International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2020; 6(2): 701-706

www.orthopaper.com
Received: 07-07-2019
Accepted: 21-08-2019

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Consequences of treatment of extracapsular fractures of hip with cemented bipolar hemiarthroplasty and dynamic hip screw fixation: A clinical study

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DOI: https://doi.org/10.22271/ortho.2020.v6.i2k.2123

Abstract
Injuries like intertrochanteric factures are a common problem in the elderly. The management of comminuted intertrochanteric fractures is challenging because of excessive collapse, cut out of the lag screw and loss of fixation. Present study has been undertaken to evaluate the functional outcome of comminuted intertrochanteric fractures treated with cemented bipolar hemiarthroplasty compared with dynamic hip screw fixation.
Objectives: To compare the results, efficacy in meeting the activities of daily routine, functional and clinical outcomes of cemented bipolar hemiarthroplasty and dynamic hip screw fixation as a treatment for comminuted intertrochanteric fractures in elderly patients.
Methodology: This prospective study was conducted on 32 cases of intertrochanteric fractures of hip, 16 cases treated with cemented bipolar hemiarthroplasty and 16 cases with dynamic hip screw fixation. The cases were classified according to AO:OTA classification.
Hardinge's modification of anterolateral approach was used for cemented bipolar cases and lateral approach was used for dynamic hip screw fixation. Preoperative care, intraoperative care, postoperative care and complications during follow up period were observed. Functional evaluation was done by using Harris hip score (HHS) and data was analysed.
Results: In the present study, age group range for patients was from 60 to 75 years. 56.17% were male & 43.75% were female. Harris hip score in cemented bipolar group showed 6(37.5%) excellent, 6 (37.5%) good, 4(25%) fair results while dynamic hip screw group showed 4(25%) excellent, 6(37.5%) good, 2(12.5%) fair and 4(25%) poor results. Complications noted in the study of cemented bipolar group were 1(6.25%) case of superficial wound infection, 4(25%) cases of shortening and 6(37.5%) cases of abductor weakness with Trendelenburg gait while complications in the dynamic hip screw group were 4(25%) cases of implant failure, 3(18.75%) cases of nonunion, 2(12.5%) cases of knee stiffness and 4 (25%) cases of varus angulation. 1(6.25%) patient died due to medical reasons. This study concludes that primary cemented bipolar hemiarthroplasty can be considered as one of the main treatment options in comminuted intertrochanteric fractures in elderly.

Keywords: Cemented bipolar hemiarthroplasty, dynamic hip screw fixation, comminuted intertrochanteric fractures, fractures in elderly

Introduction
Intertrochanteric fractures are very common around the world. Injuries around the hip are a common problem in the elderly. There were an estimated 1.66 million hip fractures worldwide in 1990 [1]. This worldwide annual number is rising rapidly [2] with an expected incidence of 6.26 million by the year 2050 [1, 3]. An increase in these fractures is on the rise due to increased life expectancy of the people and osteoporosis, [4, 5] so intertrochanteric fractures in the elderly patients are a frequent problem. These fractures are caused generally by trivial trauma like fall in bathroom or slipping while walking. The mainstay of operative treatment options of intertrochanteric fractures are extramedullary devices like dynamic hip screw and intramedullary fixation like gamma nailing and proximal femoral nailing. Stable fractures can be easily treated with osteosynthesis with predictable results.
However, the management of comminuted intertrochanteric fractures (AO/OTA type 31A2.2 and 31A2.3) [6] is challenging because of excessive collapse, cut out of the lag screw and loss of fixation due to osteoporotic bones.

Osteoporosis and instability are the most important factors leading to failure of osteosynthesis [7, 8] and also in these elderly patients early mobilization [9] and weight bearing is imperative to reduce complications like pneumonia and deep vein thrombosis. The fracture stability, quality of bone and early mobilization of the patient are the factors which determine the functional outcome of intertrochanteric fractures in elderly people. To allow early postoperative weight bearing and to decrease complications of osteosynthesis surgeons have recommended VDP Prosthesis [10], primary Bateman Leinbach prosthesis [11] or bipolar prosthetic replacement [12, 13] for the treatment of comminuted intertrochanteric fractures in elderly people. The treatment of comminuted intertrochanteric fractures in elderly patients is still controversial and there is limited literature on prosthetic replacement in comminuted intertrochanteric fractures so the purpose of this study is to evaluate the functional outcome of comminuted intertrochanteric fractures treated with cemented bipolar hemiarthroplasty compared with those treated by dynamic hip screw fixation.

Methodology

The present study was a prospective study comprising of 32 cases of intertrochanteric fractures of hip, 16 cases treated with hemiarthroplasty with cemented bipolar prosthesis and 16 cases with dynamic hip screw(DHS) fixation at Rama Medical College, Hospital & Research Centre Hapur UP, India from June 2017 to June 2019. The cases were classified according to AO-OTA classification

Inclusion Criteria

1. Unstable intertrochanteric fractures (AO 31A2.2 and AO 31A2.3)
2. Age 60 years. and above
3. Patients who were mobile previous to injury
4. No other fractures sustained

Exclusion Criteria

1. Stable intertrochanteric fractures
2. Patients who were unfit for surgery
3. Patients who were bed ridden prior to injury

Before the start of the study, institutional ethics committee permission was obtained for conducting the study. Written informed consent was obtained from the patients for participating in the study after explaining the purpose of the study.

Preoperative treatment: On admission to the hospital, x rays were taken and immediate immobilization of fractured limb with skin/skeletal traction with about 3 or 5 Kg weight respectively was applied to maintain the reduction, to reduce the pain, give comfort and to prevent further soft tissue damage. Classification was done with AO classification system. All routine investigations were done which were prerequisite for pre-anaesthetic checkups. As operative treatment was considered, the following factors, which determine the strength of fracture-implant assembly, namely the (i) Bone quality, (ii) Fracture geometry (iii) Fracture reduction, (iv) Implant design, and (v) Implant placement were stressed upon during preoperative planning. The anaesthesia employed was left to the anesthesiologist's choice. Local parts were shaved in the ward preoperatively two hours before the surgery. Every patient was given prophylactic antibiotic (1 gm parental ceftriaxone) just before surgery. The injured hip was prepared by preoperative scrubbing with povidone iodine and painted with povidone iodine solution and hip was draped under strict aseptic conditions. For dynamic hip screw (DHS) fixation, the surgery was carried out in supine position on fracture table under C-arm control in the standard manner. Cemented bipolar hemiarthroplasty (CBHP) was usually done under epidural/spinal anaesthesia. Patient was kept in lateral position for cemented bipolar hemiarthroplasty which was done in a standard fashion using Hardinge's modification of anterolateral approach. Sometimes fixation of greater trochanter was needed which was accomplished by tension band wiring of the greater trochanter.

Immediate Post-operative protocol: Postoperatively parenteral antibiotics (3rd generation cephalosporins) were given for 3 to 5 days. Drain was removed on 2nd postoperative day. Patients were ambulated with the help of walker on 2nd to 10th postoperative day depending upon the patient health status and stability of internal fixation. Sutures were removed on 12th postoperative day and patients were discharged. As the patients encompassed older age group and the bones were osteoporotic patients were given calcium citrate maleate and vitamin D and vitamin C supplements. None of the patients were given bisphosphonates preoperatively or postoperatively till the time of discharge.

Complications: In the immediate postoperative period patients were observed for the following complications.
Respiratory complications like hypostatic pneumonia, cardiovascular complications like myocardial infarction and cardiac failure in patients with hypertension and diabetes mellitus, wound infection (superficial or deep). Early superficial infection was managed by antibiotics and the removal of sutures to release wound tension and promote drainage. In deep infection, if there is presence of pus or hematoma from the wound on release of skin sutures, debridement and removal of the implant in extreme cases is recommended. These complications were less with bipolar prosthesis that were preassembled and fitted. Limb length discrepancy was noted in patients undergoing cemented bipolar hemiarthroplasty.

In the follow up period the patients were observed for the following complications.

1. Trendelenburg gait clinically.
2. Dislocation clinically and radiographically.
3. Heterotopic ossification radiologically.
   Classification of heterotopic ossification was done radiologically by Brooker Classification.
   Class 0: No ossification.
   Class 1: Islands of bone around the hip.
   Class 2: Bone spurs from either the pelvis or proximal femur, leaving least 1cm between opposing bone surfaces.
   Class 3: Space between bone spurs less than 1cm.
   Class 4: Bone ankylosis of the hip.
4. Protrusio acetabuli.
5. Loosening of stem.
6. Implant failure
7. Knee stiffness
8. Nonunion
9. Varus angulation of femur

Results

In the present study, 16 cases of unstable intertrochanteric fractures were treated with cemented bipolar hemiarthroplasty and 16 cases were treated with dynamic hip screw fixation.

Table 1: Characteristics of study participants

Characteristics	Cemented Bipolar Hemiarthroplasty(CBHP)	Percentage	DHS	Percentage
Age-(Years)				
60-64	2	12.5	10	62.5
65-69	4	25	4	25
70-75	10	62.5	2	12.5
Sex				
Male	8	50	10	62.5
Female	8	50	6	37.5
Side Involved				
Left	12	75	12	75
Right	4	25	4	25
Type of Fracture-				
AO 31A2.2	10	62.5	11	68.75
AO 31A2.3	6	37.5	5	31.25

In the present study, age group ranged from 60 to 75 years with mean value of 68.62 years for hemiarthroplasty group and 63.37 for dynamic hip screw fixation group. In hemiarthroplasty group, out of 16 cases, 8(50%) were males and 8 (50%) females and in DHS fixation group, there were 10 (62.5%) males and 6 (37.5%) females. Out of 16 hemiarthroplasty cases 4 (25%) were on right side and 12 (75%) were on left side. Out of 16 DHS cases 4(25%) were right side and 12 (75%) were left side. The classification used in the study was AO classification and it includes 21 (65.62%) of total cases of AO31A2.2 and 11 (34.38%) of total cases of AO31A2.3.

Table 2: Functional evaluation with Harris hip score in study participants

Harris Hip Score	CBHP	Percentage	DHS	Percentage
Excellent (90-100)	6	37.5%	4	25%
Good (80-89)	6	37.5%	6	37.5%
Fair (70-79)	4	25%	2	12.5%
Poor (<70)	0	0%	4	25%
Total	16	100%	16	100%

Hardinge's modification of antero-lateral approach was used for cemented bipolar cases and lateral approach was used for dynamic hip screw fixation. Result of Harris Hip Score [14] reflected that in hemiarthroplasty group, out of 16 cases, 6(37.5%) were excellent, 6(37.5%) were good, 4(25%) were fair. In DHS fixation group out of 16 cases 4(25%) were excellent, 6(37.5%) were good, 2(12.5%) were fair and 4(25%) were poor. (Fig -1)

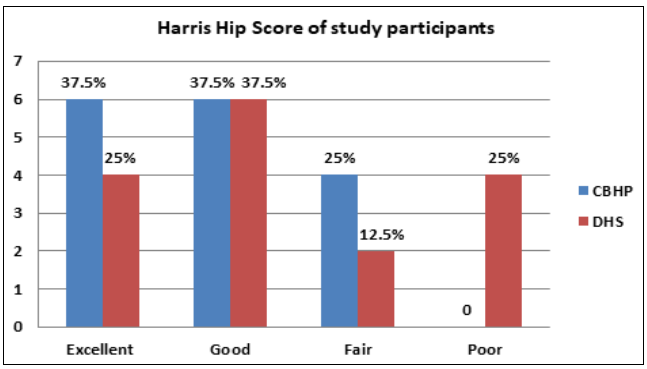

Fig 1: Bar diagram showing Harris Hip Score in study participants

Table 3: Complications observed among study participants

Sr No.	Complications	CBHP		DHS	
		n	%	n	%
1	Leg length discrepancy	4	25	0	0
2	Superficial infection	1	6.25	0	0
3	Trendelenberg gait	6	37.5	0	0
4	Failure of tension band wiring	2	12.5	0	0
5	Implant failure	0	0	4	25
6	Knee stiffness	0	0	2	12.5
7	Nonunion	0	0	3	18.75
8	Mortality	0	0	1	6.25
9	Varus angulation of femur	0	0	4	25

*Multiple complications observed in same patient.

Complications noted in the study of CBHP group were 1(6.25%) case of superficial wound infection, 4(25%) cases of shortening and 6(37.5%) cases of abductor weakness with Trendelenburg gait. Complications noted in study of DHS fixation group were 4(25%) cases of implant failure, 3(18.75%) cases of non-union, 2(12.5%) cases of knee stiffness and 4 (25%) cases of varus angulation. 1(6.25%) patient died due to medical reasons. All the results were comparable to the reported series but cemented bipolar hemiarthroplasty provided the advantage of early ambulation as compared to DHS fixation.

Discussion

Trochanteric fractures of femur are among the most common fractures encountered in orthopedic practice in the elderly. The specialty of a trochanteric fracture lies in the fact that it can be managed both conservatively and surgically. Internal fixation has the advantage of minimizing constant monitoring needed in conservative management. It also reduces the complications of prolonged immobilization like bed sores, hypostatic pneumonia and deep vein thrombosis. In recent years trend has changed from conservative to surgical management. The mainstay of treatment of intertrochanteric fractures are extramedullary devices like dynamic hip screw and intramedullary fixation like gamma nailing and proximal femoral nailing. Union rates as high as 100% have been reported in association with well-reduced, stable fractures that were treated with ideal implant placements whereas failure rates as high as 56% have been noted in association with unstable fractures, comminution, suboptimal fracture fixations or poor bone quality in elderly patients treated with DHS fixation [15, 16]. The outcome of fixation depends mainly on quality of bone, age of patient, general health, trauma to surgery interval, adequacy of treatment, co- morbidities, and stability of fixation. Holt, Dimon and Hughston, Sarmentio and Williams have done outstanding work in attempt to change an unstable intertrochanteric fracture into a stable one and fix it with an appropriate implant until it heals. Intertrochanteric fractures in elderly often leads to confusion regarding treatment options between osteosynthesis and hemiarthroplasty. In this age group the fracture configuration is generally comminuted with presence of extensive osteoporosis. Therefore, maintenance of fracture reduction which should be anatomical or near anatomical, proper positioning of the implant and monitored weight bearing are the pre-requisites to achieve good functional outcome with DHS fixation. Osteosynthesis of such fractures may reduce the morbidity of pain but it does not permit early mobilization due to fear of failure of fixation. The poor mechanical properties of the weak and osteoporotic bones in elderly patients do not provide a good purchase for the screws, which can subsequently lead to an early biomechanical failure. This leads to collapse at fracture site with migration of the screws and the collapse of femoral head into varus and retroversion, resulting in limping caused by shortening and a decreased abductor muscle lever arm. Because of these reasons walking full weight bearing before the fracture has healed is often impossible in patients who have undergone osteosynthesis but early ambulation following surgery is important for preventing complications that can be caused by long term bed rest in elderly patients with poor general condition. The special problems associated with unstable fractures in the geriatric age group are possibly due to one or more of the following factors. Osteoporosis, comminution, age related medical illnesses like hypertension, diabetes mellitus, hyperlipidemia, need for rapid mobilization, lack of psychomotor skills for partial weight bearing. All these problems are addressed by cemented bipolar hemiarthroplasty. Early mobilization is possible as the technique bypasses of fracture healing and provides immediate stability and mobility thereby avoiding the problems of prolonged recumbence. So to allow early post-operative weight bearing and to avoid excessive collapse at the fracture site, some surgeons have recommended bipolar prosthetic replacement for the treatment of comminuted osteoporotic intertrochanteric fractures. Hemiarthroplasty has been used for unstable intertrochanteric fractures since 1971, however less frequently as compared to femoral neck fracture. Its initial use was as a salvage procedure for failed pinning or other complications of dynamic hip screw. Green S *et al*. [12], in 1987 conducted study on 20 elderly patients (average age, 82.2 years) with unstable intertrochanteric hip fractures treated with a bipolar replacement. Seventeen patients had the prosthesis inserted as primary fracture management, and three, for salvage of failed internal fixation. The patients were ambulated with unrestricted weight-bearing at an average of 5.5 days after the operation. They had taken the greater trochanter as a landmark for precise placement of the femoral head so as to achieve correct limb length and concluded that the bipolar design may permit conversion to a total hip arthroplasty without removal of the femoral component, and may reduce the risk of acetabular cartilage damage. The earliest comparison of prosthetic replacement with internal fixation was undertaken by Haentjens *et al*. [17] The study involved 37 patients who were more than 75 years of age and operated with hemiarthroplasty with bipolar prosthesis. The results in this population were compared in a retrospective manner with 42 patients undergoing internal fixation with a blade plate. Patients treated with a cemented hemiarthroplasty were permitted immediate weight bearing. Those patients treated with internal fixation were not allowed to bear weight fully until osseous union had occurred radiographically. The results were comparable among groups with a significant reduction in the incidence of pneumonia and pressure sores in those undergoing prosthetic replacements. This was thought to be due mainly to rapid mobilization of the prosthetic group as compared with those fixed internally. The functional results were graded according to Merle d'Aubigne and were rated as excellent to good in 75% of patients. In another comparison study of hemiarthroplasty versus internal fixation, Kayali *et al*. [18] observed that there was no significant difference between the 2 groups in terms of sex, age, fracture type, follow-up period, hospital stay, operating time, receipt of blood transfusions and metabolic and associated diseases. The clinical results of both groups were similar, but hemiarthroplasty patients were allowed full weight bearing significantly earlier than the internal fixation patients.10 Out of 42 patients died in first six months among cemented bipolar prosthesis group and 15 out of 42 died among DHS patients. Hardy *et al.* [19] studied 100 patients who had intertrochanteric fractures treated with compression hip screw and intramedullary hip screw. Operating time was significantly greater in intramedullary group, blood loss was lesser and perioperative complications were similar in both groups. However, there is only one study by Kim *et al*. [20] which compares the cementless calcar replacement prosthesis with proximal femoral nailing in a prospective study involving two groups of 29 patients. They could not find any significant difference concerning the functional outcomes, hospital stay, time to weight bearing or general complications

but shorter operative time, less blood loss, fewer units of blood transfused, lower mortality rate was seen patients with proximal femoral nailing compared to cementless calcar replacement arthroplasty. The Cochrane database analysis of relevant studies concluded that there is insufficient evidence to prove that primary arthroplasty has any advantage over internal fixation. However, they also mentioned that there were only two randomized trials studied and both had methodological limitations, including an inadequate assessment of the longer term outcome [21]. Ahmed Elmorsy *et al*. [22] in 2011 conducted prospective study on 41 patients (22 females and 19 males, all 65 years old or above) who had bipolar hemiarthroplasty for unstable intertrochanteric fractures. Modified lateral approach was used in all patients. HHS was used for clinical evaluation. Follow up period ranged from 12 to 24 months. During the last follow up, the HHS ranged from 93 to 51 with a mean value 78.19. 4 cases (9.76%) were excellent, 16 cases (39.02%) good, 16cases (39.02%) fair and 5 cases (12.02%) poor. The complications in this study were 1 patient had infection, 1 had dislocation, 1 had stem subsidence, 1 had acetabular wear and 1 had intra-operative crack during insertion of femoral stem. Atul Patil *et al*. [23] conducted a study on role of cemented bipolar hemiarthroplasty for comminuted intertrochanteric femur fracture in elderly osteoporotic patients through a modified trans-trochanteric approach- "SION Hospital Modification" and observed that mean HHS at the mean follow up of 2.92 years was 80.76.

In present study 16 elderly patients with unstable intertrochanteric fracture were treated with cemented bipolar hemiarthroplasty.

Age group: The average age of patients in CBHP group was 68.62 years which was comparable to other studies like the one conducted by Patil A *et al*. [23] in which it was 65.5 years.

Sex: In CBHP group 8 were males and 8 were females. 12 had left hip fractured and 4 had right hip fractured. The average preoperative hospital stay was 9.8 days.

Blood transfusion: 6 out of 16 patients had blood transfusion in CBHP group. Total of 9 units of whole blood were transfused to 6 patients.

Post-operative ambulation: The CBHP group patients started ambulation with walker at an average 5.25 days after surgery (Range, 2–8 days). This is comparable with studies like K.H. Sancheti *et al*. [24] (4.2 days) Nikunjmaru *et al*. [25] (4.2 days), G.Kirankumar [26] (5.4 days) on mean period of ambulation. Early postoperative ambulation is the main factor that differs from the studies on internal fixation of intertrochanteric fractures. Walking with full weight-bearing before the fracture has healed is often impossible but early ambulation following surgeries are important. In present study we allowed the patients to ambulate full weight bearing post operatively between 2 to 8 days with mean value of 5.25 days depending on general condition of the patient post operatively.

Shortening: In CBHP group 4 patients had shortening of more than 1cm of the operated limb in present study. In studies by Atul patil *et al*. [23] 8 out of 126 patients, K.H. Sancheti *et al*. [24] 10 out of 37 patients and Nikunj Maru *et al*. [25] 5 out of 28 had limb shortening of an average of 1.1cm.

Trendelenberg gait: In present study, out of 16 patients of CBHP group, 6 had abductor muscle weakness with a positive Trendelenburg test and Trendelenburg gait at final follow-up.

Harris Hip Score: At 6 months follow-up of CBHP group, 6 patients (37.5%) were graded as excellent, 6 patients(37.5%) as good and 4(25%) as fair. This is comparable to other studies like that of K.H. Sancheti *et al*. [24] in which out of 37 patients 7(19.4%) had excellent results, 16(44.4%) had good results, 9(25%) had fair results and 2(5%) had poor results. Nikunjmaru *et al*. [25] reported that of 28 patients, 11(39.2%) had excellent, 10(35.7%) good, 4(14.2%) fair and 2(7.14%) had poor results. In our study at last follow-up, 6 patients were walking without any aid, 1 patient used a stick for walking (patient was using stick for psychological support).

Complications: In this study in CBHP group there was one case of superficial infection which settled with two weeks course of intravenous antibiotics, and no deep infections were seen. One case of superficial infection was seen in studies by Nikunjmaru *et al*. [25] and K.H. Sancheti *et al*. [24], 2 cases of superficial infection were seen in studies by Atul patil *et al*. [23] Stern and Angerman [27] reported a deep infection rate of 2.8% but made no comments on dislocations. There were no cases of heterotrophic ossification. K.H. Sancheti *et al*. [24]. reported heterotrophic ossification at 6-month follow up; however, this did not restrict the range of motion. In two patients there was failure of tension band wiring of greater trochanter in our study. In a study done by Osman Rodop [13] there were 2 cases of failure of tension band wiring and Atul Patil *et al*. [23] reported 2 cases of failure of greater trochanter tension band wiring. There was no dislocation, loosening, late infections, protrusio acetabuli and implant breakage in the present study.

In this study the other group of 16 patients with intertrochanteric fractures were treated by DHS fixation.

Age group: The average age group of the DHS group was 63.37 years. This is comparable to that quoted by most authors in literature (62.5 years. by Murray and Frew [28], 62.2 years. by Evans [5]). The average preoperative stay in hospital was 8.4 days.

Sex: In the present study there is a male preponderance in DHS group. 10 (62.5%) of the 16 patients were males. This is in contrast to the studies done in western world where there was a female preponderance in study conducted by Hornby and Grimley Evans [29], 82% were females. This is probably because in India, males are engaged in more strenuous activities compared to females who have a sedentary life.

Blood transfusion: 5 out of 16 patients had blood transfusion. Total 9 units of whole blood were transfused to 5 patients in the DHS group.

Harris Hip Score: In the present study functional and anatomical results of DHS group were graded according to HHS criteria as excellent, good, fair and poor. 4 out of the 16 patients (25%) had an excellent result. These patients had sound union both clinically and radiologically within 3 months. None of these patients had Varus deformity or shortening. In 6 patients (37. 5%) the result was good. These patients had painless mild limp with negligible shortening and walked independently 2-3 months after surgery. 4 patients (25%) had an outcome which was graded as fair. Out of these 4 patients, 3(18.75%) had no radiological union after 12 months and 2 patients had knee stiffness in functional position and were able to walk with the assistance of a stick. This is almost similar to the incidence of stiffness by conservative management like 4% in Murray and Frew [28] series. 4 patients had implant failure, 4 patients had extrusion of the compression screw and varus angulations, 2 cases of which showed no radiological union, extrusion of screw and Varus angulation after 6 months of follow up with DHS. Another 2 cases showed extrusion of compression screw.

Conclusion

The present study, reflected that primary cemented bipolar hemiarthroplasty in comminuted intertrochanteric fractures in elderly patients provides a painless stable joint allowing the patients to ambulate early in the postoperative period minimizing the complications associated with prolonged recumbency. The results of dynamic hip screw were inferior when compared to cemented bipolar hemiarthroplasty for comminuted intertrochanteric fractures. This study concludes that primary cemented bipolar hemiarthroplasty can be considered as one the main treatment options in comminuted intertrochanteric fractures in elderly patients.

Limitations of study: The study comprises few number of patients.

Recommendations: Cemented bipolar hemiarthroplasty gives better results, early mobilization of patients, less implant failure and complications as compared to DHS. This study comprises of only a few patients so there is need for a large study with more number of subjects.

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