ORIGINAL ARTICLE

Frequency and Causes of Failure of Dynamic Hip Screw Fixation for Interochanteric Fracture

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ABSTRACT

Background: Hip fractures are a leading cause of death and disability among elderly. Approximately half of these injuries are intertrochanteric fractures and the incidence is continuously increasing. It is estimated that the incidence of intertrochanteric fractures will be doubled by the year 2040. Different types of implants were tried at different times for internal fixation of these fractures, of which dynamic hip screw has remained the most popular one. But with the advent of some newer implants, the efficacy of dynamic hip screw is being questioned.
Aims: To determine the frequency of failure after dynamic hip screw fixation of intertrochanteric fracture and to identify causes (instability, increased tip apex distance and high angle side plate) leading to failure after dynamic hip screw fixation of intertrochanteric fracture.
Design: Descriptive case series.
Setting: The study was conducted in Orthopaedic ward of Ghurki Trust Teaching Hospital/Lahore Medical & Dental College, Lahore.
Duration of study: Six months (15th November, 2008 to 15th May, 2009)
Methods: Forty five cases of intertrochanteric fractures were included and operated for internal fixation with dynamic his screw under fluoroscopic guidance. Pre, per and post-operative findings during hospital stay and follow-up period were recorded.
Results: There were 32 males and 13 females with male to female ratio were 2.5:1. The mean±SD between the ages was 71.91±10.40 years. Thirty one patients were admitted through emergency and 14 patients through outdoor patient department. The size of lag screw in 12 patients of 85 mm screw and 33 patients of 900 mm screw were used. Three types of interlocking nail of 45 mm, 50 mm and 55 mm sizes were used. The failure rate was found in 22 patients of grade III, 15 patients of grave IV and 8 patients of grade V of dynamic hip screw fixation through Hammer et al radiological assessment of callus formation. At Sirkoski and Barrington pain scale, the failure rate was found in 28 patients of grade III and 17 patients of grade IV.
Conclusion: The use of this implant is associated with satisfactory result and acceptable complication rate, given the poor physical status of many of these elderly patients before the injury.
Key words: Dynamic hip screw, Intertrochanteric fracture, Outcome

INTRODUCTION

The intertrochanteric fractures are generally referred as extracapsular fractures of proximal femur in the trochanteric region. The incidence of these fractures, particularly comminuted unstable type, is increasing[1]. These fractures are the most common injuries around the hip region and are more common in elderly people[2]. These fractures are 4-5 times more common than the femoral neck fractures[3]. The patients with intertrochanteric fractures are described to be 10-12 years older than the patients with intracapsular femoral neck fractures.[4,5] Although these fractures are mostly extracapsular, however the distinction between intertrochanteric and basicervical fractures of the neck of femur, sometimes, become difficult classically. These fractures extend along a line between the lesser and greater trochanters, but this constitutes only a small fraction, as almost sixty percent of these fractures are comminuted with different geometric patterns[6].

The average age reported in these patients is 66-76 years[4]. These fractures are more common in females. The ratio of women to men ranges from 2:1 to 8:1. Less bone stock after menopause may be a contributory factor[7]. In younger people, these injuries may occur after a high velocity trauma and are less common[2]. The cancellous bone of trochanteric area of proximal femur has an excellent blood supply because of which these fractures usually heal well regardless of the mode of treatment[8].

Hip fractures result in an increasing demand on orthopedic and trauma departments, as these patients usually need comparatively a long hospital stay. Optimal treatment of such fractures is an exercise on

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balancing the biological and mechanical considerations to maximize the likelihood of healing and full restoration of function with minimal risk of complications and least cost to the patients and society[9].

Closed methods of treatment of these fractures have largely been abandoned due to high rate of complications with increased morbidity and mortality. There are only a few indications for non-operative treatment of intertrochanteric fractures. Medically unstable patients, already immobile patients and the patients with bad skin condition are the candidates for conservative management. The skeletal traction for 8-10 weeks is the most recommended treatment modality[1].

The goal of surgical treatment is to achieve union in a good position with a low morbidity and to return the patient to his or her pre fracture activity as soon as possible. If prior to injury, patient was confined to bed or chair then goal of treatment is pain relief and better nursing care.[10] In developing countries, many patients are not suitable for surgical intervention because of low socioeconomic status and other risk factors such as severe anemia, poor pulmonary status etc. In these circumstances, less invasive option i.e. external fixation may be a satisfactory alternative[11].

Different fixation techniques were tried for intertrochanteric fractures at different times, with variety of implants but the dynamic hip screw fixation is most widely accepted treatment of fracture of the proximal femur.[12] The principle of the sliding hip screw is to provide a controlled collapse at the fracture site[13]. For union of these fractures, maintenance of stable reduction is the most important factor. To determine the type of fixation, each fracture pattern must be meticulously evaluated by roentgenograms before surgery. Whether the intertrochanteric fracture is stable or unstable, is based on fracture geometry and possibility of restoration of cortical contact medially and posteriorly. Unreduced medial cortex may collapse into varus. Stable reduction, therefore, provides sufficient medial and posterior cortical contact to effectively resist varus and posterior displacement of major proximal and distal fragments[14].

Sometimes, the posteromedial fragments of bone are difficult to reduce clinically and under such circumstances, the desired anatomical reduction cannot be achieved. For such unstable intertrochanteric fractures, therefore, non-anatomical reductions can be achieved by Dimon and Hunghston medial displacement osteotomy, Sarmiento valgus osteotomy or Wayne County valgus reduction[15].

Implant failure in these fractures has been related to type of fracture particularly its stability, inadequate reduction, osteoporosis and incorrect placement of device within the femoral head[16]. The commonest mode of failure is cutting out of the screw from femoral head with a reported incidence of 2.25-12.6%[12]. It is during the screw fixation that clockwise rotational torque is imparted[13].

Kovel et al[17] reported 41% patients return to pre-fracture ambulatory ability and 40% patients remained community and household ambulators, 97% of anatomically reduced unstable fractured healed uneventfully. Fracture reduction and implant placement have also been shown to affect the rate of failure by cutting out[12].

The final out-come of the surgical management of unstable intertrochanteric fractures also depend upon quality of bone, as decreased bone density results in poor functional results. Fractures geometry and age of patient are other biological factors, which affect the surgical results[18].

Relationship between position of screw and fracture pattern is of prime importance[19]. The lag screw of dynamic hip screw (DHS) should ideally be placed inferiorly towards the medial margin in frontal plane and centrally in the sagittal plane and tip of screw should be 1.0 cm beneath the subchondral bone to achieve good union[20].

Stable fracture pattern, postero-inferior and central position of screw in the femoral neck and head produced high percentage of good result[17].

Unstability (40%), increased tip apex distance (upto 45 mm) 60%, high angle side plate that is 150° (50%) are causes of DHS failure[21-23].

Tip apex distance of 25 cm or less is considered as good, 26-30 cm as acceptable, 31-35 cm as poor and more than 35 cm as unacceptable[24].

Recently some newer implants have been advocated for the treatment of intertrochanteric fractures. Intramedullary devices like Gamma nail and proximal femoral nail are gaining popularity due to described theoretical advantages of being placed in the line of weight bearing axis and having shorter lever arm, which reduces the risk of mechanical failure[1]. Also with the introduction of hydroxyapatite-coated pins, some surgeons are in favour of using external fixator as an alternative treatment modality.[11] The objective of the study are to determine the frequency of failure after DHS fixation of inter-trochanteric fracture and to identify causes (instability, increased tip apex distance and high angle side plate) leading to failure after DHS fixation of inter-trochanteric fracture. In this study i**nter-trochanteric fracture was fra**cture of proximal end of femur that is extra-capsular and fracture line passing between greater and lesser trochanter. **DHS** failure was said to be present after 6 months of fixation according to “Hammer et al radiological assessment of callus formation” (Grade III, IV and V) & pain assessment according to Sirkoski

and Barrington scale (Grade III, IV). **Causes which were looked for failure were i**nstability assessed through radiographs showing fracture of lesser trochanter, increased tip apex distance assessed through post-operative radiograph i.e. 36 mm or more and high angle side plate assessed through post-operative radiograph i.e., 150° or above.

MATERIAL AND METHODS

This was a descriptive (case series) study conducted in Orthopaedic Ward of Ghurki Trust Teaching Hospital/Lahore Medical & Dental College, Lahore for six months ((15th November, 2008 to 15th May, 2009). The calculated sample size with 10% margin of error, 95% confidence level taking expected percentage of DHS failure i.e., 12.6% is 45 cases.

Forty five patients of both gender and more than 40 years age undergoing DHS fixation for inter-trochanteric fracture admitted through outdoor or emergency were included in study using non probability purposive sampling. Patient who had Implant failure due to another trauma or untreated osteoporosis were excluded. Written informed consent along with other information's like name, age, gender, history of mode of injury like fall, minor trauma or high energy trauma were taken. All information about patient was kept confidential. In hospital pre-discharge period, patients were assessed for instability by getting the post-operative X-rays. Tip apex distance which is the sum of distances from the tip of lag screw to the apex of femoral head measured on antero-posterior and lateral view radiographs after correction has been made i.e. 36 mm or above. High angle of side plate i.e. 150° or more was measured from postoperative radiographs. The given proforma was filled with necessary variables of patients. The collected data was transferred and analyzed accordingly using SPSS 11.0 version. The variables to be analyzed were include demographic information's like age, gender, DHS fixation (failure and success) and causes leading to failure (instability, increased tip apex distance, high angle plate). These variables were analyzed by using simple descriptive statistics, using mean and standard deviation for quantitative data like age, qualitative data like gender, failure after DHS fixation and causing leading to failure. Data was stratified for mode of injury (fall, minor trauma, high energy trauma).

RESULTS

This study includes a total of 45 patients who were admitted to the Orthopaedics Department of Ghurki Trust Teaching Hospital Lahore through accident and emergency and outdoor departments with the intertrochanteric fractures. There were 27 males (60%) and 18 females (40%). Male to female ratio was 1.5:1 (Table 1).

The patients shown in Table 2 were divided into four age groups. The first age group patients aged 51-60 years 11(24.5%), in second age group patients aged 61-70 years 15(33.3%), in the third age group patients aged 71-80 years 14(31.1%) and in the fourth age group patients aged 81-90 years 5(11.1%). The mean ± SD between the ages was 71.91±10.40 years.

Thirty one patients (68.9%) were admitted through emergency and 14 patients (31.1%) through out patient department (Table 3).

Regarding the fracture of pattern, comminuted + displaced fracture in 16 patients (35.6%), unstable + displaced fracture in 15 patients (33.3%) and stable + un displaced fracture in 14 patients (31.1%) were noticed (Table 4).

The size of lag screw in 12 patients (26.7%) of 85 mm screw and 33 patients (73.3%) of 90 mm screw were recorded (Table 5).

Three types of interlocking screws of 45 mm, 50 mm and 55 mm sizes were used. 45 mm screws were used in 17 patients (37.8%), 50 mm screws were used in 20 (44.4%) and 55 mm screws were used in 8 (17.8%) patients (Table 6).

Regarding assessment of callus formation through "Hammer et al radiological assessment of callus formation", the failure rate of DHS fixation was found in 22 patients (48.8%) of grade III, 15 patients (33.4%) of grade IV and 8 patients (17.8%) of grade V (Table 7).

The failure rate according to Sirkoski and Barrington pain scale was found in 28 patients (62.3%) of grade III and 17 patients (37.7%) of grade IV (Table 8).

Post-operatively the causes of failure were found in 31 patients (68.9%) of unstability, 11 patients (24.4%) of increased tip apex distance and 3 patients (6.7%) of high angle side plate (Table 9).

Table 1: Sex distribution of patients (n = 45)

Sex	Frequency	%age
Male	27	60
Female	18	40
Male to female ratio	1.5:1	

Table 2: Age distribution of patients (n = 45)

Age in Years	Frequency	%age
51-60	11	24.5
61-70	15	33.3
71-80	14	31.1
81 – 90	5	11.1
Mean±SD	71.91±10.40	

Table 3: Distribution of patients according to mode of admission (n = 45)

Mode of admission	Frequency	%age
OPD	14	31.1
Emergency	31	68.9

Table 4: Distribution of patients according to fracture pattern on X-ray (n = 45)

Fracture pattern	Frequency	%age
Comminuted + displaced	16	35.6
Unstable + displaced	15	33.3
Stable + undisplaced	14	31.1

Table 5: Distribution of patients according to size of lag screw (n = 45)

Size of lag screw	Frequency	%age
85 mm	12	26.7
90 mm	33	73.3

Table 6: Distribution of patients according to size of interlocking screws (n = 45)

Size of interlocking nail	Frequency	%age
45 mm	17	37.8
50 mm	20	44.4
55 mm	8	17.8

Table 7: Distribution of failure of dynamic hip screw fixation through Hammer et al radiological assessment of callus formation

Grade	Frequency	%age
Grade III	22	48.8
Grade IV	15	33.4
Grade V	8	17.8

Table 8: Distribution of failure of dynamic hip screw fixation through Sirkoski and Barrington Pain scale

Grade	Frequency	%age
Grade III	28	62.3
Grade IV	17	37.7

Table 9: Distribution of patients according to causes of failure (n = 45)

Causes of failure	Yes		No	
	Frequency	%age	Frequency	%age
Unstability	31	68.9	14	31.1
Increased tip apex distance	11	24.4	34	75.6
High angle side plate	3	6.7	42	93.3

DISCUSSION

Intertrochanteric fractures, particularly the unstable ones, also pose challenging problem for the orthopaedic surgeons regarding their management. Several methods and techniques have been advocated for treating these difficult fractures but each one is associated with its own complications. That is why it is still an “unsolved fracture”[1].

The elderly patients frequently have inadequate strength and coordination to effectively protect the fractured hip from excessive stresses while using walker or crutches. Immediate post-op integrity of implant-reduction combination is thus of particular concern[25]. The associated medical problems are common in this age group. These illnesses along with prolong period of immobilization are amongst the major causes of increased morbidity and mortality[26].

Functional outcome of such fractures depends upon several predictors including patient's general health and activity level before fracture. Primary goal in the elderly patients is to return the patient to his pre-fracture activity as soon as possible. This aim can be achieved by having stable reduction of the fracture, adequate internal fixation, minimal anaesthesia time and blood loss and early mobilization[2].

To achieve early ambulation of patients with an intertrochanteric fracture, two conditions must be met: the implant used for fixation must be strong enough to withstand loading exerted upon it during fracture healing, and the fracture itself must be rendered stable in suitably reduced position[25].

There are five determinants for surgical management of these fractures. These include fracture geometry, type of reduction, bone quality, choice of implant and placement of implant. Only two factors i.e. bone quality and fracture geometry, are out of the control of the surgeon, but with remaining three, surgeons can reduce the chances of complication up to least possible rate.[1] The importance of implant placement should always be considered as satisfactory position can produce best results.

Intertrochanteric fractures are fractures of elderly. Dorotka et al[27] reported in their series of 182 patients, the mean age of 77.1 years. Moran et al[28] in a mega study of 2903 cases, reported the mean age of 80 years for hip fractures. In the present study, the mean age was found to be 71.1 years (Table 2). The reason for les mean age in our study as compared to the international data may be the increased incidence of osteoporosis at younger age, comparatively, due to less active life style. Also increased incidence of road traffic accident especially in motorbike riders is another cause as most of them are young people.

Intertrochanteric fractures are more common in females due to the low bone mass and postmenopausal osteoporoses which is evident in most of the studies conducted in other countries[7,29]. Moran et al[28] reported 76% females with male to female ratio of 1:3.1. While Gardner et al[30] reported 78% females with male to female ratio of 1:3.5 in his series of 80 patients But in our study male to female ratio was 1.5:1 (Table 1). This sex distribution is against most of the international data but is in accordance with different local studies. The reason for

the high incidence of these fractures among male population in our study is their more active lifestyle, which is more prone to traumas.

Delay in arrival at hospital is one of the main problems in our society. The reasons are poor economic conditions, lack of awareness about the treatment and strong but false belief in local bonesetters. Now people have started seeking medical advice earlier because of increasing awareness and education[31]. It is the early diagnosis and surgical management, which decreases the morbidity and improves the mobility after surgery.

Facture geometry is a major determinant, which helps in anticipating the functional outcome of surgical management.[32] In the present study, the maximum fractures were of comminuted displaced type (Table 4).

Lack of awareness, high cost and difficulty in transportation and expenses at hospital are all the factors contributing to loss of patients in follow up in our community. These trends make data collection very difficult especially in our socioeconomic setup.

Moreover, the patients who become pain free and gain ambulation do not think necessary to report to follow up. On the other hand, those patients who develop some complications may report to other centers for further treatment.

Posteromedial contact is a very important factor for a stable fixation of these fractures.[33] If anatomical reduction is not possible then different methods for non-anatomical but stable configuration have been advocated.[15] We were able to achieve anatomical reduction in most of the patients. More recent studies have revealed that anatomical reduction allows greater load sharing by the bone than does medial displacement osteotomy[15].

Poor positioning of lag screw in the femoral head is one of the major causes of implant cut out with varus deformity. Although the optimal position of a compression screw within the head and neck is somewhat controversial, all agree that it should be central or slightly inferior and posterior.

Biomechanical studies have demonstrated that the sliding hip screw acts as a lateral tension band in stable fracture patterns, transmitting forces through the medial cortex. This allows impaction of the fracture surfaces in unstable patterns, thereby shortening the liver arm, decreasing the bending moment and avoiding cut out from the femoral head. Simpson et al[34] demonstrated that loss of this sliding capability leads to a functionally rigid construct and higher failure rates.

Intertrochanteric fractures are through the vascular cancellous bone due to which nonunion is not a common problem. These fractures usually heal well even if deformed[8] Saudan et al[35] had average 13 weeks healing time and Schipper et al[36] reported union time of 16 weeks after fixation of intertrochanteric fractures.

The incidence of post-operative complications is directly related to the state of health at the time of admission and surgery, quality of surgery and perioperative medical management.[37] Commonly happened technical complications are varus deformity, implant cutting out of femoral head, implant breakage, loosening in femoral head and plate pulling off from the shaft.[1] There is a very strong tendency of this fracture to settle in varus due to the strong adductor pull of the adductor muscles on the proximal shaft. Factors causing fracture to settle in varus and implant cutting out superiorly include type of fracture, type of reduction, medial comminution, bone quality and improper placement of screw within the femoral head[38].

Mortality rates are high in hip fractures. The main reason of increased mortality is that most these patients are of old age with multiple medical problems. Moreover, postoperatively they become bed bound for a longer period as they have less muscular strength and become dependent for their mobilization.[37] Chest infection, pressure sores, deep vein thrombosis and cardiovascular complications are major factors for increased mortality rates in already compromised patients[1].

Pain is one of the major factors as far as functional recovery is concerned. Main sources of pain are varus deformity and implant loosening[33]. This pain can be relieved by removal of implant. There is continuous decrease in pain during fracture healing.

Preservation of ambulatory function is the most important issue in the treatment of hip fractures. Larsson et al[39] also showed that severe loss in ambulatory function would increase the risk of having socioeconomic problems. The level of ambulation achieved in the post-op period is a function of the pre-operative mobility status and medical condition, associated skeletal injuries, the quality of fracture stabilization, perioperative complications and early ambulation.

This study has several limitations. Although we were able to evaluate the functional status of our patients within the follow up period after surgery, the high mortality rate, loss of follow up, general debility and poor mental status of some of the surviving patients prevented more detailed assessment of functional outcome. Also proper lateral radiographs of the hip could not be taken all the times as non-cooperative attitude of some patients due to pain and technical deficiencies made it difficult. So very accurate assessment for the lag screw placement and fracture consolidation was not possible.

CONCLUSION

Fractures of intertrochanteric region of the femur are challenging to treat. The present study demonstrated various causes and their frequency leading to failure of dynamic hip screw fixation of Intertrochanteric fracture. We found that these fractures occurred more in males (60%) and with the mean age of 71(33.3%) years. We found that most common cause of DHS failure was unstability (68.9%) followed by increased tip apex distance (24.4%) and high angle of side plate as least common cause (6.7%). The use of this implant for treatment of these fractures gives good functional result with acceptably low complication rate provided the technical details are considered properly. The use of proper instruments and facilities including Image Intensifier is much important. Optimal reduction of the fracture and positioning of compression screw in femoral head remain of crucial importance and should be obtained all the times. Although our results were comparable with other national and international studies of operatively treated intertrochanteric fractures with dynamic hip screw but we still believe that even better results can be achieved with more precise operative technique and enthusiastic rehabilitation program.

REFERENCES

1. Koval KJ, Zukerman JD. Intertrochanteric fractures. In: Bucholz RW, Heckman JD. Rockwood and Green's fractures in adults. 5th ed. Philadelphia: Lipponcott Williams & Wilkins, 2001; 1636-64.
2. Melton LJ. Who has osteoporosis? a conflict between clinical and public health perspectives. J Bone Miner Res 2000; 15: 2309-14.
3. Cummings SR, Rubin SM, Black D. The future of hip fractures in the United States: numbers, costs and potential effects of postmenopausal estrogen. Clin Orthop 1990; 252: 163-6.
4. Cummings SR, Melton LJ. Epidemiology and outcomes of osteoporotic fractures. Lancet 2002; 359: 1761-7.
5. Juby AG, De Geus-Wenceslau CM. Evaluation of osteoporosis treatment in seniors after hip fractures. Osteoporosis Int 2002; 13: 205-10.
6. Gregg EW, Pereira MA, Caspersen CJ. Physical activity, falls, and fractures among older adults: A review of the epidemiologic evidence. J Am Geriatr Soc 2000; 48: 883-93.
7. Cranney A, Guyatt G, Griffith L, Wells G, Tugwell P, Rosen C. Meta- analysis of therapies for postmenopausal osteoporosis. Endocr Rev 2002; 23: 570-8.
8. Churchil MA, Brookes M, Spencer JD. The blood supply of the greater trochanter. J Bone Joint Surg 1992; 74: 272-4.
9. Ristic B, Ristic DI, Milicic B. Factors which influence postoperative mortality after hip fracture. Vojnosanit Pregl 2006; 63: 49-53.
10. Hay D, Parker MJ. Hip fracture in the immobile patients. J Bone Joint Surg 2003; 85: 1037-9.
11. Vossinakis IC, Badras LS. Management of pertrochanteric fractures in high risk patients with an external fixation. Int Orthop 2001; 25: 219-22.
12. Kalteis T, Handel M, Herold T, Perlick L, Baethis H, Grifka J. Greater accuracy in positioning of acetabular hip by using image-free navigation system. Int Orthop 2005; 29: 272-6.
13. De Wal H, Su E, Di Cesare PE. Instability following total hip arthroplasty. Am J Orthop 2003; 32: 377-82.
14. Kesmezacar H, Ogut T, Bilgli MG, Gökay S, Tenekecioğlu Y. Treatment of intertrochanteric femur fractures in elderly patients: Internal fixation or hemiarthroplasty. Acta Orthop Traumatol Turc 2005; 39: 287-94.
15. Kumar MM, Sudhakar GM, Shah DD, Pathak RH. A study of the role of osteotomy in unstable intertrochanteric fractures. J Postgrad Med 1996; 43: 4-6.
16. Gotfried Y. The lateral trochanteric wall: A key element in the reconstruction of unstable pertrochanteric hip fractures. Clin Orthop Relat Res 2004; 425: 82-6.
17. Amiot LP, Pullin F. Computed tomography-based navigation for hip, knee, and sine surgery. Clin Orthop 2004; 421: 77-86.
18. Laufer Y, Lahav M, Lenger R, Sprecher E. Functional recovery following pertrochanteric hip fractures fixated with dynamic hip screw vs. the percutaneous compression plate. Scientific World J 2005; 19: 221-9.
19. Beck M, Kalho M, Leunig M, Ganz R. Hip morphology influences the pattern of damage to the acetabular cartilage: femoroacetabular impingement as a cause of early osteoarthris of the hip. J Bone Joint Surg [Br] 2005; 87, 1012-8.
20. Crawford JR, Villar RN. Current concepts in the management of femoroacetabuar impingement. J Bone Joint Surg [Br] 2005; 87: 1459-62.
21. Tallroth K, Lepisto J. Computed tomography measurement of femoroacetabular dimensius: normal values for correction of dysplasia. Acta Orthop 2006; 77: 596-602.
22. Dorey FJ. Survivorship analysis of surgical treatment of the hip in young patients. Clin Orthop 2004; 418: 23-8.
23. Nork SE, Schar M, Pfander G, Beck M, Djonov V, Ganz R, et al. Anatomical considerations for the choice of surgical approach for hip resurfacing arthroplasty. Orthop Clin North Am 2005; 36: 163-7.
24. Bhatti A, Qureshi S, Tan S. Dynamic hip screw failure: should we blame the surgeon or the patient? J Orthop Surg 2004; 2: 145-9.
25. Lorich DG, Geller DS, Nielson JH. Osteoporotic pertrochanteric hip fractures: Management and current controversies. J Bone Joint Surg 2004; 86: 398-410.
26. Kyle RF, Cabanela ME, Russel TA, Swiontkowski MF, Winquist RA, Zuckerman JD, et al. Fractures of the proximal part of the femur. Instr Course Lect 1995; 44: 227-53.
27. Dorotaka R, Schoechtner H, Buchingerw. The influence of immediate surgical treatment to proximal femoral fractures on mortality and quality of life: Operation

within six hours of the fracture verses late than six hours. J Bone Joint Surg 2003; 85: 1107-13.
28. Moran CG, Wennrt, Sikand M. Early mortality after hip fracture: Is delay before surgery important. J Bone Joint Surg 2005; 87: 483-9
29. McCarus DC. Fracture prevention in postmenopausal osteoporosis: A review of treatment options. Obstet Gynecol Surv 2006; 61: 39-50.
30. Gardner MJ, Brophy RH, Demetrakopoulos D. Interventions to improve osteoporosis treatment following hip fracture: A prospective, randomized trial. J Bone Joint Surg 2005; 87: 1-7.
31. Tanveer A, Saleem SM. Unstable intertrochanteric fractures of femur, Dynamic Hip Screw Vs Jewett Nail Plate fixation. J Pak Orthop Assoc 1992; 2: 114-8.
32. ElKaissi S, Pasco JA, Henry MJ. Femoral neck geometry and hip fracture risk: The Geelong osteoporosis study. Osteoporosis Int 2005; 16: 1299-303.
33. LaVelle DG. Fractures of hip. In: Canale ST, ed. Campbell's operative orthopaedics. 10th ed. Philadelphia: Mosby 2003; 2873-938.
34. Simpson AH, Warty K, Dodd CA. Sliding hip screws: modes of failure. Injury 1989; 20:227-31
35. Saudan M, Leubbeke A, Sadowski C. Pertrochanteric fractures: Is there an advantage to an intramedullary nail? : A randomized, prospective study of 206 patients comparing the Dynamic Hip Screw and proximal femoral nail. J Orthop Trauma 2002; 16: 386-93.
36. Schipper IB, Steyerberg EW, Castelein RM. Treatment of unstable intertrochanteric fractures: Randomized comparison of the Gamma nail and proximal femoral nail. J Bone Joint Surg 2004; 86: 86-94.
37. Cumming RG, Nevitt MC, Cummings SR. Epidemiology of hip fractures. Epidemiol Rev 1997; 19: 244-57.
38. Kosygan KP, Mohan R, Newman RJ. The Gotfried percutaneous compression plate compared with the conventional classic hip screw for the fixation of intertrochanteric fractures of the hip. J Bone Joint Surg 2002; 84: 19-22.
39. Larsson S, Friberg S, Hansson LI. Trochanteric fracture; Influence of reduction and implant position on impaction and complication. Clin Orthop 1990; 259: 130-9.