



## Outcome of Primary Cemented Hemiarthroplasty in Unstable Trochanteric Fractures in Elderly Patients

Authors

Dr Neilakuo Kire<sup>1</sup>, MS, Dr G. Thong<sup>2</sup>, Dr K. Koutsu<sup>3</sup>, Dr V. Viiprii<sup>4</sup>

<sup>1</sup>Orthopaedics, NHAK

<sup>2</sup>HOD, MS Orthopaedics, NHAK

<sup>3,4</sup>Senior Consultant, MS, Orthopedics, NHAK

### Abstract

**Study Design:** *Prospective Study.*

**Background:** *Trochanteric fractures are one of the most common causes of high morbidity and mortality in elderly patients. Conservative treatments were seen to have a high complication rate with typical problems including decubiti, urinary tract infection, joint contractures, pneumonia, and thromboembolic complications, resulting in a high mortality rate. Most of the treatment methods of osteosynthesis in trochanteric fractures in elderly patients with gross comminution along with osteoporosis does not provide fracture stability and bony union, leading to complications like non union, implant failure and femoral head perforation.*

**Objective:** *To assess the post operativeclinico-radiological results and functional outcome using Harris Hip score.*

**Method:** *A prospective study was done with unstable intertrochanteric fracture in elderly who underwent cemented bipolar hemiarthroplasty in a single hospital by a single surgeon (n=50). Patients informed consent were taken, case sheets for relevant history and clinical examination, clinical instruments like measuring tape for measurement of limb length, goniometer for range of motion, Harris Hip Score, roentgenography at sequential follow-ups were taken.*

**Results:** *After applying the inclusion criteria in 50 patients, 41 patients were able to complete the follow-up. Out of 50 patients, 10 patients walked with the aid of a cane including the 6 patients, afore mentioned, who were already walking with the aid of a cane pre-injury state. In the last follow up 38 patients had excellent results, 3 patients had good results, 7 patients died due to unknown reasons but unrelated to surgery and 2 patients did not turn up for their last follow up.*

**Conclusion:** *Primary cemented hemiarthroplasty as a treatment for unstable trochanteric fractures is a viable option for the elderly population. It results in early mobilization which avoids the hazards of prolonged inactivity and prevents implant failure due to osteoporosis. Hemiarthroplasty is a better option than internal fixation in the elderly of age taking into consideration their co-morbidities and poor bone stock due to osteoporosis, which can jeopardize internal fixation. Given that these fractures usually occur in the elderly, who are less mobile and less demanding, less strain is born by the prosthesis.*

**Keywords:** *unstable intertrochanteric fracture in elderly, primary cemented bipolar hemiarthroplasty, early mobilisation.*

### Introduction

Trochanteric fractures are one of the most common causes of high morbidity and mortality in elderly patients. Before the introduction of

suitable fixation devices in the 1960s, treatment for trochanteric fractures was essentially non-operative, consisting of prolonged bed rest in traction until fracture healing occurred (usually 10

to 12 weeks), followed by a lengthy program of ambulation training<sup>1</sup>. Conservative treatments were seen to have a high complication rate with typical problems including decubiti, urinary tract infection, joint contractures, pneumonia, and thromboembolic complications, resulting in a high mortality rate<sup>1</sup>. In addition, fracture healing was generally accompanied by external rotation, varus deformity and shortening because of the inability of traction to effectively counteract the deforming muscular forces<sup>1</sup>. Operative management consisting of fracture reduction and stabilization, which permits early patient mobilization and minimizes any of the complications of prolonged bed rest, has consequently become the treatment of choice for trochanteric fractures<sup>2</sup>. Most of the treatment methods of osteosynthesis in trochanteric fractures in elderly patients with gross comminution along with osteoporosis does not provide fracture stability and bony union, leading to complications like non union, implant failure and femoral head perforation<sup>2,3</sup>. Patients with internal fixation devices are more aggressively mobilized and only partial weight-bearing is allowed unlike hemiarthroplasty where immediate weight bearing is feasible. This forms the main reason for considering hemiarthroplasty as one of the viable options to achieve full weight bearing in elderly patients where the bone stock is poor.

In a hospital as busy as ours, less hospital stay is imperative so as to cater to a larger population of the society. Elderly patients benefited from hemiarthroplasty as time taken to return to pre-morbid level of activity was lesser than that taken using other modalities of treatment such as internal fixations where healing was attenuated by pre-existing or co-existing osteoporotic changes, almost quintessential in those above the age of 60 years.

A large number of patients with trochanteric fractures are admitted in our hospital including those cases referred from peripheral hospitals. Considering the superior infrastructural set up in our hospital in terms of pre-operative planning

and rehabilitations we started a pilot study of cemented hemiarthroplasty in unstable trochanteric fractures in elderly over the course of 18 months, to dictate a treatment protocol.

We conducted a prospective study which included 50 patients, all of who were more than 60 years of age, with trochanteric fractures and gross comminution along with osteoporosis. These patients were treated with cemented bipolar hemiarthroplasty from 2012 to July 2017.

### Materials and Methods

After Ethical approval and patient informed consent was taken. The proposed study was conducted in the Department of Orthopaedics, during the period 2012 to 2017. To assess the fracture geometry and osteoporosis using Singh's index in elderly patients. To present the post operative clinico-radiographic results and functional outcome using Harris Hip score in follow up cases.

Patients with trochanteric fracture with any one of the following:

- Unstable trochanteric fractures.
- Comminuted trochanteric fractures.
- Grossly osteoporotic bone (60 yrs and or above) using Singh's index

The parameters that were studied -Sequential follow up with clinical examinations and radiographic studies, charting of pain in the hip, range of motion of hip, deformity of the operated lower limb, distance that can be walked, walking with support, or without support.

Patients informed consent were taken, case sheets for relevant history and clinical examination, clinical instruments like measuring tape for measurement of limb length, goniometer for range of motion, Harris Hip Score, roentgenography at sequential follow-ups were taken.

### Procedure

A prospective study of 120 patients with trochanteric fractures who were treated with cemented bipolar hemiarthroplasty was conducted from 2012 to 2017.

The ethical approval and patient consent was taken. Patients of 60 years or above with unstable trochanteric fractures according to Evans II, AO/OTA type 31-A2.2 and 31-A2.3, fractures were included in this study. Osteoporosis is determined by the gross radiological changes in the pelvis, both hip joints, and the proximal femur using Singh's index. All was walking independently without support. None of our patients had any significant pre-existing hip pathology.

All cases were operated by using a standard posterior approach in lateral position. The fracture anatomy was assessed and a cut was taken high up in the neck (almost subcapital level) to facilitate removal of the femoral head. In 3 cases, the lesser trochanter was in continuity with the neck of the femur and was reconstructed with the shaft and greater trochanter using steel wires (Figure:1).



**Figure:1**

A neck cut was then taken roughly about 1-2 cm above the lesser trochanter depending upon the amount of comminution. At times, both the trochanters were found as a separate fragment; in these cases the lesser trochanter and the greater the neck had to be sacrificed. In 7 cases where the

lesser trochanter was comminuted, the trochanter pieces were left attached to the soft tissue and the medical defect was reconstructed using a cement mantle. In case 4 where the greater trochanter was coronally split, a tension band was applied beneath the gluteus medius tendon and a bony tunnel was drilled in the distal greater trochanter. In some cases, the greater trochanter was found to be severely comminuted; here ethibond sutures were used to suture together the trochanter pieces and the soft tissue to make a stable construct. The gluteus medius, greater trochanter, and the vastus lateralis apparatus were maintained in continuity as a stable lateral sleeve. This was then fixed loosely to the shaft fragment with steel wires or ethibond sutures. The femoral canal was broached with appropriate anteversion. A fixed bipolar prosthesis was then inserted and trial reduction was done with the leg in longitudinal traction. Cement was inserted into the canal by using cement syringe and cement gun and final prosthesis was fixed into the canal (figure: 2).



**Figure:2**

Once the prosthesis was fixed, the fracture fragments were reconstructed and reattached to the shaft. Stability of the prosthesis was checked and all the layers were closed accordingly over a suction drain after achieving hemostasis.



**Fig. 3:** 72 years old male with unstable variety of intertrochanteric fracture Immediate post-op, AP and Lateral view

### Result and Analysis

Our study was to evaluate the functional outcome of cemented bipolar hemiarthroplasty used as a primary treatment for unstable intertrochanteric fracture. 50 patients of 60 years and above (average age = 71.05) sustaining such fractures underwent this procedure. The male to female ratio was 2:3. 95% of the patients were hypertensive and some patients had other co-morbid conditions like diabetes mellitus and chest disease. All the patients were ambulatory before the operation except 6 patients walking with support due to osteoarthritis of the knee.

On admission all patients were given upper tibial skeletal traction till operation. Radiography of the pelvis, both hip joints and proximal femur were taken to assess the gross radiological changes regarding osteoporosis using Singh's index scoring system. Pre-anesthetic work-up followed by check-up was performed for all patients taking into consideration individual's existing co-morbid conditions and other relevant medical history. All patients were operated within 20 days of admission.

Of the patients operated, one patient sustained an intra-operative coronal fracture of the proximal shaft of femur while preparing the canal for the stem insertion. This was managed by cemented prosthesis insertion and encirclage of the proximal femur with stainless steel. Post operatively 7 patients received one unit of whole blood transfusion in the ward under supervision. The suction drain was removed 24 hours from surgery. All the patients were allowed to sit on the next day of the surgery. Following static exercises, patients were taught and motivated to perform dynamic quadriceps exercises before progressing to ambulation. Proper nursing care was given with emphasis on postural care, chest physiotherapy and personal hygiene. Weight bearing, as tolerated by the patient, was started with a walker. 2 patients were uncooperative and refused to walk due to psychiatric problems. 6 patients were able to walk but only with the aid of a walking stick due to pre existing osteoarthritic knee complicated

by pain. Ambulation was achieved within an average in 3 days. Average hospital stay was 8 days.

3 patients died after their 3<sup>rd</sup> follow-up visit due to causes which were unknown but unrelated to surgery. The remaining 47 patients had regular follow up. At the end of the 3<sup>rd</sup> visit i.e. 3 months, 37 patients had an excellent result, 7 patients had a good result, 1 patient had a fair result, and 2 patients had a poor result. The mean Harris Hip Score (HHS) was 84.04 (range 55-96). Out of 47 patients, 10 patients walked with the aid of a cane including the 6 patients, afore mentioned, who were already walking with the aid of a cane pre-injury state. In the last follow up 38 patients had excellent results, 3 patients had good results, 4 patients died due to unknown reasons but unrelated to surgery and 2 patients did not turn up for their last follow up.

### Discussion

The incidence of hip fracture varies substantially from country to country and it's increasing worldwide. Estimates of incidence of hip fracture in the future also differ<sup>3</sup>. Cumming et al. predicted that the annual number of hip fractures in United States will rise from 238,000 in 1986 to 512,000 by the year 2040. Another study predicted that the number of hip fractures in elder will double or triple within 20 years<sup>4</sup>. Gullberg et al. projected that the total number of hip fractures worldwide (1.66 million in 1990 will reached 2.6 million by the year 2025 and million by 2050<sup>3,4,5</sup>.

Some of the factors found to be associated with a patient sustaining an intertrochanteric rather than a femoral neck fracture include advancing age, increased number of co-morbidities, increased dependency in activities of daily living and a history of other osteoporosis related fractures<sup>3</sup>. Before the introduction of suitable fixation devices in the 1960s, treatment for intertrochanteric fractures was of necessity non-operative, consisting of prolonged bed rest in traction until fracture healing occurred (usually 10 to 12 weeks), followed by a lengthy program of

ambulation training. In elderly patients, this approach was associated with high complication rates; typical problems included decubiti, urinary tract infection, joint contractures, pneumonia, and thromboembolic complications, resulting in a high mortality rate. In addition, fracture healing was generally accompanied by varus deformity and shortening because of the inability of traction to effectively counteracts the deforming muscular forces<sup>1</sup>. Techniques of operative fixation have changed dramatically since the 1960s. and the problems associated with early fixation devices have largely been overcome. Operative management consisting of fracture reduction and stabilization, which permits early patient mobilization and minimizes many of the complications of prolonged bed rest, has consequently become the treatment of choice for intertrochanteric fractures<sup>3</sup>.

Although it is unnecessary to review each and every type of implant that has been used to stabilize intertrochanteric fractures unstable intertrochanteric (Evans type II or IV and AO/OTA type 31-A2.2 and 2.3), it is important to understand the principles behind their evolution. Stable fractures can be easily treated with osteosynthesis with predictable results. The first successful implants was fixed-angle nail plate devices (e.g., Jewett nail, Holt nail) consisting of a triflanged nail fixed to a plate at an angle of 130 to 150 degrees<sup>1</sup>. While these devices provided stabilization of the femoral head and neck fragment to the femoral shaft, they did not allow fracture impaction. If significant impaction of the fracture site occurred, the implant would either penetrate into the hip joint or cut-out through the superior portion of the femoral head and neck. If, on the other hand, no impaction occurred, lack of bony contact could result in either plate breakage or separation of the plate and screws from the femoral shaft. These complications occurred much more frequently when these devices were used to treat unstable fractures<sup>3</sup>.

Although it is an important treatment option for displaced femoral neck fractures, primary

prosthetic replacement has had limited use in acute intertrochanteric fracture management. The anatomic location of femoral neck fractures makes prosthetic replacement a reasonable option because the distal portion of the femoral neck remains intact, providing excellent prosthetic support; in addition, the greater trochanter-abductor mechanism remains undisturbed. Neither condition applies when endoprosthetic replacement is used for comminuted intertrochanteric fractures. The prosthesis selected must replace the calcar, with provisions for greater trochanteric reattachment to restore abductor function. In general, this requires a more extensive surgical procedure than internal fixation does and entails greater blood loss, longer surgical and anesthetic time, and the potential for more frequent complications, not to mention greater implant cost. On the other hand, in certain situations, prosthetic replacement may expedite patient mobilization and ambulation and thereby maximize the patient's functional recovery. Utilizing this technique, some studies have reported reduced lengths of hospital stay to some extent justifying the greater cost of the prosthesis as compared to internal fixation devices<sup>3</sup>.

Excessive collapse, loss of fixation and cut-out of the lag screw resulting in poor function remains problems associated with internal fixation of unstable intertrochanteric fractures in elderly with osteoporotic bone. To allow early post operative weight-bearing and to avoid excessive collapse at the fracture site, some surgeons have recommended prosthetic replacement for the treatment of unstable intertrochanteric fractures<sup>6,7,8</sup>.

The indications for primary prosthetic replacement remain ill-defined. Most authors cite as the primary indication: elderly, debilitated patients with a comminuted, unstable intertrochanteric fracture in severely osteoporotic bone, an assessment that is difficult to quantify at best. Many patients with peritrochanteric fractures that fit this description have been successfully treated by internal fixation. However, some elderly patients who sustain a comminuted

unstable intertrochanteric fracture experience loss of reduction or fixation and require revision surgery. This population of patients would benefit most from primary prosthetic replacement. However, it is virtually impossible to identify these patients before surgery<sup>9</sup>.

Haentjens et al reported a prospective series comparing 37 consecutive patients older than 75 years of age who were managed by either bipolar arthroplasty or internal fixation. They concluded that the arthroplasty group had an easier and faster rehabilitation, with a lower incidence of pressure sores, pulmonary infection, and atelectasis, which they attributed to earlier return to full weight bearing. A 5% dislocation rate was noted in the arthroplasty group<sup>6</sup>.

Harwin et al. reported on fifty-eight elderly patients with osteoporosis in whom a comminuted intertrochanteric femoral fracture had been treated with a bipolar Bateman-Leinbach prosthesis and who were followed for an average of twenty-eight months. The average patient age was seventy-eight years, and 91% walked prior to discharge. Two patients had a nonunion of the greater trochanter. There were no deep infections, dislocations, acetabular erosions, or cases of stem loosening<sup>10</sup>.

Broos et al. reported on ninety-four elderly patients treated with a bipolar Vandeputte prosthesis. They found that the average operating time was shorter, the mortality rate was lower, and the functional results were better in the group treated with the bipolar hemiarthroplasty than in groups treated with Ender nailing, an angled blade-plate, or a dynamic hip screw<sup>11</sup>.

Recently, Rodop et al. reported on fifty-four elderly patients who had been treated with a bipolar leinbachhemiprosthesis (Protek; Sulzer Orthopedics, Baar, Switzerland). A good excellent result, as assessed with the Harris hip-scoring system, was reported in 80% of the patients. There were no dislocations or cases of stem loosening<sup>12</sup>.

Sinno et al. the results of the hemiarthroplasty group were significantly better than those of the internal fixation group regarding operative time,

blood loss, perioperative blood transfusion, and hospital stay<sup>13</sup>. Early postoperative full weight bearing in the hemiarthroplasty group compared with early partial or non-weight bearing in the internal fixation group was the main reason for significant reduction in postoperative complications such as pressure sores and pulmonary complications<sup>13,14,15</sup>. There was no significant difference in postoperative deep vein thrombosis between the two groups. Sinno et al. also showed that the cemented mantle used to fix the prosthesis in the femoral shaft was possibly able to transmit the stresses of weight bearing directly to the femoral diaphysis bypassing the posteromedial area of the proximal femur<sup>13</sup>. In addition, calcar reconstruction had the potential advantage of improved trochanteric healing, restoration of bone stock, re-establishment of proper limb length and reduced implant cost. This mechanism was properly efficient for elderly patients with low functional demands<sup>16</sup>.

Most intertrochanteric hip fractures can be treated successfully with internal fixation<sup>7,17</sup>. Dynamic devices, also known as a sliding screw/side plate, sliding nail, telescoping nail, dynamic hip screw, and sliding hip screw, are currently in wide use as reliable methods of internal fixation although the operative technique is not always easy and postoperative regimens cannot be standardized<sup>9,18-20,21-23</sup>. Although union rate as high as 100% have been reported in association with well-reduced, stable fractures that were treated with ideal implant placement, failure rates of as high as 56% have been noted in association with unstable fractures, comminution, suboptimal fracture fixation, or poor bone quality in elderly patients<sup>17,24</sup>.

The poor mechanical properties of the weak and porotic bone in these elderly patients do not usually provide a firm purchase for the screws leading to early biomechanical failure<sup>21,25</sup>. This will lead to collapse with migration of the femoral head into varus and retroversion resulting in limping due to shortening and decreased abductor muscle lever arm<sup>26,27</sup>. Another complication of

internal fixation in porotic weak bone is cutting-out of the implant from the femoral head leading to profound functional disability and pain<sup>28</sup>. Many surgeons prefer arthroplasty for the treatment of unstable trochanteric fractures in the elderly in order to decrease complications.

K.casey Chan and Gurdevs.Gill<sup>28</sup> found that Use of standard cemented hemiarthroplasty is a reasonable alternative to a sliding screw device for the treatment of intertrochanteric fractures to achieve less postoperative complications. Rosenfeld et al .used arthroplasty and reported 86% satisfactory results in the early period. Stern and Angerman<sup>9</sup> reported 94% good and excellent results after a mean follow-up period of 8 months<sup>30</sup>.

Sancheti et al. reported that primary hemiarthroplasty does provide a stable, pain-free, and mobile joint with acceptable complication rate<sup>32</sup>.

Prof. Chris Grimsud, Raul J. Monzon treated all unstable three and four part hip fractures with standard femoral stem and circlage cabling of trochanters and they conclude that bipolar arthroplasty allows safe early weight bearing on the injured hip and had a relatively low rate of complication<sup>33</sup>.

P. Florian Geiger; P. Monique Zimmermann-Stenzel found that Morality was significantly influenced by Age, Gender, Amount of Co-morbidities but not by fracture classification<sup>34</sup>.

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Chris Grimsud, Raul J. Monzon

### Bipolar Arthroplasty

	MORTALITY AT 1 yr
Stern et al	14%
Green et al	20%
Chris	10.3%
Grismud	NR
Harwin et al	35%
Haentgens et al	7.3%
Chan et al	14%

### Internal Fixation

	MORTALITY AT 1 yr
Haentgens et al	24%
Kyle at al	NR
Hardy et al	35%
Haidukewvch	19%

Bipolar arthroplasty group as compare to internal fixation had a lower postoperative complication rate and resulted in earlier weight bearing, which was also reported by others. There was a significant differences in full weight bearing time between the 2 groups. Though more costly, bipolar arthroplasty is a treatment option for patients with unstable Intertrochanteric fractures, which can achieve earlier mobilization<sup>35</sup>.

Cemented hemiarthroplasty is a successful procedure for the elderly population over 70 years with femoral neck fractures. Return to pre-morbid level of activity and independent functions occur early, avoiding the hazards of prolonged incumbency, to prevent implant failure secondary to osteoporosis. This might result in higher chances of complications like pulmonary embolism, deep vein thrombosis, pneumonia, and decubitus ulcer. Good functional results were obtained<sup>36</sup> by early cemented hemiarthroplasty<sup>36</sup>.

Jotanovic Z et al. believe that in selected very old patients, with co-morbidities and obvious osteoporosis (which can imperil internal fixation), hemiarthroplasty is much safer than internal fixation which can be compromised with poor bone stock. Given that that these fractures usually occur in the elderly, who are less mobile and less demanding and therefore put less strain on the endoprosthesis, we believe that this kind of treatment is the treatment of preoperative activity level with fast mobilization, which imply satisfactory hip function<sup>34,35</sup>.

Ninety percent of intertrochanteric fractures in the elderly result from a domestic injury. The tendency to fall increases with patient age and is exacerbated by several factors, including poor vision, decreased muscle power, labile blood pressure, decreased reflexes, vascular disease, and coexisting musculoskeletal pathology<sup>36</sup>.

Unsatisfactory surgical outcome is common in elderly patients with intertrochanteric fractures; medical illness, osteoporosis, and fracture in stability are contributing factors. Early mobilization may decrease the risk of mortality and morbidity, although older patients are unable

to walk well and only capable of partial weight bearing in the postoperative period<sup>35,37</sup>.

When the concept of prosthetic replacement was first introduced, this perhaps was the most important advantage. As patients with internal fixation devices are more aggressively mobilized than in the past and the majority are allowed at least partial immediate weight-bearing. Primary hemiarthroplasty offers a modality of treatment that provides adequate fixation and early mobilization in these patients thus preventing post operative complications. This advantage is less distinct than previously thought. This finding has a definite selection bias because patients undergoing hemiarthroplasty tend to be more elderly and have more medical co-morbidities. The Indian perspective regarding the use of primary arthroplasty as a modality of treatment for comminuted unstable intertrochanteric fractures is been commented on by few authors<sup>31,32</sup>.

P. Florian Geiger; P. Monique Zimmermann-Stenzelfound that Mortality was significantly influenced by Age, Gender, Amount of Co-morbidities but not by fracture classification<sup>33</sup>.

In a comparative study between bipolar arthroplasty and internal fixation, arthroplasty group had a lower postoperative complication rate and resulted in earlier weight bearing, which was also reported by others. There was a significant difference in full weight bearing time between the two groups. Though more costly, bipolar arthroplasty is a treatment option for patients with unstable intertrochanteric fractures, which can achieve earlier mobilization<sup>33,34</sup>.

In our study, however, could not give further comments because of sample size and duration of follow-up, one of the limitations of this study. Thus in conclusion, primary hemiarthroplasty thus provide a stable, pain-free, and mobile joint in this study; however a larger prospective randomized study and longer duration of follow-up will be needed.

## Conclusion

Primary cemented hemiarthroplasty as a treatment for unstable trochanteric fractures is a viable option for the elderly population. It results in early mobilization which avoids the hazards of prolonged inactivity and prevents implant failure due to osteoporosis. Hemiarthroplasty decreases chances of complications resulting from prolonged incumbency such as pulmonary embolism, deep vein thrombosis, hypostatic pneumonia, and decubitus ulcer.

Hemiarthroplasty is a better option than internal fixation in the elderly of age taking into consideration their co-morbidities and poor bone stock due to osteoporosis, which can jeopardize internal fixation. Given that these fractures usually occur in the elderly, who are less mobile and less demanding, less strain is born by the prosthesis.

Good functional results were obtained by cemented hemiarthroplasty which can therefore be considered as a preferential method for unstable trochanteric fractures in elderly, although further prospective randomized trials are required to support our conclusion.

## References

1. Zuckerman JD. Comprehensive care of orthopaedic injuries in the elderly. Baltimore: Urban and Schwarzenberg, 1990.
2. Haidukewych GJ, Berry DJ. Hip arthroplasty for salvage of failed treatment of intertrochanteric hip fractures. J Bone Joint Surg Am. 2003; 85(5):899-904.
3. Haidukewych GJ, Berry DJ. Salvage of failed internal fixation of intertrochanteric hip fractures. ClinOrthopRelat Res. 2003; (412):184-188Zein elabdien B, Olerud S, Karlstrom G, Smedby B. Rising incidence of hip fracture in Uppsala 1965-1980. ActaOrthopScand 1984; 55:284-289.
4. Gerhart T. Managing and preventing hip fractures in elderly. Journal of Musculoskeletal Medicine 1987; 4:60-68.



5. Luthje P. Incidence of hip fracture in Finland: A forecast for 1990. *Acta Orthop Scand* 1985; 56: 223-225.
6. Koval KJ, Aharonoff GB, Rokito AS, et al. Patients with femoral neck and intertrochanteric fractures. Are they the same? *ClinOrthop* 1996; 330:166-172.
7. Haentjens P, Casteleyn P, Opdecam P. Primary bipolar arthroplasty or total hip replacement for the treatment of unstable intertrochanteric and subtrochanteric fractures in elderly patients. *Acta Orthop Belg* 1994; 60[Suppl]: 124-128.
8. Broos PL, Rommens PM, Geens VR, Stappaerts KH. Pertrochanteric fractures in elderly. Is Belgian VDP prosthesis the best treatment for unstable fractures with severe comminution? *ActaChirBelg* 1991; 91:242-249.
9. Harwin SF, Stern RE, Kulick RG. Primary Bateman-Leinbach bipolar prosthetic replacement of the hip in the treatment of unstable intertrochanteric fractures in the elderly. *Orthopedics* 1990; 13:1131-1136  
Zukerman JD. *Comprehensive care of orthopaedic injuries in the elderly*. Baltimore: Urban and Schwarzenberg, 1990.
10. Green S, Moore T, Proano F. Bipolar prosthetic replacement of unstable intertrochanteric hip fractures in the elderly. *ClinOrthop* 1986;224:169-177.
11. Rodop O, Kiral A, Kaplan H, Akmaz I. Primary bipolar hemiprosthesis for unstable intertrochanteric fractures. *IntOrthop* 2002; 26:233-237
12. Zuckerman J. Current concepts: hip fracture. *N Engl J Med* 1996; 334:1519-1525.
13. Stern MB, Angerman A. Comminuted intertrochanteric fractures treated with a Leinbach prosthesis. *ClinOrthop* 1987; 218:75-80.
14. Sinno K, Sakr M, Girard J, Khatib H. The effectiveness of primary bipolar arthroplasty in treatment of unstable intertrochanteric fractures in elderly patients. *North Am J Med Sci* 2010; 2: 561-568.
15. Stern MB, Angerman ALEX. Comminuted Intertrochanteric Fractures Treated with Leinbach Prosthesis. *ClinOrthop* 1987; 218: 75-80.
16. Kayali C, Agus H, Ozluk S. Treatment for unstable intertrochanteric fractures in elderly patients: internal fixation versus cone hemiarthroplasty. *Journal of Orthopaedic Surgery* 2006; 14(3):240-244.
17. Bucholz, Robert W, Heckman, James D, Court-Brown, Charles M. *Rockwood & Green's Fractures in Adults*, 2006; 6th Edition, 45:1794-Harwin SF, Stern RE, Kulick RG. Primary Bateman-Leinbach bipolar prosthetic replacement of the hip in the treatment of unstable intertrochanteric fractures in the elderly. *Orthopedics* 1990; 13:1131-1136.
18. Kyle RF, Cabanela ME, Russell TA, Swionkowski MF, Winquist RA, Zuckerman JD, Schmidt AH, Koval KJ. Fractures of the proximal part of femur. *Instr Course Lect* 1995; 44:227-253.
19. Cobelli NJ, Sadler AH. Ender Rod versus Compression Screw Fixation of Hip Fractures. *ClinOrthop* 1985; 201:123-129.
20. Esser MP, Kassab JY, Jones DHA. Trochanteric Fractures of the Femur. A Randomised Prospective Trial Comparing the Jeweu Nail-Plate with the Dynamic Hip Screw. *J Bone Joint Surgery* 1986;68-B (4): 557-560.
21. Bonamo JJ, Accettola AB. Treatment of Intertrochanteric Fractures with a Sliding Nail-Plate. *J Trauma* 1982; 22: 205-215.
22. Doherty JH, Lyden JP. Intertrochanteric Fractures of the Hip Treated with the Hip Compression Screw. Analysis of Problems. *ClinOrthop* 1979; 141: 184- 187.
23. Heyse-Moore GH, Maceachern AG, Jameson Evans DC. Treatment of Intertrochanteric Fractures of the Femur. A Comparison of the Richards Screw-Plate

- with the Jewett Nail-Plate. *J Bone Joint Surg* 1983; 65-B (3): 262-267.
24. Wolfgang GL, Bryant MH, O'Neill JP. Treatment of Intertrochanteric Fracture of the Femur Using Sliding Screw Plate Fixation. *ClinOrthop* 1982; 163: 148-158.
25. Liang YT, Tang PF, Gao YZ, Tao S, Zhang Q, Liang XD, Han G, Cui G, Yang MY. Clinical research hemiprosthesisarthroplasty for the treatment of unstable intertrochanteric fractures in elderly patients. *Zhonghua Yi XueZaZhi*. 2005; 85(46): 3260-3262.
26. Kesmezacar H, Ogut T, Bilgili MG, Gokay S, Tenekecioglu Y. Treatment of intertrochanteric femur fractures in elderly patients: internal fixation or hemiarthroplasty. *Acta OrthopTraumatolTurc* 2005; 39(4):287-294.
27. Mariani EM, Rand JA. Nonunion of intertrochanteric fractures of the femur following open reduction and internal fixation. Results of second attempts to gain union. *ClinOrthop* 1987; 218:81-89.
28. Waddell JP, Morton J, Schemitsch EH. The role of total hip replacement in intertrochanteric fractures of the femur. *ClinOrthopRelat Res* 2004; (429):49-53.
29. K. Casey Chan, Gurudev s. Gill. Cemented Hemiarthroplasty for Elderly Patients with Intertrochanteric Fractures *Clinical Orthopaedic and Related Research Number 371*, pp. 206-215
30. C. Grimsrud, R. Monzon, J. Richman, M. Ries. Cemented Hip Arthroplasty With a Novel Circlage Cable Technique for Unstable Intertrochanteric Hip Fractures *The Journal of Arthroplasty*, Volume 20, Issue 3, and Pages 337-343.
31. P. Florian Geiger; P. Monique Zimmermann Stenzel. Mortality was significantly influenced by Age, Gender, and Amount of Co-morbidities but not by fracture classification. *Arch Orthop trauma Surg*.2007-Sept.
32. Patil Suresh, PanghatevAtul. Unstable Intertrochanteric Fracture In Elderly Patients – Bipolar Arthroplasty Or Internal Fixation?-A Matched Pair Analysis of High Risk Cohort To Compare Mortality And Morbidity In Two Group. *J. Orthopaedics* 2008; 5(3)e7.
33. Sancheti KH, Sancheti PK, Shyam AK, Patil S, Dhariwal Q, and Joshi R. Primary hemiarthroplasty for unstable osteoporotic intertrochanteric fractures in the elderly: A retrospective case series. *Indian J Orthop*. 2010 Oct-Dec; 44(4); 428-434.
34. Dwiri M, Aleyadah Z. Hemiarthroplasty for unstable osteoporotic intertrochanteric fractures in the elderly: A retrospective study?
35. Jotanovic Z, I Jurdana H, Sestan B, SasaRapan Vladimir Boschi and Gulan G. Hemiarthroplasty is an Effective Surgical Method to Manage Unstable Trochanteric Fractures in Elderly People. *Coll.Antropol*. 35 (2011); 2: 427-431.
36. Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? *J Bone Joint Surg Am*. 2005; 87:483-9.
37. Hayes WC. Biomechanics of falls and hip fracture in the elderly. In: Apple DF, Hayes WC, eds. *Prevention of falls and hip fractures in the elderly*. Rosemont, Illinois: American Academy of Orthopaedic Surgeons, 1994:41-65.
38. Harris Hip Score. [www.advancedortho.info/upload/HarrisHipScore.pdf](http://www.advancedortho.info/upload/HarrisHipScore.pdf)