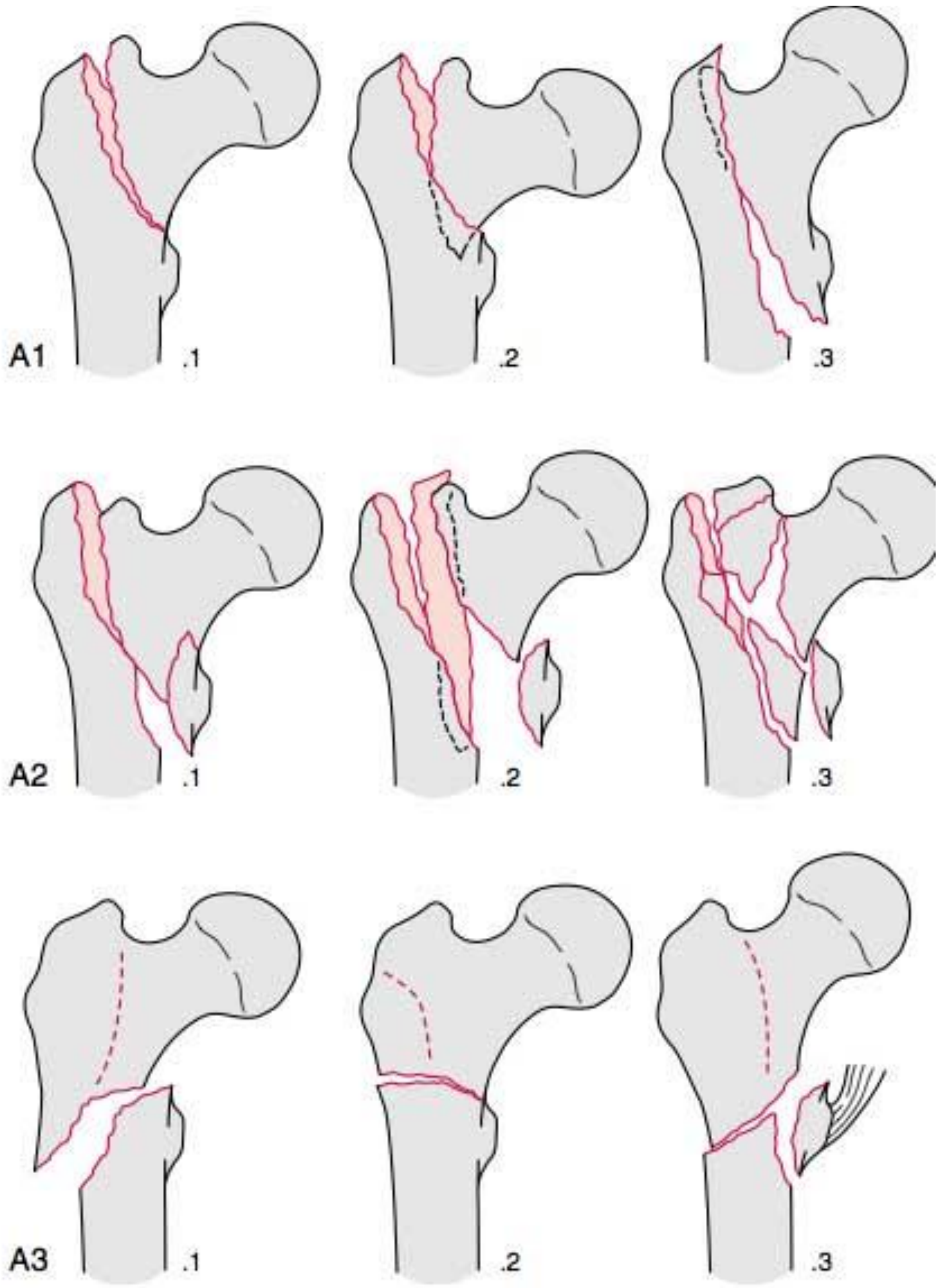


Figure 9: AO classification of intertrochanteric fractures

MANAGEMENT OF TROCHANTERIC FRACTURES: [61, 62, 63]

The goal of treatment of any intertrochanteric fracture in the elderly is to restore mobility safely and efficiently while minimizing the risk of medical complications and technical failure and to restore the patient to preoperative status. For displaced fractures, this goal cannot be achieved without surgical intervention. Restoration of mobility in patients with unstable intertrochanteric fractures ultimately depends on the strength of the surgical construct.

Intertrochanteric fractures can be managed in two ways:

a) Conservative method
b) Operative method

CONSERVATIVE METHODS:

Indications:

- An elderly patient with severe co-morbid conditions who is unfit for anaesthesia and surgery.
- Non-ambulatory patient with minimal discomfort following fracture.

Approaches:

- Establishing and maintaining a reasonable reduction with continuous traction until fracture union occurs.
- Early mobilization of the patient out of bed into a chair within the limits of the patient's discomfort within a few days of the patient's injury. Ambulation is delayed.

Methods:

- Simple support with pillows
- Buck's traction
- Skeletal traction
- Well-leg traction
- Russell's balanced traction
- Splint immobilization

Buck's traction:

It is skin traction applied to the lower extremity with weights of up to 5 kg. The traction force is applied over a large area of the skin. This spreads the load, is more comfortable and efficient. External rotation cannot be controlled. In senile patients, the skin is atrophic, thin and inelastic and this leads to distressing results.

Skeletal traction:

Initially, in 1907, Fritz Steinmann described a method of applying skeletal traction through the femur by inserting two pins into the femoral condyles.

In the year 1909, Martin Kirschner, of Greifswald, introduced small diameter stainless steel wires, which were inserted through and through to apply skeletal traction. But they were insufficiently rigid.

In the year 1916, Steinmann introduced the Steinmann pins, which were rigid stainless steel pins of 9 inches length and 3-5 mm diameter. He perfected the through and through pinning technique with these pins.

In the year 1929, Bohler of Austria developed a special stirrup that could be attached to the Steinmann pin and helped in varying the direction of traction without rotating the pin in the bone.

In the year 1972, Denham introduced a pin similar to the Steinmann pin, except for a short raised threaded portion in the middle portion of the pin. This threaded portion engages into the bony cortex and prevents the sliding of the pin in the bone. This is particularly useful in cancellous bones and osteoporotic bones of the elderly.

Skeletal traction can be used as a means of reducing the fracture as well as maintaining the reduction of the fracture by overcoming the muscle spasm. The most common complication is pin tract infection which can lead to pin loosening and chronic osteomyelitis.

Well-leg traction:

In 1932, Roger Anderson described a method wherein skeletal traction was applied to the injured leg and the well leg was used as counter-traction.

It helps in the correction of the abduction and adduction deformity at the hip. The principle of this technique is that, if there is an abduction deformity at the hip, the affected limb appears longer. When traction is applied to the well-limb and the affected limb is simultaneously pushed up, the abduction deformity is reduced. Reversing the arrangement reduces the adduction deformity.

This technique allows the patient to be moved from bed to chair. But, using the normal limb for counter-traction can lead to skin problems and ulceration, especially in the elderly.

Russell's balanced traction:

It was introduced by Hamilton Russell of Melbourne in the year 1924.

It is a simple and uncomplicated form of balanced traction. The principle is application of two forces at the knee which tend to establish a vector force more or less in the axis of the femur. The complications include equinus contractures of the foot, thromboembolic phenomena and the cost of this treatment.

Splints:

Various splints have been designed for immobilization of the affected extremity. These splints can be used either for providing fixed traction or help in maintaining the reduced position of the limb with balanced traction. Ex: Thomas splint, Bohler Braun splint.

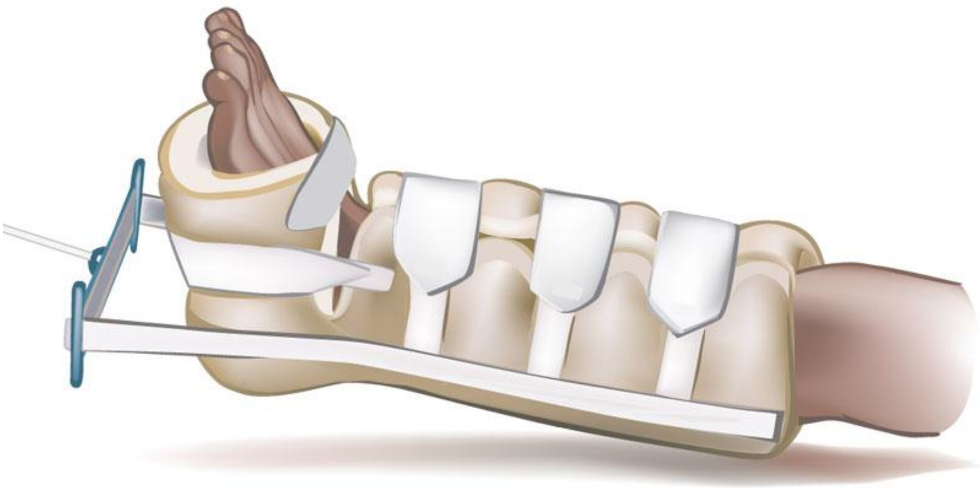


Figure 10: Buck's traction

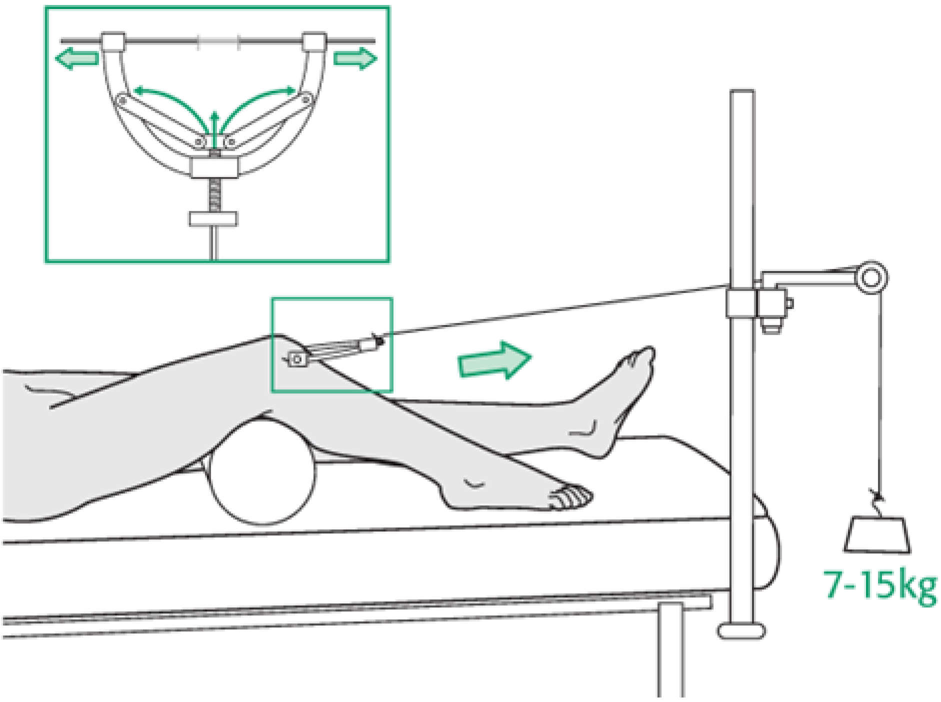


Figure 11: Skeletal traction

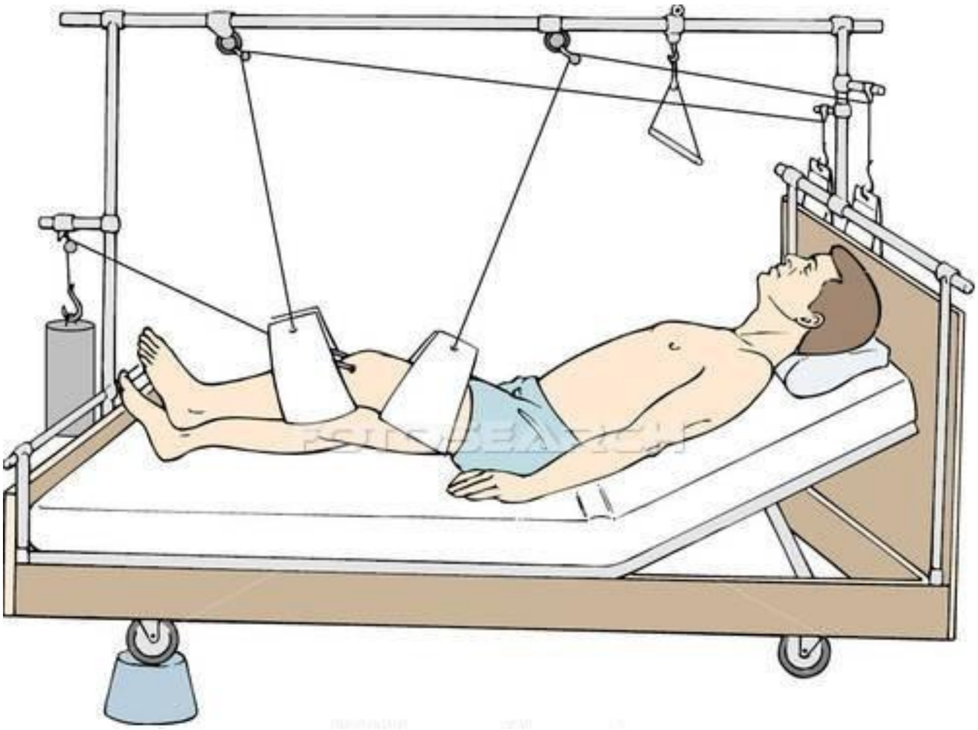


Figure 12: Well-leg traction

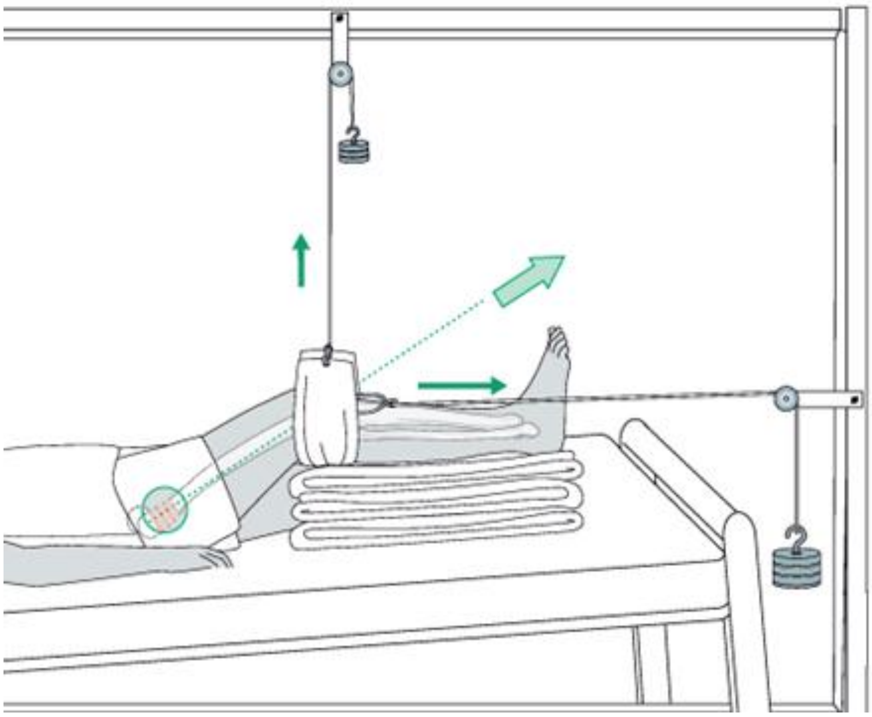


Figure 13: Russell's balanced traction

OPERATIVE METHODS: [60]

The treatment of choice of intertrochanteric fractures is operative management.

The goals of operative management are:

- Stable fixation of fracture fragments
- Early mobilization of the patient
- Restoration to the patient's pre-operative status as early as possible.

Kaufer, Matthews, and Sonstegard listed the following variables as those that determine the strength of the fracture fragment-implant assembly

- Bone quality
- Fragment Geometry
- Reduction
- Fixation Device
- Device Placement

Of these five elements of stable fixation, the surgeon can control only the quality of the reduction and the choice of implant and its placement.

. **Fixation devices:**

1) Extramedullary Implants:

   a) Fixed angle nail-plates
   b) A.O. 95 degree blade-plate
   c) DCS
   d) DHS
   e) Medoff's axial compression Screw

2) Intramedullary Implants

a) Condylocephalic

Enders pins

b) Cephalomedullary;

I) Gamma Nail

II) Russell and Taylor reconstruction Nail,

III) Zickel Nail,

IV) Proximal Femoral Nail (Short & Long)

3) Prosthetic Replacement

4) External Fixation

Fixed angle nail plates:

Ex.: **Jewett Nail**

From the 1940s to the l960s, the Jewett nail was the most commonly utilized device for trochanteric fracture stabilization. It consisted of a triangle nail fixed to a plate at angles ranging from 130° to 150°. It provided adequate fixation of the proximal fragment and stabilization to the femoral shaft. But the Jewett nail did not make allowances for postoperative fracture impaction. If significant impaction of the fracture site occurred, it resulted in penetration of the nail into the hip joint or “cutting out” of the nail through the superior portion of the femoral head. If fracture impaction did not occur, loading on the device secondary to lack of bone contact resulted in either breakage of the device at the nail-plate junction or separation of the plate and screws from the femoral shaft.

AO Blade Plate:

The AO/ASIF 95° fixed-angle condylar blade plate gained popularity in the 1970s.

The 95° design allows two or more cancellous screws to be inserted through the plate into the calcar region. This provides additional fixation of the proximal fracture fragment. An additional benefit of this device is that it can be inserted into a small proximal fragment before reduction. When correctly used, the device restores femoral alignment and provides stable fixation. Placement of the 95° condylar blade plate, however, is a technically demanding procedure requiring exact three-plane insertion.

Dynamic screws:

The dynamic screw is a two-piece device. A large-diameter cannulated lag screw is inserted over a guide pin after its channel is reamed and tapped. The device is technically easier to insert than the blade plate. Varus/valgus malalignment of the guide pin is easily corrected, and flexion/extension can be adjusted by rotation of the lag screw. The sliding mechanism allows impaction of fracture surfaces as well as medial displacement of the femoral shaft relative to the proximal fragment, which serves to, reduce the bending movement on the implant and thus decrease the possibility of varus displacement or device failure. For impaction to occur, however, the sliding mechanism must cross the fracture site and the plate must not be fixed to the proximal fragment.

Medoff's Axial Compression Screw:

The Medoff sliding plate was designed to allow compression along both the axis of the femoral neck and the longitudinal axis of the femoral shaft. Although it uses a large-diameter lag screw, similar to a sliding hip screw, to allow compression along the axis of the femoral neck, instead of the usual side plate of the sliding hip screw, it employs a sliding component to enable the fracture to impact parallel to the longitudinal axis of the femur. A distal compression screw allows intraoperative longitudinal compression along the femoral shaft.

Figure 14: **Jewett Nail**

Figure 15: **AO Blade Plate**

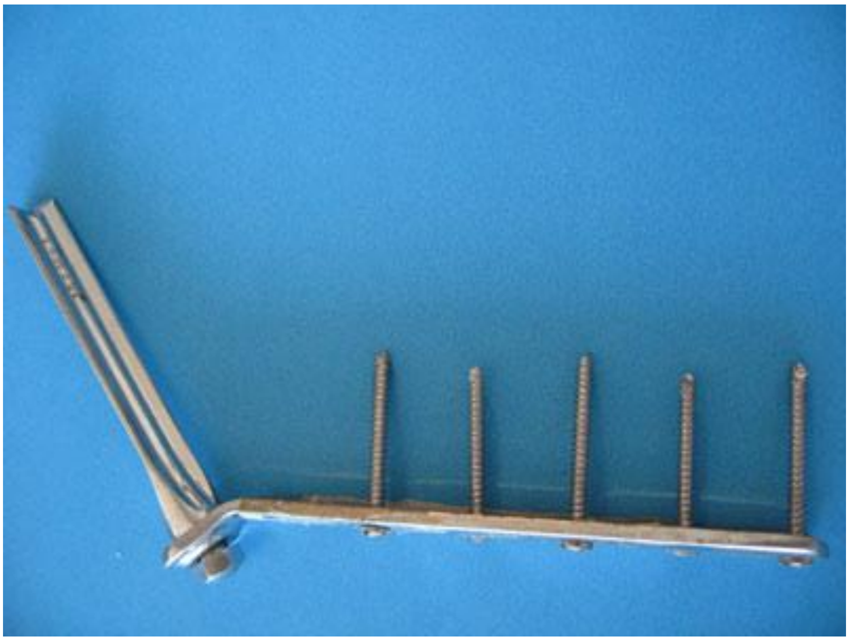


Figure 16: **Smith-Peterson Nail**

Figure 17: **McLaughlin Nail Plate**

Figure 18: **Dynamic screws**

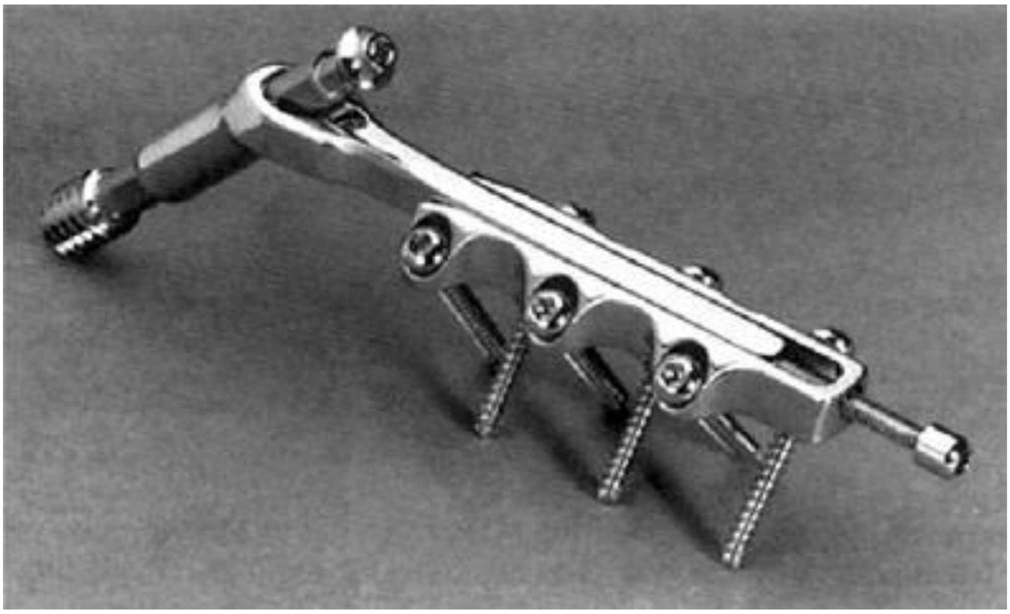


Figure 19: **Medoff's Axial Compression Screw**

Enders nails:

These are flexible nails, which are usually inserted retrograde into the femoral canal in a stacked fashion to provide fracture stability. The use of flexible Ender nails may require supplemental fracture fixation such as circlage wire for axial and torsional stability. The theoretical advantages of Ender nails include limited surgical exposure, lower blood loss, and decreased operative time. The most common complications include nail migration, loss of fixation, malrotation deformity, and knee pain. Early revision surgery rates ranging from 10% to 32% have been reported.

Gamma Nail:

The initial Gamma nail consisted of a 12-mm diameter lag screw that passed through a short intramedullary nail. Because this device is intramedullary, it lies more medial than the standard sliding compression hip screw and plate. Therefore less force is dissipated on the implant with weight bearing. Also, the device transmits the patient's body weight closer to the calcar than the sliding compression hip screw. This results in greater mechanical strength.

Zickel Nail:

The Zickel nail was introduced in the early 1970s. It accommodates the anterior bow of the femur. The trochanteric section is wide, but it tapers distally to accommodate the mid-shaft area in sizes ranging from 11 to 15 mm. Fixation of the proximal fragment is supplemented by a modified triangled nail that is passed through the proximal portion of the nail into the femoral neck.

Russell-Taylor reconstruction nail:

It is the first modern cephalomedullary reconstruction nail. It is a closed-section, stainless steel nail with proximal interlocking screws that extend into the femoral head and distal interlocking screws similar to standard first-generation interlocking nails. The Russell-Taylor reconstruction nail is recommended for use in unstable intertrochanteric fractures.

Proximal Femoral Nail:

The proximal femoral nail was introduced for treatment of peritrochanteric femoral fractures. It was designed to overcome implant-related complications and facilitate the operative treatment of unstable peritrochanteric fractures. The proximal femoral nail uses two implant screws for fixation into the femoral head and neck. The larger screw, the femoral neck screw, is intended to carry the majority of the load. The smaller screw, the hip pin, is inserted to provide rotational stability. Cutout of the hip pin and the femoral neck screw is a serious complication that leads to revision surgery and related morbidity.

Prosthetic Replacement:

Prosthetic replacement for trochanteric fractures is not popular. The indications remain ill-defined. They are as follows:

- Symptomatic ipsilateral degenerative hip disease.
- Extensive comminution and poor bone quality.

Prosthetic replacement is a very extensive and invasive procedure. It causes severe morbidity and has high risk of complications.

External Fixation:

It is the method of choice in high risk geriatric patients. The application of an external fixator is safe and simple. Under image intensifier and with the help of a fracture table, the fracture is reduced. Two Schanz pins are passed into the neck of femur. Three to four Schanz pins are passed into the shaft of the femur. These pins are then connected to the tubular rods with the help of universal clamps. The complications include pin tract infection, varus collapse at the fracture site and pin migration or breakage.

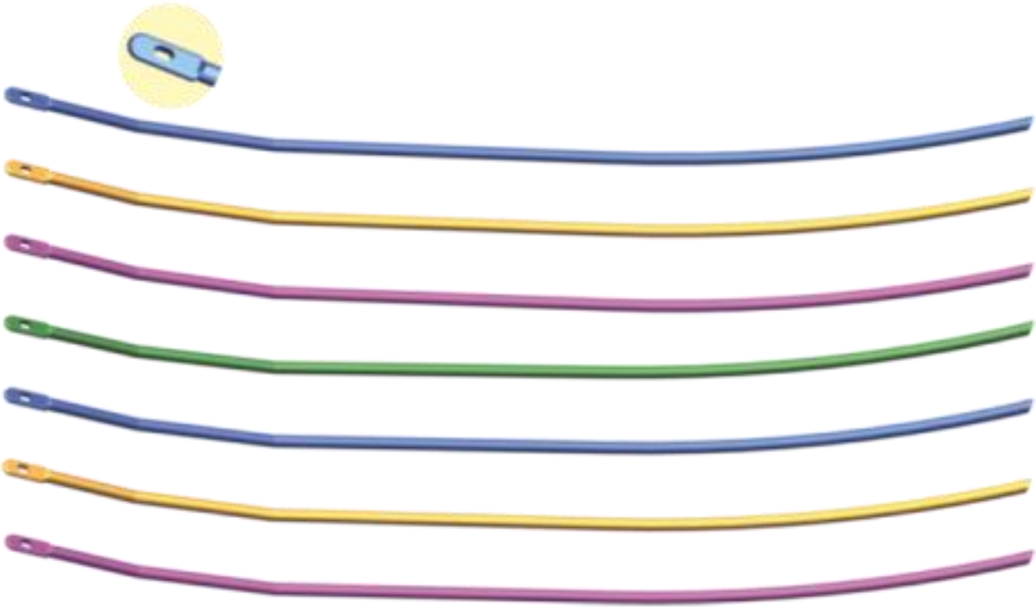


Figure 20: Enders nails

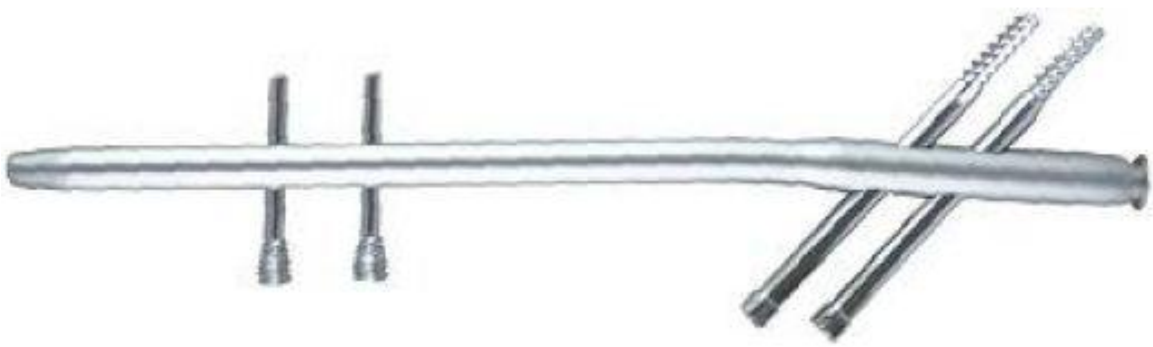


Figure 21: Gamma nails

Figure 22: Russell-Taylor reconstruction nail

Figure 23: Proximal Femoral Nail

COMPLICATIONS OF TROCHANTERIC FRACTURES

Following conservative management, the elderly patients need prolonged immobilization. Due to prolonged immobilization, the patients develop some general complications, which increase the rate of morbidity and mortality in the elderly. These are:

- Thromboembolic phenomena
- Hypostatic pneumonia
- Urinary tract infection
- Cerebrovascular accidents
- Deep vein thrombosis

Following operative management, patients may develop complications at the operative site locally, or due to the mechanical and technical aspects of the implant.

The local complications include:

- Haemorrhage
- Infection

The complications due to implant include:

- Varus angulation
- Implant cut-out
- Rotational deformities
- Stress fractures
- Avascular necrosis

MATERIALS AND METHODS

The present study includes 30 cases of intertrochanteric and peri-trochanteric fracture of femur in adult patients above 20 years of age irrespective of sex treated by open reduction and internal fixation with 95 degrees angle blade plate, in the Department of Orthopaedics at R.L Jalappa Hospital and Research Centre, Kolar, from October 2012 to October 2014, selected on the basis of purposive sampling (Judgment sampling) method. The clearance has been obtained from ethical committee.

This study was conducted with due emphasis on clinical observation and analysis of results after surgical management of unstable intertrochanteric and Peri-trochanteric fractures with 95 degrees angle blade plate.

Inclusion Criteria

- Age group: above 20 years.
- Fracture from the extracapsular part of the neck of the femur to 5 cm below the lesser trochanter.
- Consent to participate in the study

Exclusion Criteria

- Gustillo-Anderson's Type III C open fractures's
- Pathological fractures
- Multiple fractures in the femur
- Previous surgeries on ipsilateral hip/femur
- Fractures in children
- Old neglected fractures.
- Medical disorders that definitively influence a patient's rehabilitation

DATA COLLECTION METHOD:

Thirty cases above the age group of 20 years with unstable intertrochanteric and peri-trochanteric fractures of the femur were enrolled in the study after admission to hospital. Essential data was recorded in the proforma prepared for the study. Fractures were treated by 95 degrees angle blade plate. They were asked to come for follow up regularly to the out-patient department at 2 and 6 months. At every follow-up, the cases were analysed clinically and radiologically using Harris Hip Score.

PRE-OPERATIVE PATIENT MANAGEMENT

Patients were admitted to the ward. Detailed history was taken with particular emphasis on mode of injury and associated medical illness. Oral or parenteral NSAIDs were given to relieve the pain.

Diagnosis was confirmed through antero-posterior and lateral radiographs of pelvis with both hips. Fractures were classified according to Evans's classification.

Routine blood investigations such as Hb%, BT, CT, blood grouping and typing, urine routine, RBS, blood urea, serum creatinine, HBsAg, HIV, Chest X-ray, ECG, were done in all cases. Pre-existing medical co-morbidities were treated before the surgery. Associated injuries were evaluated and treated simultaneously. The patients were operated on elective basis after overcoming the avoidable anaesthetic risks.

Patients as well as the attenders were explained in their own language about the surgery and its risk factors and written consent for the surgery was taken for all patients. The patient was prepared from umbilicus to ipsilateral knee including perineum and back.

PRE-OPERATIVE PLANNING:

The trabecular anatomy and distribution of bone in the proximal femur determine the optimal position for the blade of the 95º angled blade plate. There is a zone within the head where the tension and compression trabeculae intersect. This is the zone offering good anchorage for the tip of the blade. The tip of the blade should come to lie just below this point of trabecular intersection on the AP image and in the center of the neck on the axial view. The blade of the 95º angled blade plate should pass approximately 10 mm below the superior cortex of the neck.

Note that the tip of the blade lies in the lower half of the femoral head. The blade passes below the superior cortex of the neck.

X-rays of the uninjured femur are taken to serve as a template for preoperative planning. The x-rays are taken with the hip in 15°- 20° internal rotation to correct for femoral neck anteversion.

A tracing of the outline of the uninjured proximal femur is then reversed and the fracture lines are added.

The appropriate angled blade plate is then chosen, using the transparent implant templates and traced onto the plan.

To assist in the choice of the insertion point for the seating chisel, measure the distance from the tip of the greater trochanter to the center of the insertion point. This measurement can be used intraoperatively to locate the insertion point.

A step-by-step tactic is then derived from this drawing and should stipulate the order in which the various steps of the procedure will be performed. It should also indicate whether a gliding hole for an inter fragmentary lag screw is to be predrilled prior to fracture reduction, depending on the inclination of the fracture plane.

These technical drawings and their derived tactic are mandatory for any angled blade plate procedure.

IMPLANT PROFILE

A 95 degrees angle blade plate is an implant which consists of a metal plate or a shank terminated by a blade at an angle of 95°. The profile of the blade and the shaft are similar to each other. It is made of stainless steel. The 95° design allows two or more cancellous screws to be inserted through the plate into the calcar region, providing additional fixation of the proximal fracture fragment. An additional benefit of this device is that it can be inserted into a small proximal fragment.

Blade:

The blade has a U- profile. It is available in lengths of 50mm, 60mm, 70mm, 80mm, 90mm and 100mm. The most commonly used size for the adult proximal femur is 70mm. The thickness of the blade is 6.4mm. The width of the blade is 16mm. The blade needs to be inserted in the middle of the femoral neck.

Plate:

The shaft has a fixed angle of 95° with the blade. The two round holes next to the blade accept 6.5 mm cancellous bone screws; the remaining screw holes have a DCP profile and accept 4.5mm cortical screws. There are 5, 7, 9 and 12 hole versions of the 95° angled blade plates. The thickness of the plate is 6.4mm. The width of the plate is 16mm. The spacing between the holes is 16 mm. The plate portion of the angled blade plate must line up with the axis of the femoral shaft at the end of the procedure.

PRINCIPLES OF ANGLE PLATE FIXATION:

In the proximal femur, the blade needs to be inserted in the middle of the femoral neck and at a predetermined angle to the shaft axis. In addition, the plate portion of the angled blade plate must line up with the axis of the femoral shaft at the end of the procedure.

Because of these technical complexities, a preoperative plan and tactic, including a preoperative drawing, are essential, so that the operation can be conducted step by step. The surgeon must be precise and pay particular attention to anatomical landmarks, the sitting and orientation of the angled blade plate, in both, the AP and axial views, as well as rotation of the blade about its axis (which determines the alignment of the plate with the femoral shaft).

Figure 24: 95 degrees angle blade plate

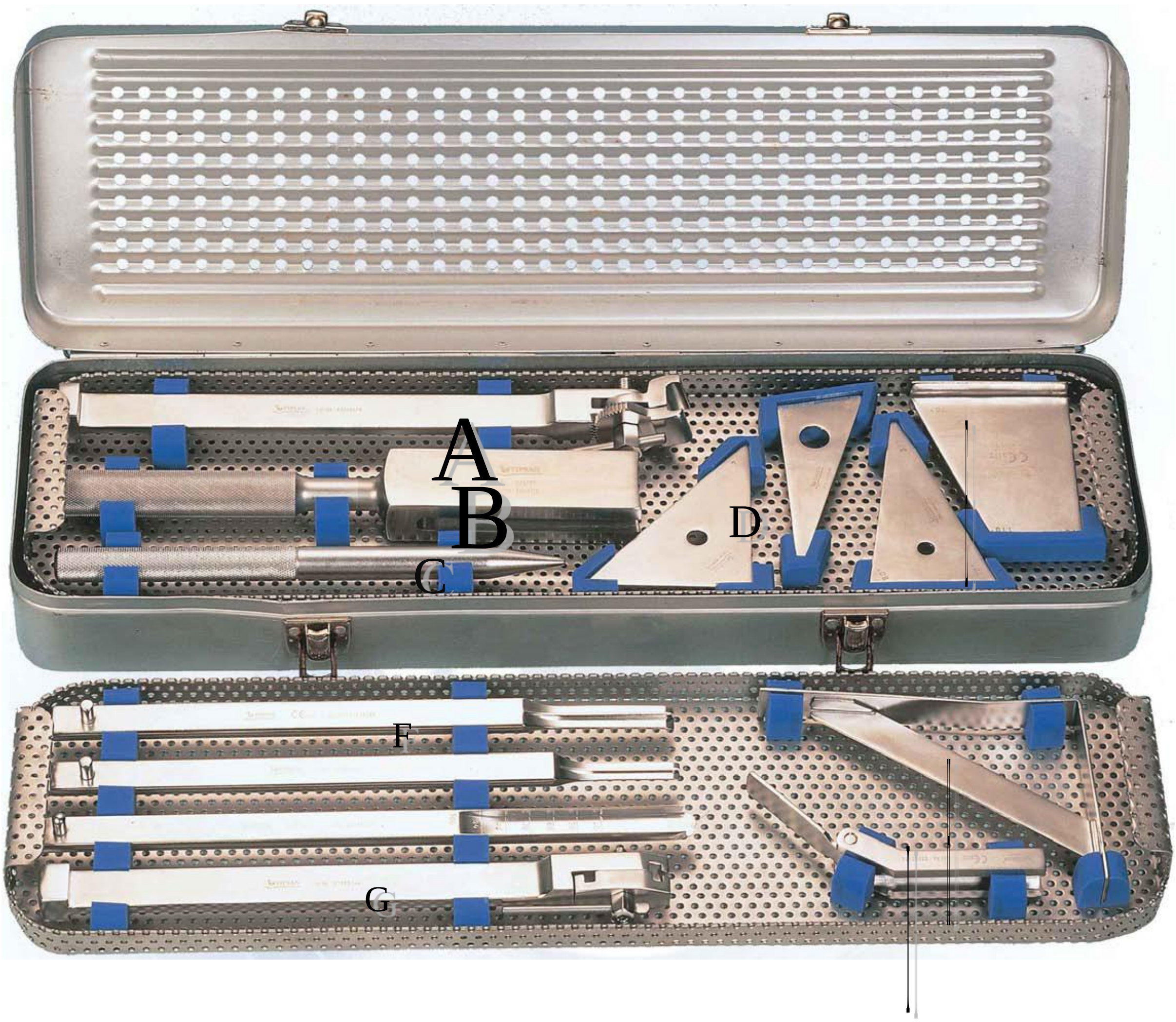


Figure 25: Instrumentation set for 95° angle blade plate

A - Inserter/ Extractor (for adults)

B - Slotted Hammer

C - Impactor

D - Triangular Positioning Plate

E - Quadrangular Positioning Plate

F - Seating Chisel

G - Inserter/ Extractor (for children)

H – Condylar Plate Guide

I – Chisel Guide

INSTRUMENTATION:

Several dedicated instruments are needed for the precise conduct of the angled blade plate insertion, in accordance with the preoperative plan. No fluoroscopy can substitute for a three-dimensional appreciation of the local anatomy, nor will it serve as a guide to the correct insertion of the guide wires.

Correct insertion is based on certain anatomical landmarks and on the geometry of the 95º angled blade plate. The image intensifier is used to check the position of the definitive guide wire and the final position of the seating chisel.

Seating chisel

The seating chisel is used for cutting the track for the blade in the proximal femur.

It has a “U” profile that corresponds to the profile of the blade of the angled blade plate.

Seating chisel guide

The seating chisel guide slides over the seating chisel and is used to determine the rotation of the seating chisel about its long axis.

The flap of the seating chisel guide must remain in line with the long axis of the femoral shaft throughout chisel insertion.

Condylar blade guide

The angle between the flap and the body of the seating chisel guide may be set with the aid of the 85° condylar blade guide and is maintained by tightening the screw with a screwdriver.

Slotted hammer

During insertion, the rotation of the seating chisel is controlled with the slotted hammer. The slotted hammer serves also for removal of the seating chisel, or for hammering out the plate holder when removing a blade plate.

Plate inserter/extractor

The plate inserter/extractor is used for insertion and removal of blade plates. The blade plate should be so fastened in the plate holder such that its long handle is in line with the blade of the angled plate.

Impactor

The impactor is used to drive the last 5 mm of the blade into the bone.

OPERATIVE PROCEDURE:

Anaesthesia

Spinal anaesthesia, epidural anaesthesia, combined spinal and epidural anaesthesia or general anaesthesia.

Patient position

Patient is placed in supine position. Support is provided to the ipsilateral hip by means of a pillow under the hip.

Incision

The initial incision is facilitated with slight internal rotation of the leg. A straight lateral incision is made two finger breadths below the vastus ridge to a point 5-7 cm distally. Typically the incision is made too cephalad, and typically is made much longer than is necessary. Large Beckman Retractors are used to retract the subcutaneous tissue in obese patients.

Ilio-Tibial Band

A periosteal elevator is used to sweep the subcutaneous tissue from either side of iliotibial band. The fascia lata is incised in line with the incision. It is best performed by making a small nick with a knife, and completing the incision with Mayo scissors.

Vastus Lateralis Incision

The adhesions between the vastus lateralis and the iliotibial band are bluntly swept away. The vastus lateralis is retracted anteriorly using either the surgeon's hand or large Hibbs type Retractors, in order to place the muscle under tension. Alternatively the vastus can be shifted anteriorly, by clamping two Kocher’s forceps into the posterior vastus fascia, and then pushing the Kocher’s anteriorly and medially so that they come to rest on the anterior femoral surface. Using a periosteal elevator, the posterior 20% of the vastus is bluntly split directly down to bone, and then elevated off the bone. Using a cautery, a "L" shaped incision is made across the vastus origin, which starts along the vastus ridge until its posterior edge is reached, and then continues distally for about 5 cm along the posterior tendinous border of the vastus. Before a more distal dissection is made, the "L" shaped musculotendinous flap is elevated subperiosteally from the femur. Subsequently an incision is taken along the posterior tendinous border of the vastus lateralis for a few additional centimetres. Incising over the vastus ridge frees the vastus tendon and allows the muscle to be retracted anteriorly and distally. Using a periosteal elevator, the remaining tissue is stripped from the lateral aspect of the femur. At the superior aspect of the incision, only a small amount of the muscle requires elevation. Avoiding excessive stripping decreases post-operative pain and facilitates rehabilitation. In cases of an especially complicated fracture which cannot be closed reduced, a more extensive exposure is required.

Correct track for the angled blade plate

Before an angled blade plate can be inserted into bone, a channel must be cut with the U-profile seating chisel. The sides of the tip of the seating chisel converge slightly, which facilitates the centering of the chisel within the femoral neck.

In order to insert the 95º angled blade plate correctly into bone, 4 degrees of freedom must be controlled:

- the point of entry of the blade into bone,
- parallelism to the anteversion of the femoral neck,
- the angle between the blade and the femoral shaft axis and
- the rotation of the seating chisel about its long axis.

Once the track of the blade is determined on the preoperative plan, the surgeon will know the exact position that the seating chisel should occupy in the bone.

Parallelism to the anteversion of the femoral neck and the angle between the blade and the femoral shaft axis

Guide wires are used to mark the plane of anteversion of the femoral neck and also to mark the appropriate inclination of the seating chisel in relation to the long axis of the femur. The surgeon will be guided in the chisel insertion by a definitive guide wire.

Firstly, a wire is passed in close contact with the front of the femoral neck and will indicate the axis of the neck in the axial plane. This wire must pass distal to the anterior ridge which runs along the front in the intertrochanteric area, or it may be deflected anteriorly.

The 95º condylar plate guide is then placed along the lateral cortex and a second, definitive guide wire is inserted, parallel in the axial view to the first guide wire and parallel with the upper edge of the condylar plate guide in the AP view. It is drilled into the greater trochanter just above the planned point of entry. The track for the seating chisel will be parallel to this wire. The wire's position should be checked radiologically in both planes, and adjusted accordingly, as necessary.

Preparing the point of entry

Guided by the measurement made on the preoperative plan, the point of entry on the outer face of the greater trochanter is determined.

It is important to remember that, at this level, the posterior edge of the greater trochanter overhangs more than the anterior edge and the center of the point of insertion is at the junction of the anterior one third and middle one third of the outer face of the greater trochanter.

Three 4.5 mm drill holes are made. These holes are then enlarged with a router to produce a horizontal slot matching the width and height of the seating chisel. The lower edge of the entry hole should be bevelled, using a chisel, to accommodate the curve of the shoulder of the angled blade plate.

Preparation of the track for the blade

The seating chisel can now be inserted through the prepared entry slot and parallel in both axial and AP views to the definitive guide wire. This parallelism is judged by frequent visual reference, in both planes, to the advancing seating chisel and the guide wire. Radiology has no part to play in this manoeuvre. The use of the slotted hammer over the seating chisel aids the control of this track.

Throughout the insertion of the seating chisel, the parallelism of the tongue of the seating chisel guide to the femoral shaft axis is also carefully maintained.

This is the most demanding and crucial step of the procedure, and the grip on the slotted hammer and the seating chisel guide is crucial.

Seating chisel insertion depth

Once the seating chisel has been inserted, its position should be checked radiologically. This determines also whether the planned blade length is appropriate. The seating chisel bears markings that indicate the depth of its insertion.

The seating chisel is then removed by back strokes with the slotted hammer.

Blade insertion

The chosen 95° angled blade plate is then mounted into the plate holder and the blade is pushed by hand into the pre-chiselled track. The blade should pass easily into the pre-cut track and light blows with a hammer should be all that is required to insert it into the femoral neck.

When the plate is about 5 mm from the bone, remove the plate holder and hammer the plate fully home, using the point of the impactor in the indent on the shoulder of the implant.

Proximal screw insertion

The blade should be stabilized with a screw. After the angled blade plate has been inserted into the proximal femur, it is secured with a fully threaded 6.5 mm cancellous screw through the most proximal of the holes of the plate.

The use of a cortical screw at this site would require drilling of the calcar of the femur, with the attendant weakening of this important bony buttress.

Reduction Techniques

Direct reduction:

- If lesser trochanter is still attached to proximal fragment, psoas becomes a deforming force causing flexion and external rotation of proximal fragment;
- 90 to 90 position aligns distal fragment;
- Abduction of distal fragment may be needed to compensate for hip abductor force on the proximal fragment;
- Determine if fracture fragments are amenable to lag screw fixation prior to plate application

- This may convert a complex multi-part fracture to a more simple 2 or 3 part fracture

Indirect reduction:

- 95 degree blade plate is introduced into proximal fragment;
- Either using the fracture table or a universal femoral distractor, the fracture site is distracted, bringing the fracture out to length and assisting with reduction of comminuted fragments;
- The medial fragments are not keyed into position (in order not to strip these fragments of their soft tissue fragments);

Fracture compression

Once the angled blade plate is firmly anchored in the proximal fragment, the distal femur is aligned onto the plate and held, if necessary, with a clamp.

In single plane transverse or short oblique fractures, the first screw in the distal fragment should be a load screw, in order to compress the fracture.

Completion of the fixation

The remaining, neutral screws are then inserted: at least 8 cortical holds are necessary in the shaft fragment.

Closure

After fixation is over, lavage is given using normal saline. Suction drain is used. Incision is closed in layers. Sterile dressing applied over wound and compression bandage given.

POSTOPERATIVE MANAGEMENT

In case of spinal anaesthesia, foot end was elevated depending on the patient's postoperative blood pressure. Regular monitoring of blood pressure, pulse rate, temperature, and respiratory rate was done for the first 24 hours.

Whenever necessary, postoperative blood transfusion was given. Intramuscular analgesics were given as per patient's compliance; intravenous antibiotics were continued for 7 days.

Post-operative x-ray was taken once the patient was comfortable.

Quadriceps and hip muscle exercises were initiated on 1st post-operative day. Suture removal was done between tenth or twelveth postoperative day. The patients were assessed for any shortening or deformities if any and discharged from the hospital. Patients who had infection were treated accordingly before discharging them from the hospital. Complete weight bearing was allowed after fracture union was seen on X-ray.

FOLLOW UP

At the time of discharge patients were asked to come for follow up after 2 months and 6 months. At each follow up, clinical examination was done with regards to any deformities of hip, shortening of limb, tenderness at fracture site, range of motion of hip joint, signs of infection. At the end of 6 months patients were evaluated according to Harris Hip Score for pain, limp, the use of support and range of movements. All the details were recorded in the follow up chart. The radiograph of the operated hip was taken at regular intervals, at each follow up.

HARRIS HIP SCORE

Harris Hip Score

Pain *(check one)*

- ☐ None or ignores it (44)
- ☐ Slight, occasional, no compromise in activities (40)
- ☐ Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin (30)
- ☐ Moderate Pain, tolerable but makes concession to pain. Some limitation of ordinary activity or work. May require Occasional pain medication stronger than aspirin (20)
- ☐ Marked pain, serious limitation of activities (10)
- ☐ Totally disabled, crippled, pain in bed, bedridden (0)

Limp

- ☐ None (11)
- ☐ Slight (8)
- ☐ Moderate (5)
- ☐ Severe (0)

Support

- ☐ None (11)
- ☐ Cane for long walks (7)
- ☐ Cane most of time (5)
- ☐ One crutch (3)
- ☐ Two canes (2)
- ☐ Two crutches or not able to walk (0)

Distance Walked

- ☐ Unlimited (11)
- ☐ Six blocks (8)
- ☐ Two or three blocks (5)
- ☐ Indoors only (2)
- ☐ Bed and chair only (0)

Sitting

- ☐ Comfortably in ordinary chair for one hour (5)
- ☐ On a high chair for 30 minutes (3)
- ☐ Unable to sit comfortably in any chair (0)

Enter public transportation

- ☐ Yes (1)
- ☐ No (0)

Stairs

- ☐ Normally without using a railing (4)
- ☐ Normally using a railing (2)
- ☐ In any manner (1)
- ☐ Unable to do stairs (0)

Put on Shoes and Socks

- ☐ With ease (4)
- ☐ With difficulty (2)
- ☐ Unable (0)

Absence of Deformity (All yes = 4; Less than 4 =0)

Less than 30° fixed flexion contracture	☐ Yes	☐ No
Less than 10° fixed abduction	☐ Yes	☐ No
Less than 10° fixed internal rotation in extension	☐ Yes	☐ No
Limb length discrepancy less than 3.2 cm	☐ Yes	☐ No

Range of Motion (**indicates normal)*

Flexion (*140°) ________

Abduction (*40°) ________

Adduction (*40°) ________

External Rotation (*40°) ________

Internal Rotation (*40°) ________

Range of Motion Scale

211° - 300° (5)	61° - 100 (2)
161° - 210° (4)	31° - 60° (1)
101° - 160° (3)	0° - 30° (0)

Range of Motion Score ____________

Total Harris Hip Score ____________

Figure 26: Patient position

Figure no.27: Patient Draping

Figure 28: Skin Incision

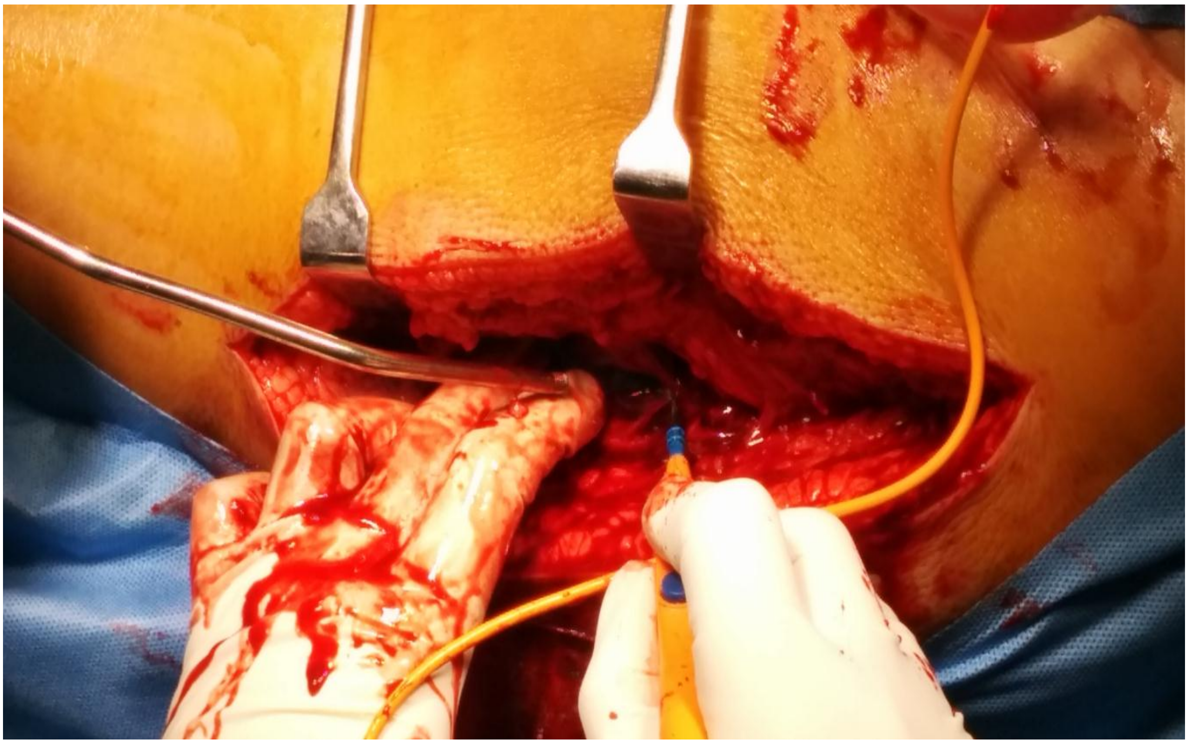


Figure 29: Muscle incision

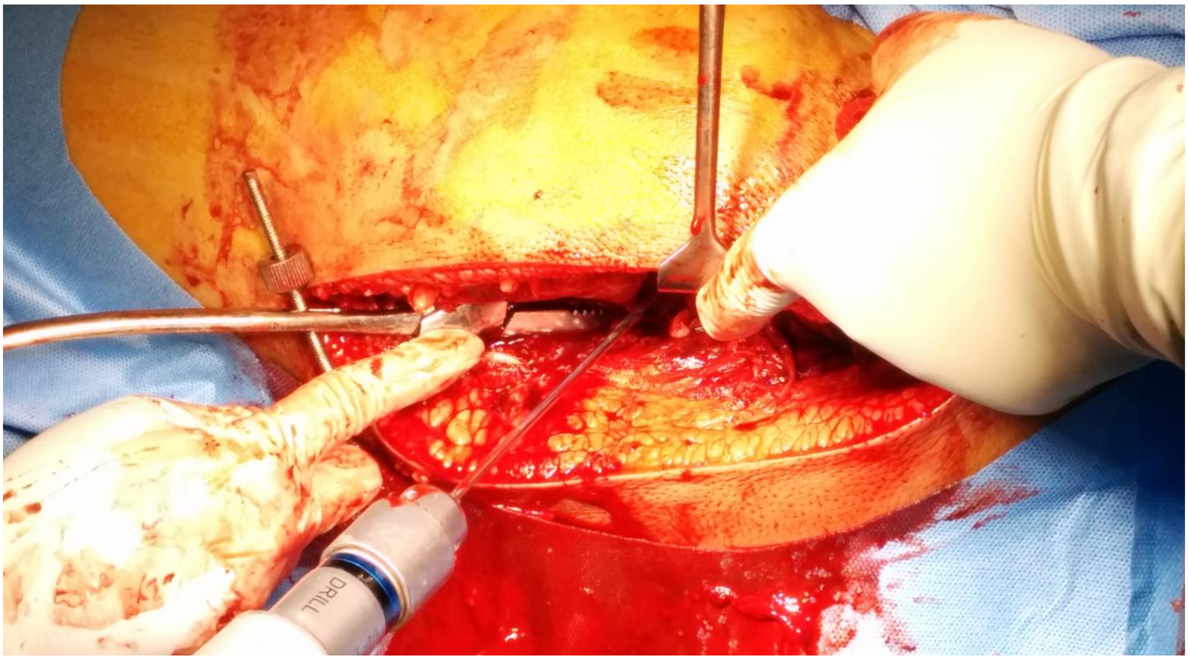


Figure 30: Guide wire insertion

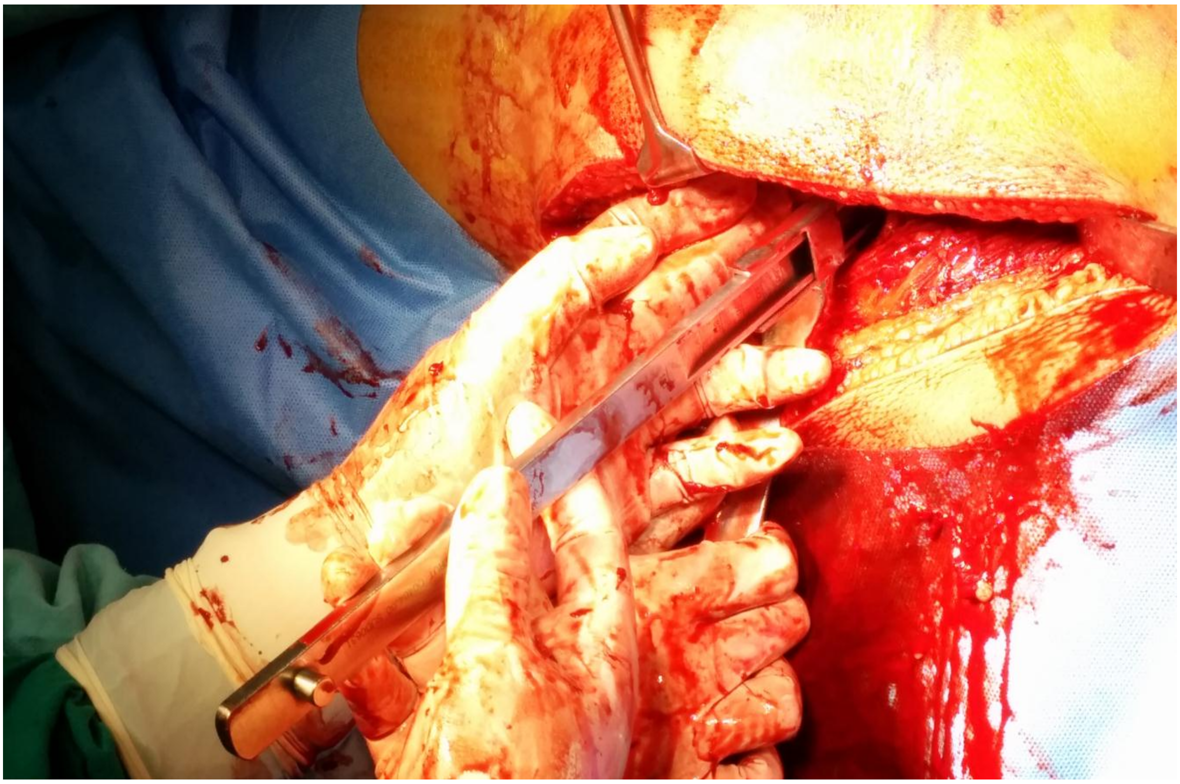


Figure 31: Seating Chisel Insertion

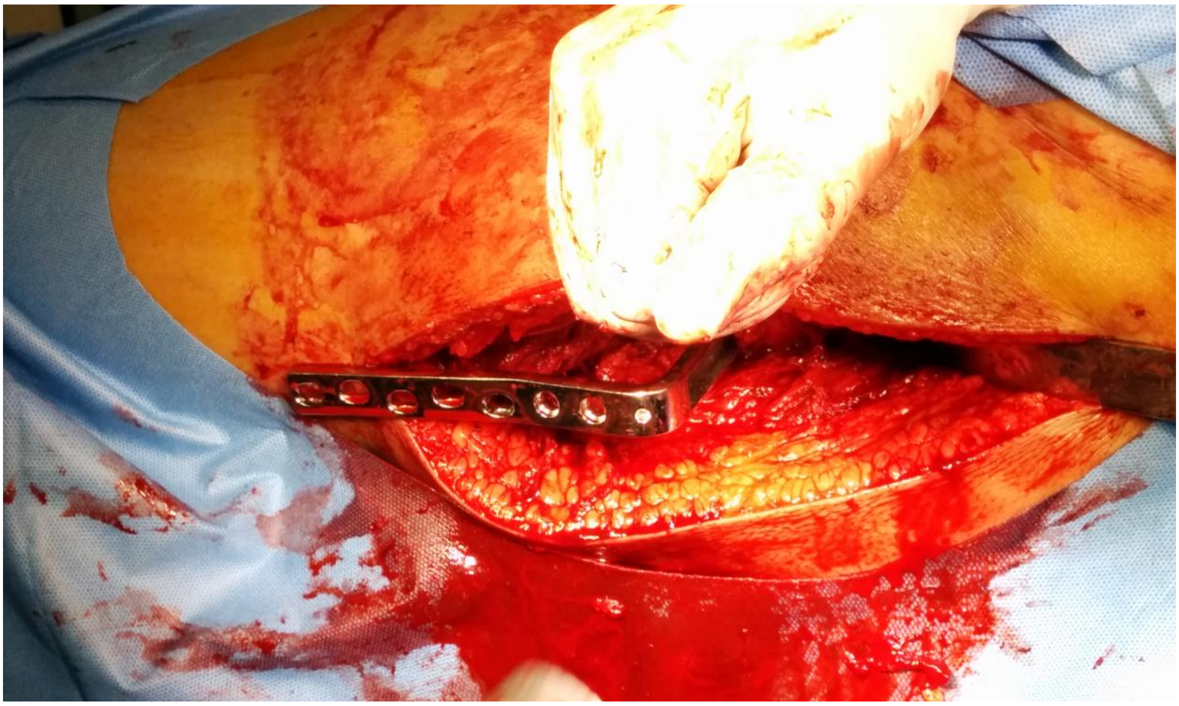


Figure 32: Plate Insertion

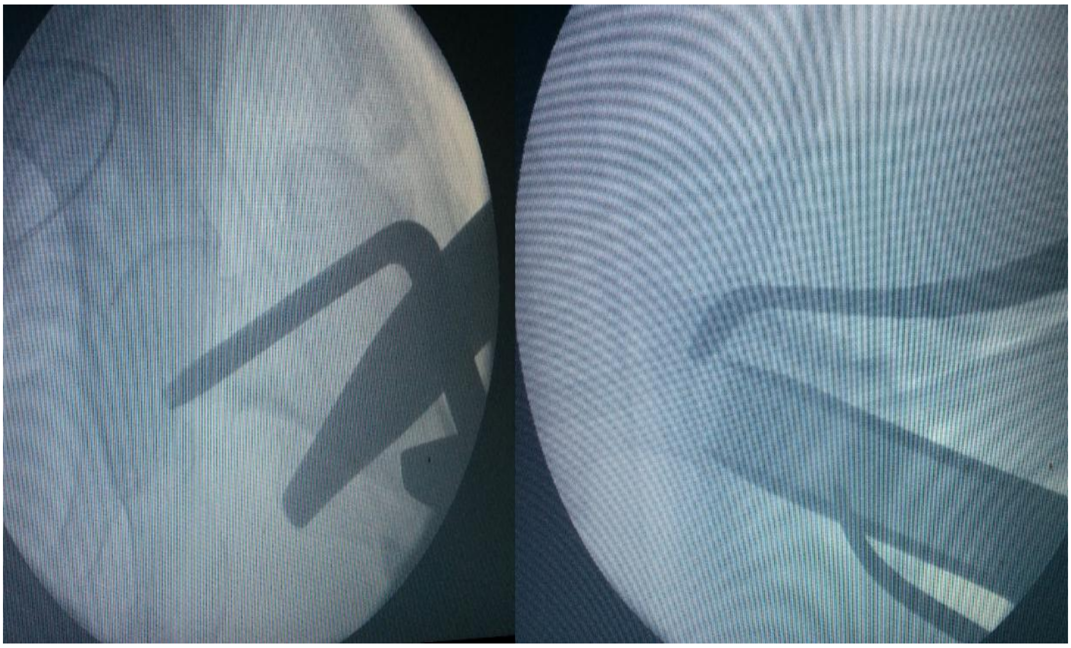


Figure 33: Confirmation on C-ARM

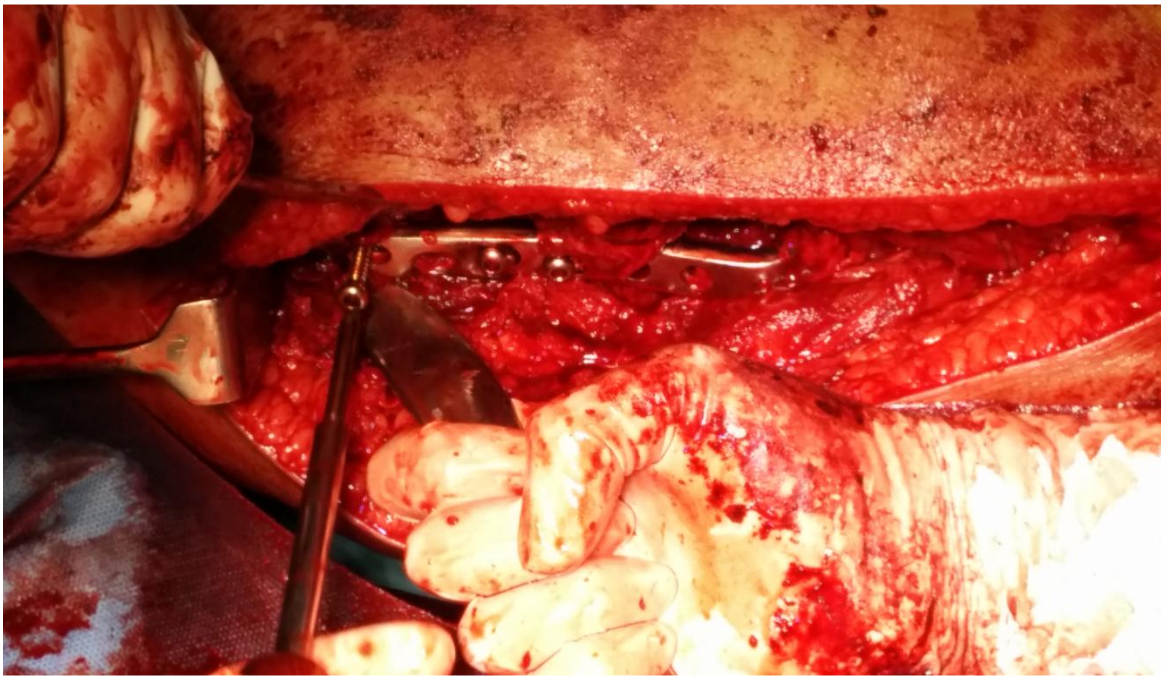
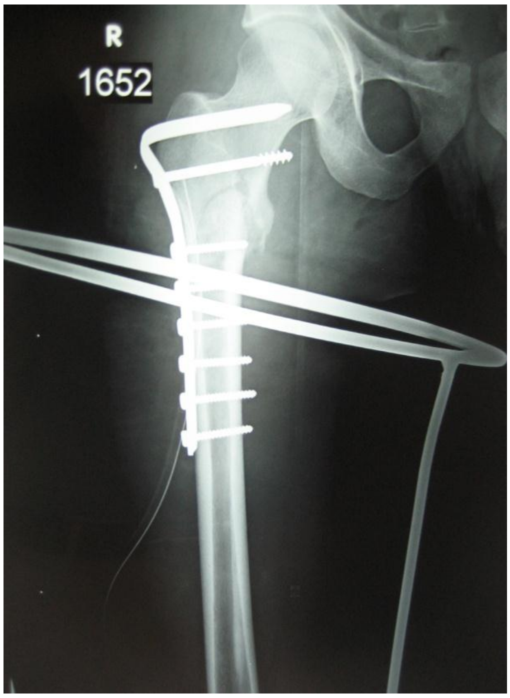


Figure 34: Fixation of blade plate

Figure 35: Skin closure over drain



Preoperative x-ray **Post-operative x-ray**

Post operative range of movements

Preoperative x-ray **Post-operative x-ray**

Post operative range of movements

Preoperative x-ray

Post-operative x-ray

Post operative range of movements

Preoperative x-ray

Post-operative x-ray

Implant failure

RESULTS

The following observations were made from the data collected during the study of treatment of intertrochanteric fractures of the femur in adults by open reduction and internal fixation using a 95 degrees angle blade plate in the Department of Orthopaedics, R.L Jalappa Hospital and Research Centre, Kolar, from October 2012 to October 2014.

Side affected:

In our study, 16 patients had fracture on the right side. And 14 patients had a fracture on the left side.

Table 1: Affected Side distribution

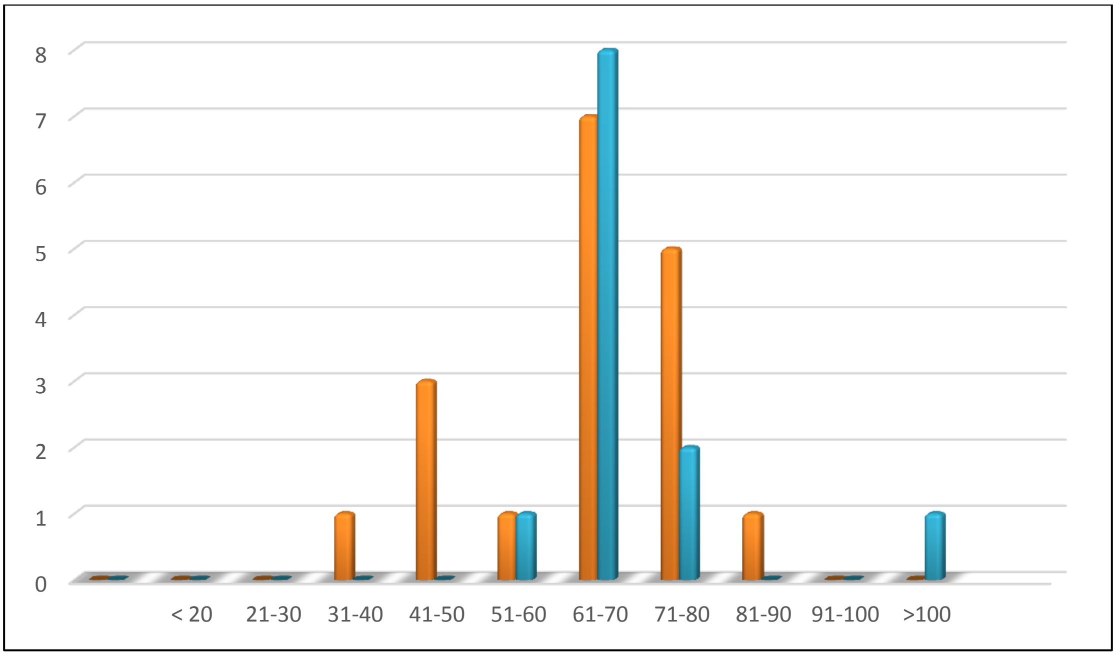
Side affected	No. of cases	%
Right	16	53.3
Left	14	46.7
Total	30	100

Age and Sex Incidence:

The study group comprised of 18 males and 12 females. Among them the minimum age was 38 years and maximum age noted was 103 years. Fifty percent of the patients were in the age group of 61 - 70 years, with the mean age of 64.8 years for males and 70.1 years for females. The study showed a male preponderance over females.

Table 2: Age and sex distribution

Age in years	Gender		Total
	Male	Female	
< 20	-	-	-
21-30	-	-	-
31-40	1	-	1
41-50	3	-	3
51-60	1	1	2
61-70	7	8	15
71-80	5	2	7
81-90	1	-	1
91-100	-	-	-
>100	-	1	1
Total	18	12	30



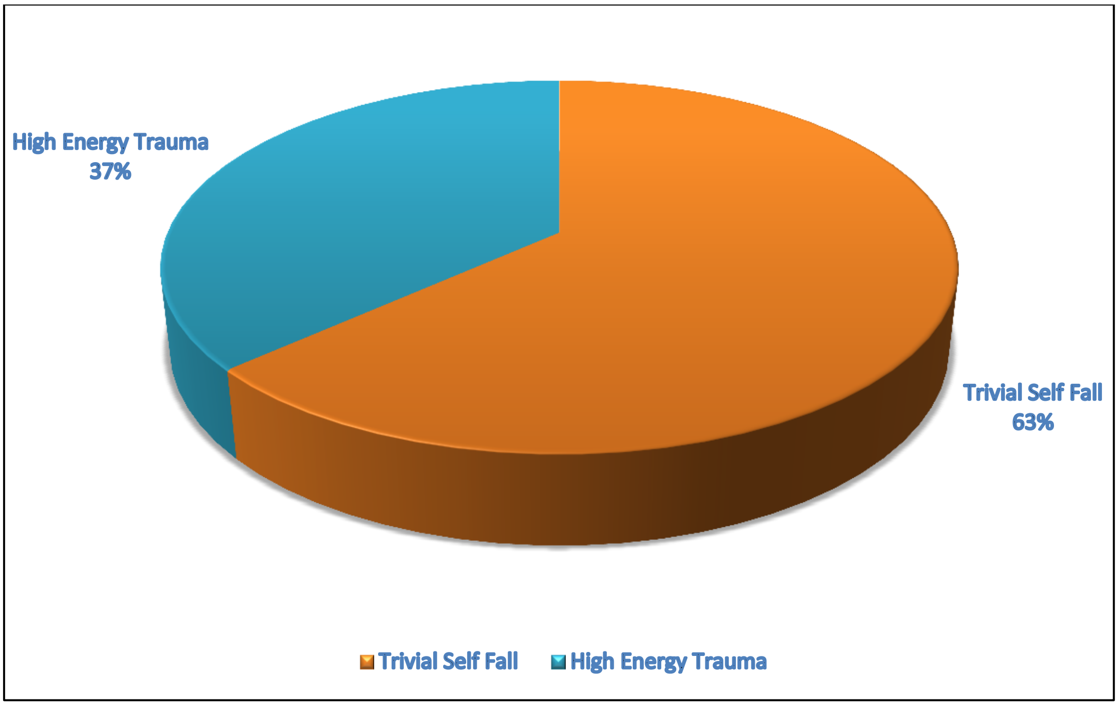
Graph 1: Age and Sex distribution

Mechanism of injury:

Out of the 30 fractures 19 were due to domestic self-fall and 11 were due to high energy road traffic accidents.

Table 3: Mechanism of injury

Mechanism	**Number**
Trivial Self fall	19
High energy trauma	11
Total	30



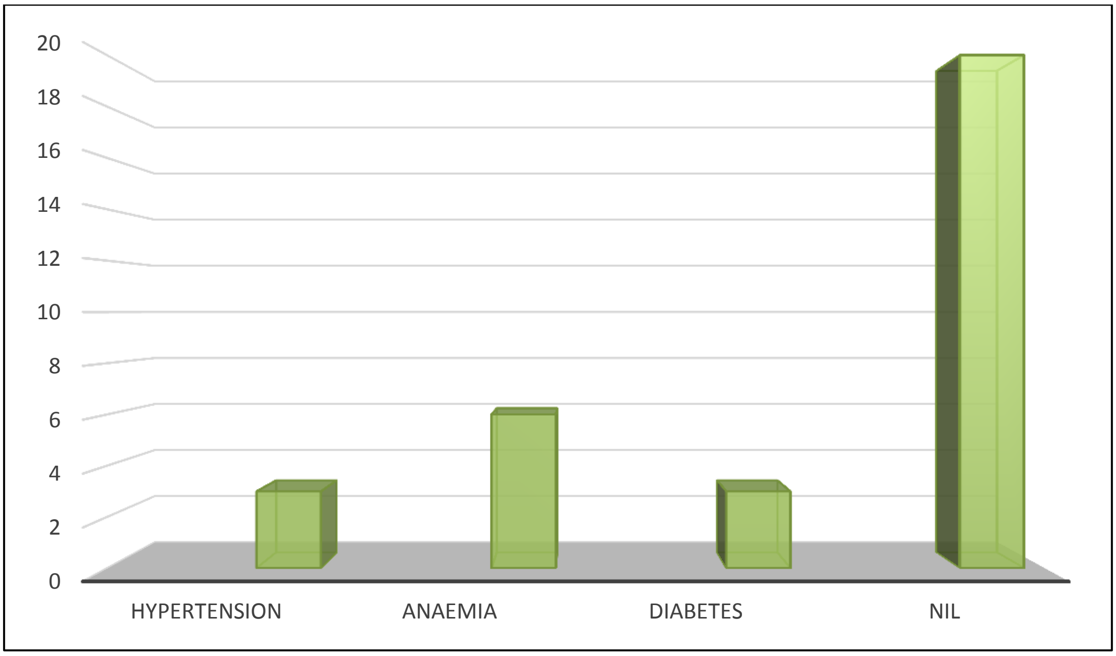
Graph 2: Mechanism of injury

Associated medical condition:

Co morbidities like hypertension in 3, anaemia in 6, diabetes in 3 in our present study.

Table 4: Co- morbid conditions

Associated condition	Number
Hypertension	3
Anaemia	6
Diabetes	3
Nil	20



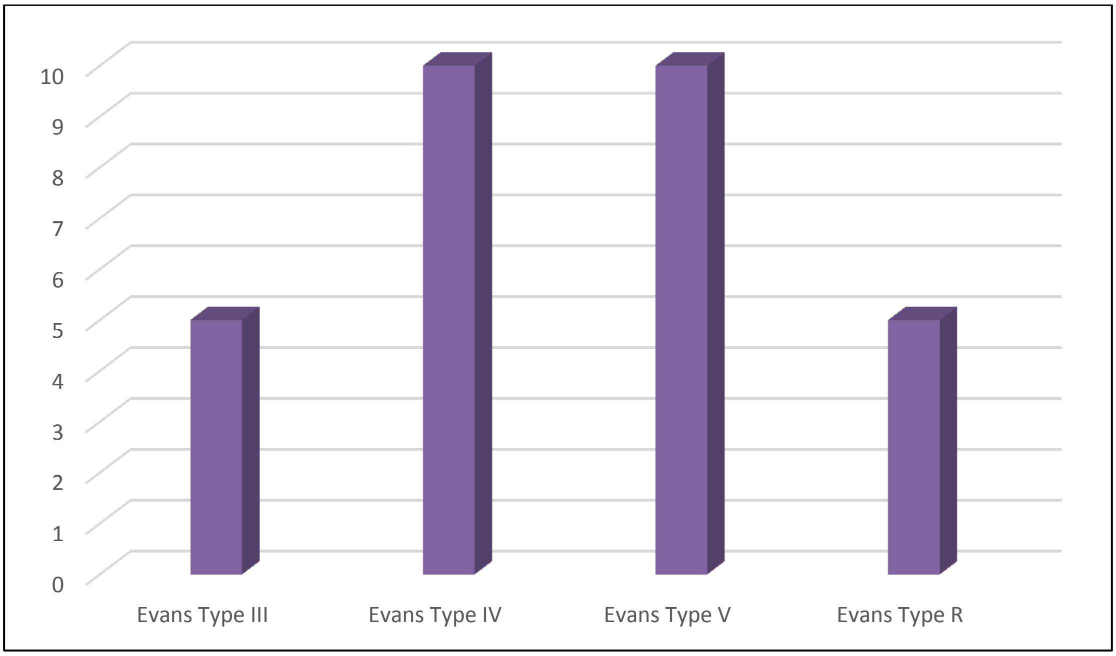
Graph 3: Co-morbid conditions

Type of fracture:

In this series 5 fractures were Evans Type III fractures, followed by 10 cases of type IV, 10 cases of type V and 5 cases of Reverse Oblique Type.

Table 5: Type of fracture

Type of fracture	Number of cases
Evans Type III	5
Evans Type IV	10
Evans Type V	10
Evans Type R	5
Total	30



Graph 4: Type of fracture

Duration of Hospital Stay:

The mean duration of hospital stay for the sample was 20.15 ± 8.2 days.

Table 6: Mean duration of hospital stay

Minimum	Maximum	Mean	SD
6	40	20.15	8.2

Duration of post-operative stay:

The mean duration of post-operative stay for the sample was 10.7 ± 4 days.

Table 7: Mean duration of post-operative stay

Minimum	Maximum	Mean	SD
5	19	10.7	4.0

Implant position:

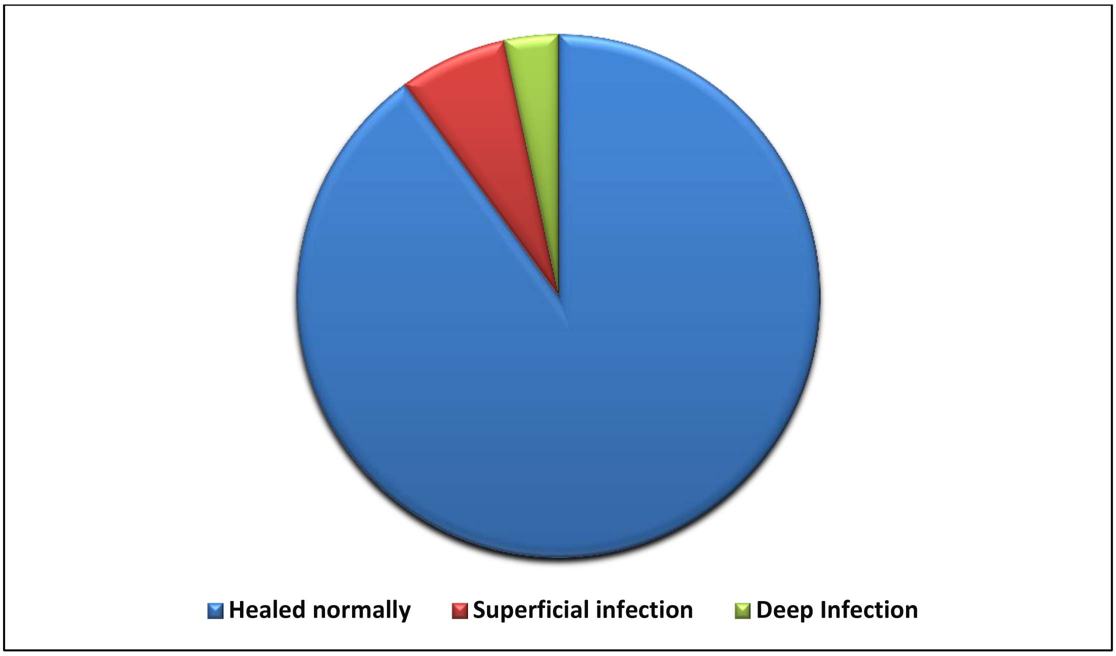
In the immediate post-operative x-rays, the position of the implant was noted. In all the patients, the tip of the blade was noted to be in the lower half of the femoral head. Also, the blade passed below the superior cortex of the neck.

Immediate post-operative complications:

Twenty seven patients healed normally. Two patients developed superficial infection which healed well with i.v. antibiotics for 3 weeks and one patient had deep infection for which wound exploration and debridement was done followed by i.v antibiotics for 3 weeks.

Table 8: Immediate post-operative complications

	No. of cases	**%**
Healed normally	27	90
Superficial infection	2	6.7
Deep Infection	1	3.3



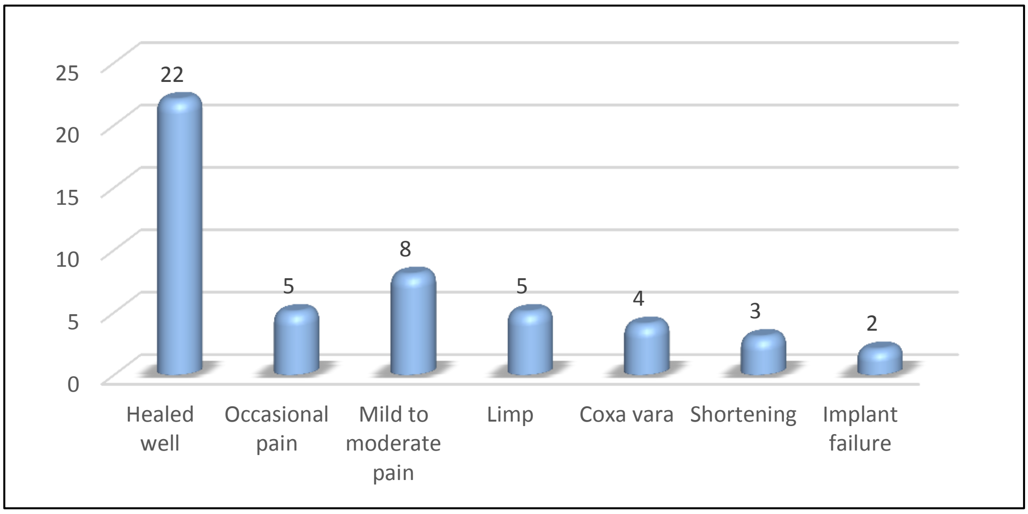
Graph 5: Immediate post-operative complications

Delayed post-operative complications:

In the present study, 12 patients healed well without any post-operative complications. 5 patients had occasional pain. 3 patients had mild to moderate pain. Limping was present in 5 cases, coxa vara in 4 cases, shortening in 4 cases and implant failure in 2 patients.

Table 9: Delayed post-operative complications

	No. of cases	%
Healed well	22	73.3
Occasional pain	5	16.7
Mild to moderate pain	8	26.7
Limp	5	16.7
Coxa vara	4	13.3
Shortening	3	10
Implant failure	2	6.7



Graph 6: Delayed post-operative complications

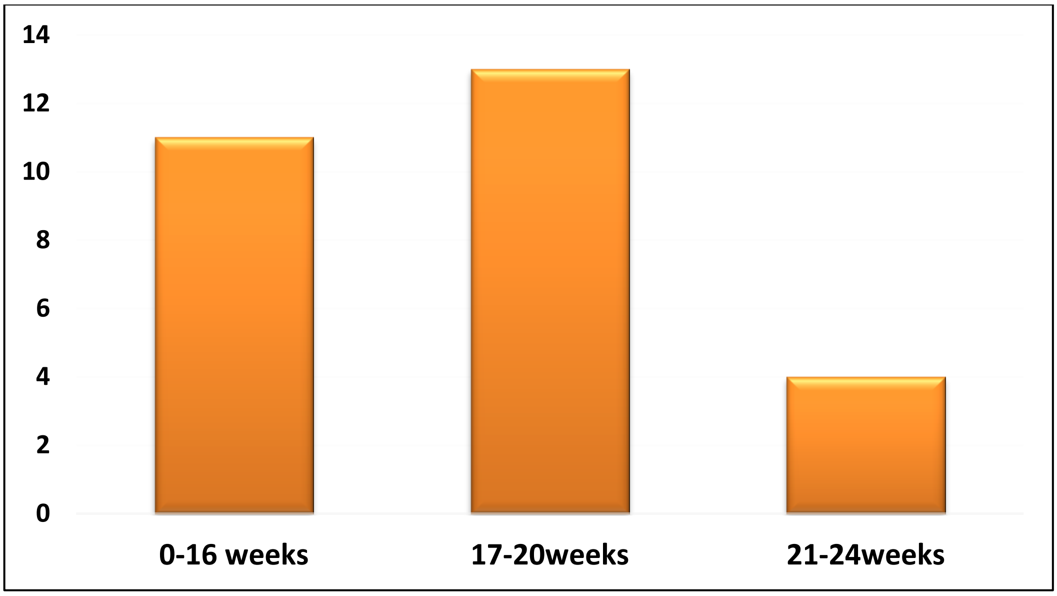
Radiological union:

Radiological union was said to be achieved on the evidence of obliteration of fracture lines and trabecular continuity between the two fragments on AP & lateral x-rays in three cortices.

11 cases showed union by 4 months, 13 cases at 5months and 4 cases showed union at 6 months duration. 2 cases had implant failure at 1st month and 6th month of follow-up respectively.

Table 10: Union in weeks

Union in weeks	Frequency	Percentage
0-16 weeks	11	36.7
17-20weeks	13	43.3
21-24weeks	4	13.3



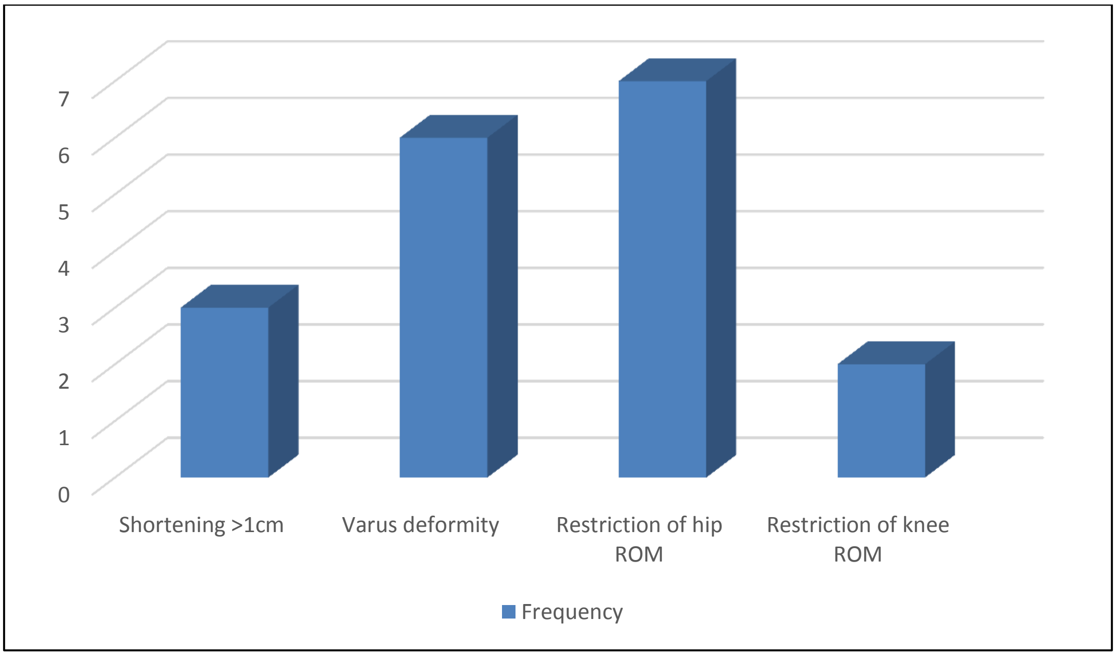
Graph 7: Union in weeks

Anatomical results:

Anatomical results were assessed on 30 patients available for follow up by presence or absence of shortening, varus deformities and range of movements in hip and knee joints. 75% of the cases had good results and 25% had fair results.

Table 11: Anatomical results

Anatomical results	Frequency	Percentage
Shortening >1cm	3	10
Varus deformity	4	13.3
Restriction of hip ROM	7	23.3
Restriction of knee ROM	2	6.7



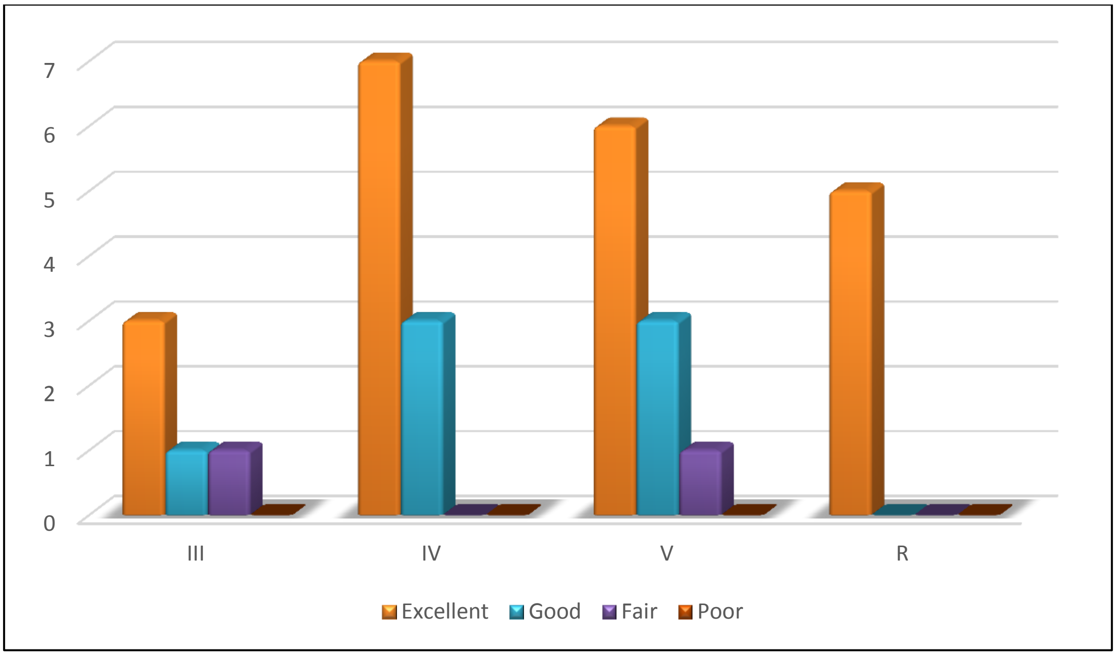
Graph 8: Anatomical results

Comparison of results with type of fracture:

In our study, type II fractures had more of excellent results and good results.

Table 12: Distribution of sample in comparison with fracture type

Evans type	No. of cases	Results			
		Excellent	Good	Fair	Poor
III	5	3	1	1	0
IV	10	7	3	0	0
V	10	6	3	1	0
R	5	5	0	0	0



Graph 9: Distribution of sample in comparison with fracture type

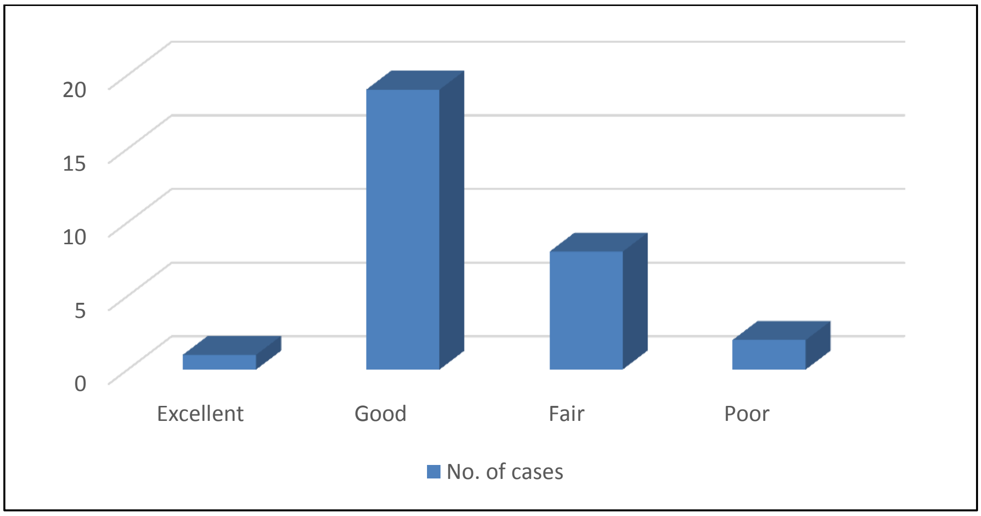
Functional outcome:

The total functional outcome was assessed using Harris Hip Score, which consisted of evaluation of patient on the basis of pain, limp, ambulation with support, distance walked, ability to sit, ability to enter public transport, ability to climb stairs, ability to put on footware, deformity and range of movements.

In the study, at 2 months follow up, 1 patients scored ‘excellent’, 19 patients scored ‘good’ and 8 scored ‘fair’ results. Poor score was scored by 2 patients.

Table 13: Functional outcome at 2 months

Functional Outcome	No. of cases	%
Excellent	1	3.3
Good	19	63.3
Fair	8	26.7
Poor	2	6.7

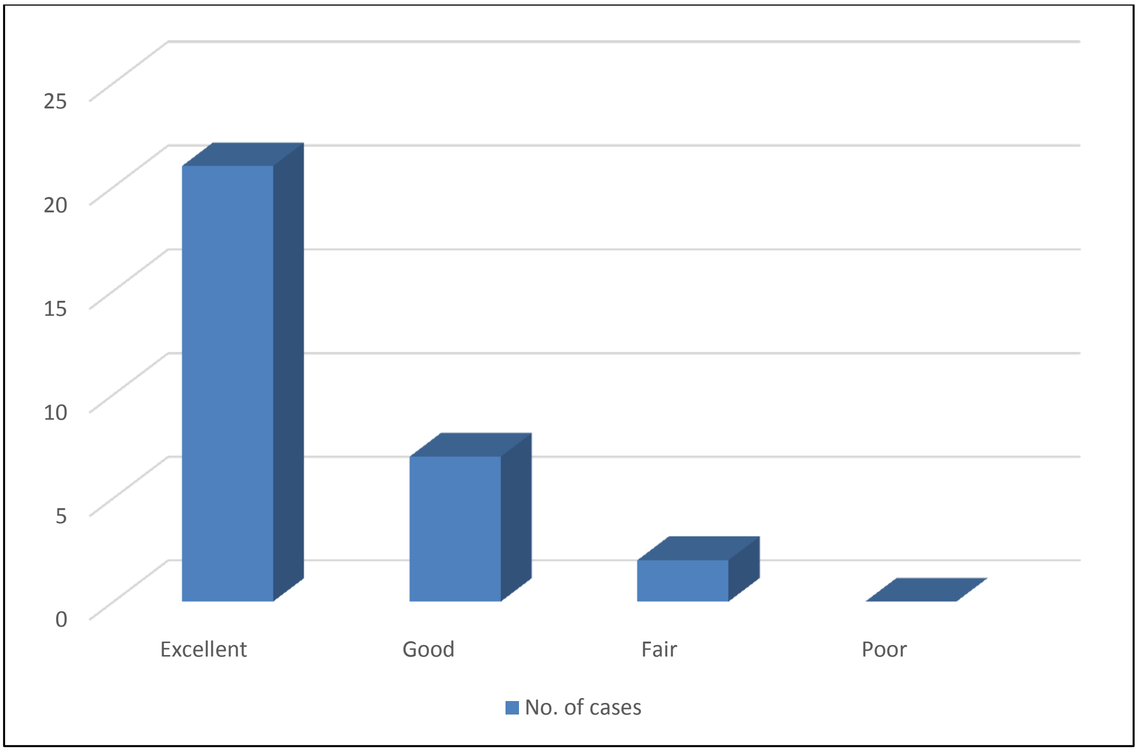


Graph 10: Functional Outcome at 2 Months

At 6 months follow up, 21 patients scored 'excellent', 7 patients scored 'good' and 2 scored 'fair' results.

Table 14: Functional outcome at 6 months

Functional Outcome	No. of cases	%
Excellent	21	70
Good	7	23.3
Fair	2	6.7
Poor	0	0



Graph 11: Functional Outcome at 6 Months

Statistical Analysis

Primary outcome analysis:

The paired difference in Harris Hip Score at 2 and 6 months was not normally distributed and the data had an outlier. Hence, a nonparametric test, Wilcoxon signed rank test was used to compare Harris Hip Score at 2 months and 6 months post operatively. The median difference in Harris Hip Score was computed using Hodges Lehman Estimator along with bootstrapped 95% Confidence Intervals. P value less than 0.05 was considered statistically significant at an alpha of 5%.

Table 15: Comparison of Harris Hip Score at 2 months and 6 months post operatively along with median difference in Harris Hip Score with the 95% CI for the median difference

Harris Hip Score at 2 months	Harris Hip Score at 6 months	Median difference in Harris Hip Score at 2 and 6 months	*p* value (significant if less than 0.05)	95% Confidence Interval for median difference	
Median (Interquartile Range)				Lower Bound	Upper Bound
83.5 (77.75-86)	91.5 (88.75-95)	10	***<0.001***	8	11

There was a significant improvement in Harris Hip Score at 6 months compared to Harris Hip Score at 2 months postoperatively

DISCUSSION

Trochanter fractures are difficult to manage and need surgical management most of the time. Early operative treatment of trochanteric fractures reduces both mortality and morbidity giving best chance of early independency and reducing the risk of prolonged bed rest.

Various modalities are available for the management of intertrochanteric fractures. These include both intramedullary and extramedullary implants. Unstable trochanteric fractures are technically much more challenging than stable fractures; a stable reduction of an intertrochanteric fracture requires providing medial and posterior cortical contact between the major proximal and distal fragments. Hence the surgeon must understand the implant options available and strive to achieve accurate realignment and proper implant placement.

The present study was done to evaluate the results of surgical treatment of intertrochanteric fractures with 95° angle blade plate. The study was conducted at R. L Jalappa Hospital and Research Centre, Kolar from October 2012 to October 2014.

Patients with intertrochanteric fractures satisfying the inclusion criteria were included in the study. They were thoroughly evaluated pre-operatively. Their details were collected and entered in a pre-formed proforma. The patients were operated upon and intra-operative details recorded. The patients were followed up regularly after being discharged from the hospital and their post-operative details were recorded.

Age Distribution:

The average age incidence in our study was 67 years. The mean age for males was 64.8 years and for females was 70.1 years. Majority of the patients belonged to the age group of 61-70 years.

Studies done in Indian population have shown similar mean age of patients; while studies done elsewhere show a higher mean age group.

Authors	Average Age (in years)
Yong [61]	78
Suriyajakyuthana [45]	70
Kesemenli [51]	67.6
Evans [22]	62.2
Murray & Frew [23]	62.5
Arun Kumar Singh [62]	52.5
Present Study	67

Sex Incidence:

The sex incidence in our study was 60:40 for males: females.

In age below 60 years, the incidence was 5:1 for males: females.

In age above 60 years, the incidence was 13:11 for males: females.

In younger and elderly patients, there is a male preponderance in our study. The most probable reason for this could be because Indian males are more active and more mobile than Indian females.

Various other authors have shown to have female preponderance in their studies.

Authors	Female: male
Yong [61]	66:34
Suriyajakyuthana [45]	67:33
Kesemenli [51]	55:45
Murray & Frew [23]	44:56
Arun Kumar Singh [62]	62:38
Present Study	40:60

Side involved:

In our study, the right hip fractures were found in 53.3% of cases. And the rest 46.7% cases had left hip fractures.

Studies conducted by Kesemenli [51] and Arun Kumar Singh [62] show right hip fractures to be more common, whereas a study by Suriyajakyuthana [45] shows left hip fractures to be more common.

Authors	Right	Left
Kesemenli [51]	62%	38%
Arun Kumar Singh [62]	60%	40%
Suriyajakyuthana [45]	46.4%	53.6%
Present Study	53.3%	46.7%

Mechanism of injury:

In our study, most patients (63.3%) sustained intertrochanteric fracture after a trivial fall. Of these, almost all patients were elderly patients.

Only 36.7% of our patients had a high energy trauma following a road traffic accident. Among these, the majority were young males.

Most other studies such as that of Suriyajakyuthana [45] and Kesemenli [51] have similar outcome regarding the mode of injury.

Mechanism of injury	Number of cases	Percentage (%)
Trivial fall	19	63.3
Road traffic accident	11	36.7
Total	20	100

Authors	Fall
Suriyajakyuthana [45]	75.4%
Kesemenli [51]	72%
Present Study	63.3%

Implant Failure:

In our study, 2 cases (6.7%) showed breakage in implant. Studies conducted by van Meeteren[38], Suriyajakyuthana et al [45] and Yoo MC et al [46] showed breakage of implants in 5%, 3.5% and 2.5% respectively.

Authors	Implant Breakage
van Meeteren[38]	5%
Suriyajakyuthana [45]	3.5%
Yoo MC [46]	2.5%
Present Study	6.7%

Classification of trochanteric fractures based on Evans Classification:

We have classified the intertrochanteric fractures in our patients based on the Evans Classification.

We found that Type IV and V fractures were the most common (33.3%).

Type IV fractures were 33.3%.

Type V fractures were 33.3%.

Type III fractures constituted 16.7%.

Type R fractures were 16.7%.

Our results are comparable with the studies of Arun Kumar Singh [62] and studies of Murray and Frew [23]

Co-morbid status:

Anaemia was the most common condition, especially seen in the elderly females (20%).

Hypertension and diabetes mellitus were the other common co-morbid conditions seen commonly in our patients.

In the study conducted by Suriyajakyuthana [45], 60% of patients had co-morbid conditions. Our study however had lesser comorbid patients.

Implant position:

In the immediate post-operative x-rays, the position of the implant was noted. In all the patients, the tip of the blade was noted to be in the lower half of the femoral head. Also, the blade passed below the superior cortex of the neck.

Duration of hospital stay:

The average duration of stay for the patients in our study was 20.15 days.

In the earlier days, when the patients with intertrochanteric fractures were treated conservatively, the patients were admitted for an average of 6 weeks. This can be seen in the studies of Evans [22] and Murray & Frew [23].

The present day studies of Yong [61] and Kesemenli [51] show that the duration of hospital stay is less than 3 weeks, which is comparable with our study.

Immediate Post-operative Complications:

In our study, 27 patients (90%) healed well without any immediate post-operative complication. 2 patients developed superficial infection, which was treated aggressively with intravenous antibiotics and adequate debridement, after which they healed well and one patient had deep infection for which wound exploration and debridement was done followed by i.v antibiotics for 3 weeks.

Delayed Post-operative Complications:

The delayed post-operative complications noted in our study were hip pain, limp, coxa vara and limb shortening.

Hip pain: Pain in the hip region was the most common and the most important complication. Pain is an important criterion for evaluation of hip fractures. Persistent pain could be due to infection, implant failure, non-union, avascular necrosis etc.

In our study, 60% of patients had no pain. 16.7% of patients had occasional pain. 26.3% of patients had mild to moderate pain not affecting their daily activities which subsided with medication.

Limp: In our study, 83.3% of the patients had a normal gait. 5 patients in our study had a limp on the affected side. Limp is due to shortening, coxa vara etc.

Coxa vara: In our study, 86.7% of the patients had a neck-shaft angle of 130° or more. 1 patient had varus angulation of 5°, 1 had varus angulation of 15° and 2 patients had varus angulation of 10°. No case had varus angulation of more than 15°.

Varus angulation of up to 15° is acceptable and does not need re-doing.

Shortening: In our study, 90% of our patients had no shortening. 2 patients developed shortening of 1 cm and 2 patients developed shortening of 2 cm. No case had shortening of 3 cm or more.

Shortening of up to 2.5 cm is acceptable and can be corrected by a shoe raise.

Evaluation of cases using Harris Hip Score:

In our study, at the end of 6 months, 70% (21 patients) scored excellent results, 23.3% (7 patients) had good results, 6.7% (2 patients) had fair results and none had poor results. 2 patients had implant failure of which one needed re-doing.

Evaluation of cases according to anatomical outcome:

In our study, 75% patients had a good result and 25% had fair result. Shortening of more than 1 cm was noted in 2 patients, varus angulation was noted in 4 patients, restriction of hip movements was noted in 7 patients and knee movement restrictions were noted in 2 patients.

Limitations of study:

Small sample size limited our statistical analysis.

Short follow up period: a longer follow up period is needed to evaluate the late complications.

CONCLUSION

Hip fractures are the leading cause of morbidity and mortality in the elderly. Intertrochanteric fractures are a common injury, more commonly seen in elderly females and arising out of trivial fall. Patients with trochanteric fractures are bed-ridden, which leads to severe health problems and reduced quality of life which increases the burden on the care-givers.

Patients with trochanteric fractures undergoing early surgery have an improved ability to return to independent living and prevention of complications of prolonged immobilisation.

The 95 degrees angle blade plate can be used for nstable intertrochanteric fractures, but the final outcome is dependent on various factors such as the type of fracture, the condition of the medial wall, the bony architecture, and the co-morbid conditions of the patient, the operative technique, implant position and post-operative care.

The position of the implant should be such that the tip of the blade should be in the lower half of the femoral head and the blade should pass below the superior cortex of the neck.

This study shows that the 95 degrees angle blade plate offers a reliable and effective alternative for the treatment of trochanteric fractures.

The 95 degrees angle blade plate is a stable and acceptable implant for the treatment of intertrochanteric fractures.

SUMMARY

In the present study, 30 cases of intertrochanteric fracture of femur were treated by open reduction and internal fixation with 95 degrees angle blade plate, in the Department of Orthopaedics at R.L. Jalappa Hospital and Research Centre, Kolar, from October 2012 to October 2014.

The data obtained was analysed and results were evaluated and compared.

- The average age incidence was 67 years.
- Predominantly males were affected.
- Fall from standing height was the most common mechanism of injury.
- Type IV and Type V fractures were the most common.
- The average duration of hospital stay was 20.15 days.
- 80% patients achieved bony union within 20 weeks.
- Based on Harris Hip Score, at the end of 6 months, 70% (21 patients) had excellent results, 23.3% (7 patients) had good results, 6.7% (2 patients) had fair results and none had poor results.
- Based on anatomical results, 75% patients had good results and 25% had fair results.

The 95 degrees angle blade plate is a suitable option for the treatment of intertrochanteric fractures and subtrochanteric fractures.

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ANNEXURE – I

PROFORMA OF THE CASE SHEET

NAME: **I.P. NO.:**

AGE: **DATE OF ADMISSION:**

SEX: **DATE OF SURGERY:**

DATE OF DISCHARGE:

ADDRESS:

PRESENTING COMPLAINTS:

I) H/O OF PRESENTING ILLNESS

a) Pain

b) Ability to walk

c) Mechanism of injury - Trivial/ Violent

II) PAST H/O INJURY / INJURIES

a) History of previous injury

b) Hypertension

c) Diabetes Mellitus

d) Pulmonary Tuberculosis

e) Any other disease

III) FAMILY AND PERSONAL HISTORY

IV) GENERAL PHYSICAL EXAMINATION

V) SYSTEMIC EXAMINATION

a) R.S.

b) C.V.S.

c) P/A

d) C.N.S.

VI) LOCAL EXAMINATION

A) GAIT

B) INSPECTION

1) Anterior Superior Iliac spine – Same level/ raised
2) Lumbar lordosis- Yes/ No
3) Attitude of limb
4) Apparent shortening- Yes/ No
5) Swelling around the hip- Yes/ No
6) Muscle wasting- Yes/ No
7) Skin changes- scars, sinuses

C) PALPATION

1) Tenderness- Yes/ No
2) Abnormal mobility
3) Local rise of temperature- Yes/ No
4) Broadening/ Migration of the greater trochanter- Yes/ No
5) Swelling
6) Vascular sign of Narath – Yes/ No
7) Crepitus
8) Transmitted movement- Yes/ No

D) MOVEMENT

	Active	Passive
1) Flexion		
2) Extension		
3) Adduction		
4) Abduction		
5) External rotation		
6) Internal rotation		

E) MEASUREMENTS

Length of the limb -	Normal	Affected
a. Apparent length		
b. Total length (true)		
c. Thigh segment		
d. Leg segment		
e. Girth of the limb		

VII) ANY ASSOCIATED INJURIES/ FRACTURES

VIII) INVESTIGATIONS

a. X-Ray hip- AP/ Lateral

b. Chest X-Ray PA view

c. ECG

d. Routine Blood investigations-

Hb:	BT:	CT:
RBS:	B.Urea:	S.Creat:
HIV:	Hbs Ag:	BLOOD GP:

e. Urine routine

f. Special investigations (if required)- Liver Function Tests

Any other Specific investigations

IX) DIAGNOSIS

X) MANAGEMENT

Pre-Operative Treatment

a) I.V. Fluids

b) Antibiotics & Analgesics

c) Blood transfusion

d) Splinting

e) Fixed skin traction in Thomas splint

Operative Treatment

a) Date of operation

b) Anaesthesia

c) Approach

d) Intra operative complications

Post-operative Treatment

a) Analgesics & Antibiotics

b) Blood transfusion

c) Suture Removal on

d) Follow up x-ray

Post-operative complications

Immediate:

1. Swelling of the limbs
2. Other complications

Late

1. Wound infection
2. Deep vein thrombosis
3. Shortening/Lengthening
4. Pulmonary embolism
5. Deformity

Follow up at 2 months and 6 months to assess Harris Hip Score

ANNEXURE – II

HARRIS HIP SCORE

Harris Hip Score

Pain *(check one)*

☐ None or ignores it (44)
☐ Slight, occasional, no compromise in activities (40)
☐ Mild pain, no effect on average activities, rarely moderate pain with unusual activity; may take aspirin (30)
☐ Moderate Pain, tolerable but makes concession to pain. Some limitation of ordinary activity or work. May require Occasional pain medication stronger than aspirin (20)
☐ Marked pain, serious limitation of activities (10)
☐ Totally disabled, crippled, pain in bed, bedridden (0)

Limp

☐ None (11)
☐ Slight (8)
☐ Moderate (5)
☐ Severe (0)

Support

☐ None (11)
☐ Cane for long walks (7)
☐ Cane most of time (5)
☐ One crutch (3)
☐ Two canes (2)
☐ Two crutches or not able to walk (0)

Distance Walked

☐ Unlimited (11)
☐ Six blocks (8)
☐ Two or three blocks (5)
☐ Indoors only (2)
☐ Bed and chair only (0)

Sitting

☐ Comfortably in ordinary chair for one hour (5)
☐ On a high chair for 30 minutes (3)
☐ Unable to sit comfortably in any chair (0)

Enter public transportation

☐ Yes (1)
☐ No (0)

Stairs

☐ Normally without using a railing (4)
☐ Normally using a railing (2)
☐ In any manner (1)
☐ Unable to do stairs (0)

Put on Shoes and Socks

☐ With ease (4)
☐ With difficulty (2)
☐ Unable (0)

Absence of Deformity (All yes = 4; Less than 4 =0)

Less than 30° fixed flexion contracture	☐ Yes	☐ No
Less than 10° fixed abduction	☐ Yes	☐ No
Less than 10° fixed internal rotation in extension	☐ Yes	☐ No
Limb length discrepancy less than 3.2 cm	☐ Yes	☐ No

Range of Motion (**indicates normal)*

Flexion (*140°) ________
Abduction (*40°) ________
Adduction (*40°) ________
External Rotation (*40°) ________
Internal Rotation (*40°) ________

Range of Motion Scale

211° - 300° (5)	61° - 100 (2)
161° - 210° (4)	31° - 60° (1)
101° - 160° (3)	0° - 30° (0)

Range of Motion Score ____________

Total Harris Hip Score ____________

ANNEXURE – III

CONSENT FORM

I/we ____ have been explained, in my/own language, about the condition of the patient, the nature of injury, the need for surgery, the various options available and the risks and complications involved.

I understand the need for the study and the methods used for conducting the study.

I hereby give my full valid consent for the use of my case details, x-rays, investigations and photographs for research purpose.

Name:

Address:

Signature / Left thumb impression

Date:

Place:

KEY TO MASTER CHART

Sl.	-	Serial number
IP no.	-	Inpatient number
DOA	-	Date of admission
DOS	-	Date of surgery
DOD	-	Date of discharge
ABP	-	95° angle blade plate
M	-	Male
F	-	Female