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Original Research Article

Comparison of outcomes of dual-mobility cemented total hip arthroplasty versus bipolar cemented hemiarthroplasty in patients with femoral neck fractures

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ABSTRACT

Background: Elderly people with femoral neck fractures are more likely to experience complications after hip replacement. Compared with total tripolar hip arthroplasty (THA), bipolar hemiarthroplasty (HA), more effective alternative treatments that improve overall safety. We aimed to review the benefits of dual mobility tripolar arthroplasty and compare it to bipolar hemiarthroplasty in treatment of the femoral neck in the elderly.
Methods: This study was conducted as a comparative randomized controlled prospective study. Patients were divided randomly to two equal groups 19 patients each one group underwent cemented bipolar hip hemi arthroplasty and the other group underwent cemented tripolar total hip arthroplasty, surgical approach for the two study groups was modified lateral Hardinge approach. The patients were followed up after one month, three months 6 months and one year. The follow up period was one year, and modified Harris hip score was reported, and radiograph scan of fracture site was done before and after surgery. Complications were reported whether intraoperative or in the follow up period.
Results: The result of the study showed that the operative time was much longer in tripolar group as compared to bipolar group, there was more blood loss in tripolar group more than bipolar group. The functional outcome assessed using Harris hip score showed better outcome in tripolar group as compared to bipolar group. As regard complication, there was one case of periprosthetic fracture intraoperative in bipolar group and one case of cement extrusion in tripolar group. There was no dislocation in both groups.
Conclusions: Tripolar total hip arthroplasty had better functional outcome than bipolar hip hemiarthroplasty and we recommend more studies for a longer period of follow up to assess rate of complications and functional outcome on the long run.

Keywords: Elderly, Femoral fractures, Hemiarthroplasty, Hip arthroplasty, Tripolar, Bipolar, Dual mobility

INTRODUCTION

Hemiarthroplasty and total hip arthroplasty (THA) are treatment options for adults with femoral neck fractures (FNF).[1] Hemiarthroplasty has lower side effects compared with tripolar total hip arthropathy, but many studies show lower operative and repeat operations.[2,3] In recent years, dual-mobility tripolar arthroplasty has been proven to be an effective treatment for femoral neck fracture. Compared with standard bipolar, the design of dual mobility cemented total hip arthroplasty improves the head quality, which can reduce the effect of primary THA and repair THA.[4] The development dual-mobility cemented total hip arthroplasty is promising for the elderly with FNF, because these patients may develop more complications after standard THA.[2,3,5] In addition, elderly patients are often fatigued.[6-8] Therefore, it is important to reduce the rate of reoperation in these individuals. Many studies reported a lower rate in the DM-THA group, while others found no difference.[9-11] In terms of patient-reported outcomes, some

studies concluded that dual-mobility cemented total hip arthroplasty is a better procedure with higher Harris hip score (HHS) scores.[10,11] However, Yok et al, the scores of both groups were similar.[9] Because of these inconclusive results, we performed a randomized controlled trial to determine the outcomes in elderly patients who underwent HA or dual mobility cemented total hip arthroplasty for the treatment of FNF. We hypothesized that patients who received DM-THA would have fewer complications and reoperations, and better functional scores compared with patients who received HA.

METHODS

A randomized controlled trial study was conducted, the total number patients enrolled in the study was 38 and was subjected to follow up for 12 months post-operative from 01 June 2021 to 01 June 2023. The patients enrolled in this study were admitted to El Salam general hospital in Port Said, Egypt.

Inclusion criteria

The inclusion criteria were: the age is greater than 65 years; fracture neck femur which is non-pathologic; good cognitive function; and ambulatory before the occurrence of the fracture.

Exclusion criteria

The exclusion criteria were: patients with pathological fractures, and non-ambulatory before fracture.

A patient consent was obtained before the start of any investigation, treatment or intervention of a patient. All patients were informed about the type of intervention and risks of surgery.

The evaluation of the patients was done before the surgery by obtaining a very detail history with proper clinical examination. All patients were put on skin traction till time of operation. Any accompanied health problems were corrected before surgery. Assessment of blood pressure were done and in case of hypertension, blood pressure was controlled and if the patient was diabetic on oral hypoglycaemic agents, the patient was shifted on insulin therapy before surgery.

Patients were divided randomly in two equal groups 19 patients each - group 1: patients undergo bipolar hip hemi arthroplasty, and group 2: patients undergo tripolar total hip arthroplasty. Surgery approach for the two study groups was modified lateral Hardinge approach.

Patients started static quadriceps and gluteal exercises immediately after surgery. Strengthening exercises of the hip joint and knee joint, the patients were followed up after one month, three months, six months and one year. The follow up period was one year, and modified HHS was reported, and radiograph scan of fracture site was done before and after surgery.

Main efficacy outcomes of this study include: time required for the surgery, the amount of blood loss in the operation and assessment of functional hip outcome using the HHS.

Complications that were reported include: dislocation of the prostheses, periprosthetic fracture, infection at site of surgery, thromboembolic complications, and reoperation required were reported during the period of follow-up.

Radiological assessment of position of the stem, position of the cup, loosening and leg length. The angle between abduction of hip joint and the stem alignment will be measured and calculated. Any angle greater than 55° and less than 35° are considered outliers.

Statistical analysis

Data were analysed by statistical package for the social sciences (SPSS) database. The data were expressed as mean±SD. All continuous variables were statistically analysed as to distribution by the use of suitable test (the Kolmogorov-Smirnov test).

RESULTS

38 patients were included in this study, of which 19 patients underwent bipolar hemiarthroplasty and 19 patients underwent tripolar hemiarthroplasty. The demographic data of the patients included in the study are shown in Table 1. The age of all patients in this study is more than 65 years. The mean age of the patients in the bipolar group was 70.3 years, and in the tripolar group, it was 68.9 years. Females were 60% and males 40% of studied patients.

The operative time was much longer in tripolar group as compared to bipolar group, there was more blood loss in tripolar group than bipolar group, the difference between the two study groups was statistically significant (p value <0.05), however the duration of stay in hospital after surgery was the same.

In the follow up period, HHS was used after one month, three months, six months, and one year, to assess the functional outcome of the surgery and this is shown in Figure 1. In the group that underwent bipolar, the mean HHS was 59.95, 60.25, 63.80, and 70.70 at the follow-up visits at one month, three months, six months, and one year, respectively. In the group that underwent tripolar, the mean HHS were 65.06, 69.40, 72.50, and 78.19 at the follow-up visits at one month, three months, six months, and one year, respectively. During the follow up visits we found that HHS was more in patients of the tripolar group than in the bipolar group. All the functional outcome data are shown in Table 2.

Table 1: Demographic data and detailed surgery information.

Characteristics	Bipolar group	Tripolar group	P value
Age (years)	70.3±5.4	68.9±7.5	>0.001
Operation time (minutes)	80±15.6	150.4±15.3	<0.001
Blood loss (ml)	250.7±80.5	400.6±100.2	<0.001
Hospital stay	6.5±1.4	7±1.2	>0.001

Table 2: Functional outcome of patients in study groups.

Variables	Bipolar	Tripolar	P value
Harris hip score at 3 months follow up	60.25±3.9	69.4±3.7	<0.0001
Limping	1	1	
Harris hip score at 6 months	63.80±1.7	72.5±6.5	<0.0001
Sitting cross-legged, squatting after 1 year	11	15	<0.0001
Range of motion at 1-year follow-up			<0.0001
Flexion	99.5±7.4	104.8±10.7	
Extension	5.8±1.6	10.5±3.3	
Abduction	35.3±5.1	40.5±2.8	
Adduction	20.8±4.3	24.3±2.7	
Internal rotation	11.3±5.6	16.7±1.9	
External rotation	34.6±9.6	40.8±3.9	
Cement extrusion	0	1	
Periprosthetic fracture	1	0	
Dislocation	0	0	
Revision THR	0	0	
DVT/PE	0	0	
Deep infection	0	0	
Superficial infection	1	0	
UTI	0	0	

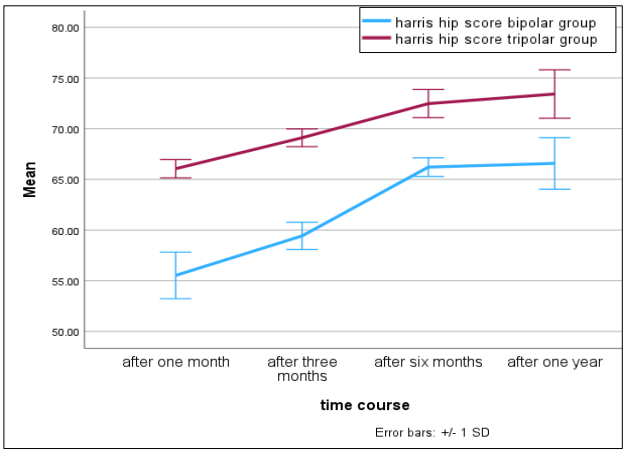

Figure 1: Time course comparison of Harris hip score in study groups in follow up visits.

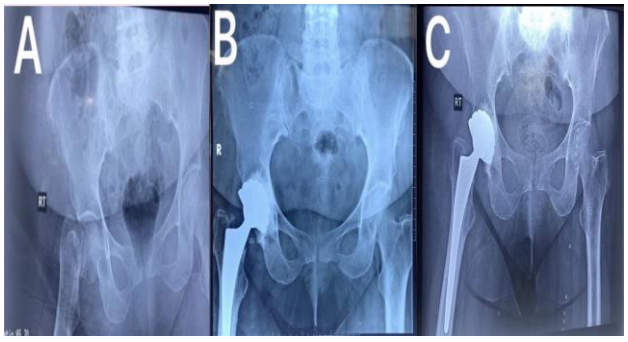

Figure 2: AP hip radiograph of 73-year-old patient with fracture right neck femur treated with tripolar total hip arthroplasty (A) preoperative, (B) immediately after operation, and (C) one year after operation and prothesis well fixed.

Radiological outcome

In the follow up visits, the radiological assessment showed no signs of loosening, radiolucent lines or heterotrophic ossification in the patients of the two groups. The radio graphical assessment was done by measuring femoral offset and leg length discrepancy and angle of cup inclination.

Complications reported in the study groups

Patients included in the study were able to walk with full weight bearing and could climb stairs after 3 months. One of the patients had trochanteric fracture in bipolar group intraoperative. No patients had dislocation after operation and no patients needed revision arthroplasty. One patient had cement extrusion to pelvis in tripolar group without postoperative urinary or pelvic complications and not

accompanied by change in modified HHS. All the patients of both groups were able to do routine daily activities after one year of operation.

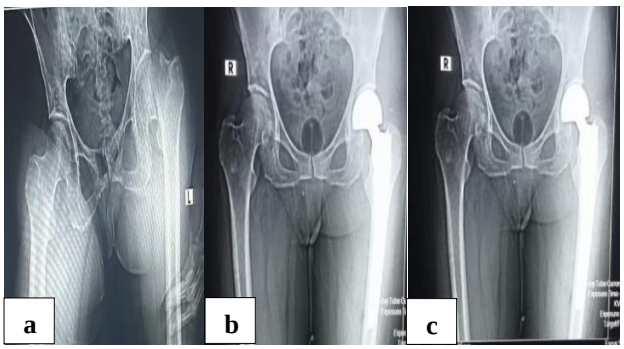

Figure 3: AP hip radiograph of 70-year-old female patient with fracture left neck femur treated with bipolar hip hemiarthroplasty (a) preoperative, (b) immediately after operation, and (c) one year after operation and prothesis well fixed.

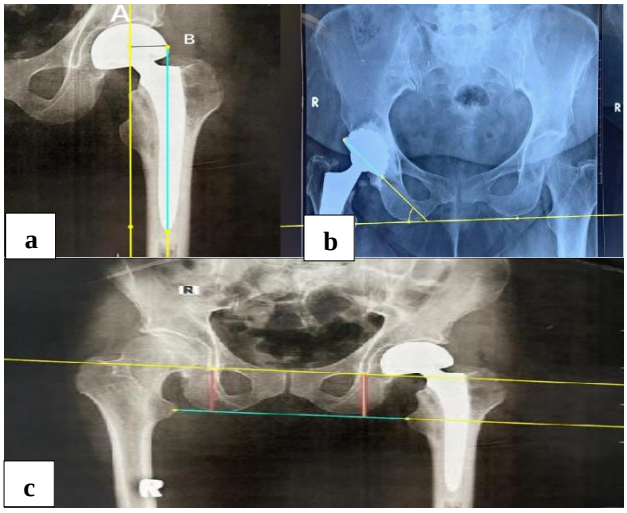

Figure 4: Radiological measurements of the study (a) femur offset measurement in which A represents a line passes through the COR, B represents a line bisects long axis of femur; (b) measuring acetabular inclination angle, the angle between transaction line and the line through cup margin; (c) measuring leg length discrepancy. Two lines one of them passes at the tips of lesser trochanter and the other one passes at the level of lower edge of the tear drop points. So, red line is length between the two lines mentioned above and represents leg length discrepancy.

Case study 1

A 76 female patient fractured his left hip after slipping on the ground. she is a hypertensive diabetic patient. After this relatively minor fall she had the immediate onset of excruciating left hip pain with the inability to walk or even move without severe pain. On examination, she had external rotation of left leg and shortening. X ray showed left fracture neck femur. She was selected for bipolar hip hemiarthroplasty after 3 days of admission. Perioperative control of diabetes and hypertension. We used lateral decubitus position, modified lateral Hardinge approach. Periprosthetic femur fracture occurred during surgery which was repaired by fixation of greater trochanter by non-absorbable ethibond sutures Figures 5 and 6. Operation time was 120-minute, amount of blood loss was 400 ml, duration of hospital stay was 7 days.

During follow up period there was pain during walking which decreased gradually over the next three months. She used walker for three months and then one crutch then was able to walk after one year follow up.

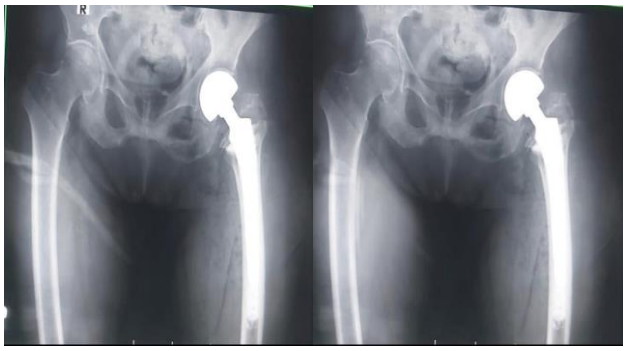

Figure 5: Periprosthetic femur fracture during bipolar hemiarthropasty (greater trochanter) after operation and after one year.

Figure 6: Leg length before and after surgery (a) shortening of left leg before operation, and (b) restoration of leg length after surgery.

Case study 2

A 62-year-old male patient presented with left hip trauma due to fall, he is not diabetic or hypertensive. He had a history of previous falls and left fracture ankle treated with open reduction and internal fixation.

We planned for tripolar total hip arthroplasty which was done 3 days after admission. We used spinal anaesthesia, lateral decubitus positioning and modified lateral Hardinge approach. During acetabular reaming intraoperative, thinning of the medial acetabular wall and minimal perforation of central portion occurred. Postoperative X-ray pelvis showed intrapelvic cement extrusion. Duration of surgery was 165 minutes, amount of blood loss was 500 ml and duration of hospital stay was 7 days.

Follow up postoperative X-rays demonstrated no event (implant mobilization, loosening, or cement fracture) that could have had functional consequences. The modified HHS was good Figure 7. The subjective criterion of the hip being "forgotten" was good. The pelvic signs (pollakiuria, dysuria, rectal tenesmus, and vesical tenesmus) were not present in spite of cement leakage. The patient has a good range of motion at the left hip. The functional outcome is good as per HHS.

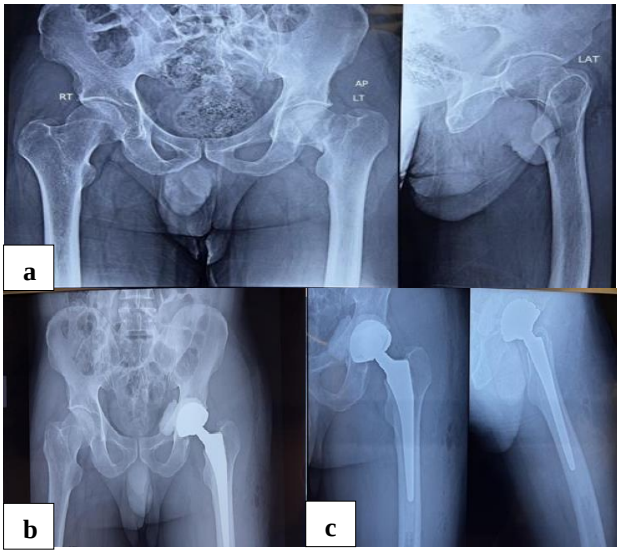

Figure 7: (a) Preoperative X-ray demonstrated left fracture neck femur, (b) immediately after surgery, and (c) after one year.

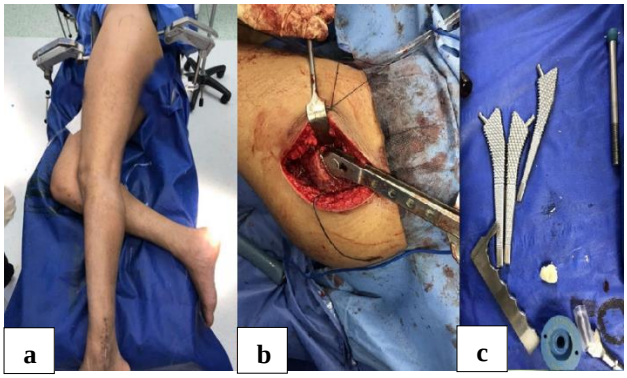

Figure 8: Intraoperative patient positioning lateral decubitus with pelvic support and femoral rasping (a) intraoperative patient positioning lateral decbitus with pelvic support, and (b) femoral rasping.

DISCUSSION

In this study, the mean age of the bipolar group was 70.4 years, while the mean age of the tripolar group was 68.9 years; the difference was not significant. The age of the Khalek et al study group was 78 years.[12] Philipp von Roth et al reported on 20 elderly patients with a mean age of 79 years (range 60-99) who underwent bipolar arthroplasty.[13] In this study, women were more affected than men, probably because women have more bone and fat and are more likely to lose weight. Osteoporosis is also considered a disease of postmenopausal women. Although some organizations recommend screening older men for osteoporosis.[14]

Most studies show a higher incidence of femoral neck fractures in older women, primarily because the bones in women are more mature, making women more prone to osteoporosis.

In this study, we found that operation time, blood loss and urine output were significantly lower in the BHA group. In our study, operation time was longer in the tripolar group than in the bipolar group and the difference between the two study groups was significant (p value<0.05), but the post-hospital outcome was almost the same. These findings confirm the results of many studies. Treatment outcomes in adults are greatly affected by surgical time and blood loss. Increased surgical time and blood loss make these patients more susceptible to infection.[13]

Treatment of the elderly is greatly affected by operation time and blood loss. Increased operation time and excessive blood loss increase liability to infection. An operative time more than 90 minutes is a predictor of complications which may occur and the liability to readmissions after THA, and an operative time between 40 and 90 minutes would be ideal, we found that although THR was associated with a longer operative time, the complication rate was comparable to the BHA group, but other studies have reported additional problems with BHA as observed by Ossendorf et al and Dawson et al.[15-17] This may be due to the short duration of our study and the longer follow-up period required to evaluate complications, and the surgery may be the main factor in obtaining better and less problematic results because we used the modified lateral sclerosis approach. The least resistance to the posterior muscle was used as much as possible, while other studies used the anterior approach as reported by Ossendorf et al.[16]

In our study, the duration of stay in hospital after operation was mostly same in the two groups and therefore it was not considered significant. This is compared to the observation of Wang et al who reported no difference in total time of stay in hospital in both operations.[18]

In our study, there was only one case with limping in the tripolar group and this was due to shortening on the other hip due to previous bipolar surgery on the other hip as

reported before. There was one case of limping in bipolar group due to greater trochanter fracture as reported before.

Abdelkhalek et al showed in their study that 90% of the patients had no lameness and 10% had mild lameness.[19] This result is comparable to our results, although they performed bipolar arthroplasty from the posterior approach, which preserved the abductor muscle and allowed for rapid and quick recovery. The proportion of patients who had their condition repaired by modification method was 78.4%, which was higher in our study.[20]

The cause of claudication may be attributed to muscle weakness, abductor insufficiency, pain or unequal leg length, but in our study all of these factors were controlled by external modifications that preserved the muscles, so the percentage of patients. was found to have decreased postoperative claudication compared to other studies. Lameness is a common symptom of hemijoint replacement in adults. Changes in abductor muscle mechanics due to neck size are the most likely cause.[21]

In our study, the final HHS after 1 year represents a good outcome.

Burgers and colleagues studied 212 patients with intracapsular fractue of neck femur and was treated with the use of bipolar hip hemiarthroplasty and found good outcomes equal to approximately 83.2% of patients with a HHS of 86.[22]

In a systematic review and review of clinical trials comparing arthroplasty methods for femoral neck fractures, the HHS was used to compare outcomes with the study.[23] Total scores for the THR were higher than for other arthroplasties.

The HHS range is from 0 to 100 points. It reports the following: pain, deformity, function and range of motion. The previous items are used in many studies to provide a clear picture of the patient being evaluated. The same review found that patients who underwent THR had better pain and functional outcomes.

In our study, we found that the THR score was higher than the HHS at one month, three months, six months and one year. Patients who received THR scored slightly higher compared to BHA.

Another study of 252 patients found non-significant difference in the hip function between hemiarthroplasty and total hip arthroplasty after five years follow-up.[24] Their one year follow-up is similar to ours but there was higher dislocation rate. The authors used a direct lateral approach and a posterolateral approach, whereas we used modified lateral Hardinge approach in all patients. This may explain the difference in dislocation rates. Avery et al found that after a 3-year follow-up, no significant difference in outcome between THA and hemiarthroplasty after 7 to 10 years.[25]

Tol et al found that comparable results to this study were reported in another long-term randomized controlled trial, in which there was no difference in complications or costs between the THA and hemiarthroplasty groups.[26] THA is superior to hemiarthroplasty in the treatment of independent patient.

Blomfeld et al found that hip function improved at 1 year in all hip arthroplasty groups, but no patients in the bipolar hemiarthroplasty group showed signs of acetabular erosion.[27] Both patient groups in our study had lower HHS at 1-year follow-up compared with patients by Blomfeldt et al. The study found that the hemiarthroplasty group had worse hip function and shorter self-reported walking times compared with the total hip arthroplasty group. These findings may be due to the inclusion of healthy, young, active, ambulatory patients in the study.

Hedbeck et al stated that there is significant difference in hip function and decreased complication in the THA group after one year of follow-up had improved functional outcome after four years of follow up.[28] The difference in life expectancy and decrease mortality was nonsignificant after one year but was more significant after four year of follow up. Mouzopoulos et al reported non-significant difference between the hemiarthroplasty and THA groups after one and four year of follow-up.[29] They recommended THA is used for patients more than 70 years of age with good cognitive status as in those patients it is associated with less pain and less rates of reoperation.

Two meta-analyses studies reported that total hip arthroplasty can decrease morbidity and cause good functional outcome when compared with hemiarthroplasty in elderly patients, however the two studies stated that there was dislocation rate which was increased in the group underwent THA. But, their findings need further research and they recommended this. Another review reported non-significant difference in pain levels, ambulation or walking between total hip arthroplasty and hemiarthroplasty; but, their evidence was not sufficient and needed further clinical research.[30]

Our study showed that there was no difference between the two groups in terms of CFR and CFR, but the two foreign THA groups performed better than the BHA group in the treatment of femoral neck replacement in the elderly.

In our study, 1 patient from the bipolar group had a trochanter fracture during surgery. No patient experienced postoperative complications or required combination surgery. One patient in the tripolar group underwent cement extrusion without serious complications or affecting the outcome of surgery because there was no change in urinary or pelvic pain or Harris hip band pressure after surgery.

The choice of total hip arthroplasty or bipolar hip arthroplasty for the treating femur neck fractures in healthy patients remains controversial.[31] Tripolar THA decreases

the rate of dislocation, reduces impact, and reduces friction and wear. The range of motion is increased. However acetabular pain and pain from implant compression are common finding in bipolar hemiarthropasty.[32]

There was no difference between the two groups in our study regarding dislocation rate. The data suggest that bipolar arthroplasty has higher medical costs than total hip arthroplasty. This pressure change is related to acetabular erosion.[33] However, no revision problems occurred in this study.

Several studies have evaluated mortality 1 year after bipolar compared to tripolar and found no difference between the two in our study there was nonsignificant difference in one year mortality between the two study groups and, this may be due to the short duration, as there was no mortality reported in our study.[34]

We evaluated femoral excursion and change in FO of the contralateral hip compared to preoperative radiographs taken 1 year after BHA surgery. FO is reversible in patients with fracture neck femur.

Buecking et al studied the clinical results of 126 patients who received BHA for femoral neck fractures at 1-year follow-up.[35] The Spearman correlation analysis results show that FO and HHS are positively associated with the daily life of the heir. Long-term success and low complications after THA are important. Ji et al showed that the results were early compared with our study. Anteversion and tilt are two indicators of THA cup orientation and can be measured with X-ray film.

Radiographic anteversion and tilt is measured and calculated with standard anteroposterior (AP) X-ray. Acetabular inclination is established using two lines the transverse axis line (ischial tuberosity line) and the plane of the acetabular foramen. These calculations can be made manually or using computer software.[35]

Haidukewych et al studied 212 bipolar hemiarthropasty cases.[36] Mortality was decreased in their cohort; the ten-year survival rate (without requiring reoperation for any reason) was 93.6%, 96.5% for aseptic femoral loosening, and 99.4% for acetabular bone wear.

Limitations

The limitation of our study is that the follow-up period is not long enough as longer follow up period is required to determine the rate of revision surgery. Being a single centre study and unblinded observer used for assessment of functional outcome were other limitations of the present study.

CONCLUSION

We found that in elderly patients with displaced fracture neck femur, tripolar hip arthroplasty caused better functional outcome and better range of motion without increasing rate of complications. It does not increase the rate of mortality or morbidity when compared to bipolar hemiarthropasty and should be taken into consideration as first choice in treating elderly patients with displaced fracture neck femur.

We recommend tripolar total hip arthroplasty for primary management of fracture neck femur in elderly patient due to better functional outcome yet further and longer duration studies are required for better assessment of long term complications that may occur.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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