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" Tripolar total hip arthroplasty versus Bipolar hip hemiarthroplasty in displaced femoral neck fracture in elderly: a randomized controlled trial "

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ABSTRACT:

Displaced fractures of femur neck in elderly needs surgical intervention with total hip arthroplasty, unipolar hemiarthroplasty or bipolar hemiarthroplasty, but, there is still controversy about the most effective implant. In this study we compare tripolar total hip arthroplasty versus bipolar hip hemiarthroplasty for displaced fracture neck femur in elderly

Material and methods: This study was conducted as a randomized controlled trial Patients were divided randomly in two equal groups 19 patients each one group underwent bipolar hip hemi arthroplasty and the other group underwent 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.

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
There was no dislocation in both groups. There was one case of superficial infection in both groups which was treated by antibiotics
There was one case of cement extrusion in tripolar group and one case of periprosthetic fracture in bipolar group

Conclusion: 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

Keywords: Elderly; Femoral fractures; Hemiarthroplasty; Hip arthroplasty.

INTRODUCTION

The higher quality of life and improved health services increased the elderly people percentage in the whole world population, thus there is increased incidence of osteoporotic hip fractures [1]. There is increased incidence of hip fracture every year all over the world [2]. The annual incidence of fracture hip in Egypt in above 40 years old people in 2022-2023 was 123.34 per 100,000 in women and 55.19 per 100,000 in men [3].

Displaced neck fractures of the femur compromise almost one half of the hip fracture; when fracture is displaced, it may lead to complications such as non-union or avascular necrosis [4]. There are many complications that may occur in the fractures of femoral neck such as interference of patient mobility, loss of function of the affected limb, and difficulty in self-dependence, all these complications can lead to increased mortality and morbidity in the elderly people [5, 6].

There is much debate on the best treatment of displaced fracture femur in the elderly patient, there are many studies discussing this issue [7]. There are many options for the treatment of the displaced fracture femur in elderly patients including internal fixation, but this option is mostly not suitable or recommended in elderly patients due to many complications and disadvantages which may occur in this age group [8–11], and arthroplasty of different types.

Studies showed that either bipolar hemiarthroplasty (HA) and tripolar total hip arthroplasty (THA) are considered acceptable treatment options in the surgery of hip replacement in displaced femoral neck fracture.

Therefore, in this study we performed a randomized controlled study to compare the clinical and functional results of bipolar hemiarthroplasty and tripolar total hip arthroplasty as treatment options of displaced fracture neck femur in elderly patients

Methodology

Type of study:

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.

Type of sample: simple random sample by using table of random numbers.

The inclusion criteria were:

1) the age is greater than 65 years; 2) fracture neck femur which is non-pathologic; 3) good cognitive function; 4) ambulatory before the occurrence of the fracture

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

Group 2- patients undergo tripolar total hip arthroplasty

Surgery approach for the two study groups: 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 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.

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 Harris Hip Score (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 SPSSdatabase . The data were expressed as mean±SD. All continuous variables were statistically analysed as to distribution using 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.

Table 1 Demographic data of study groups:

	Age(years)	Sex	
		Male	Female
Bipolar	70.3 ± 5.4	8	11
THR	68.9 ± 7.5	9	10

The detailed surgery information of study groups is shown in table 2

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.

Table 2: Detailed surgery information

	Bipolar group	Tripolar group	P value
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>

In the follow up period, Harris hip score 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 Harris hip score 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 Harris hip scores 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 Harris hip score was more in patients of the tripolar group than in the bipolar group.

Table 3: Functional outcome of patients in study groups:

Variable	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	

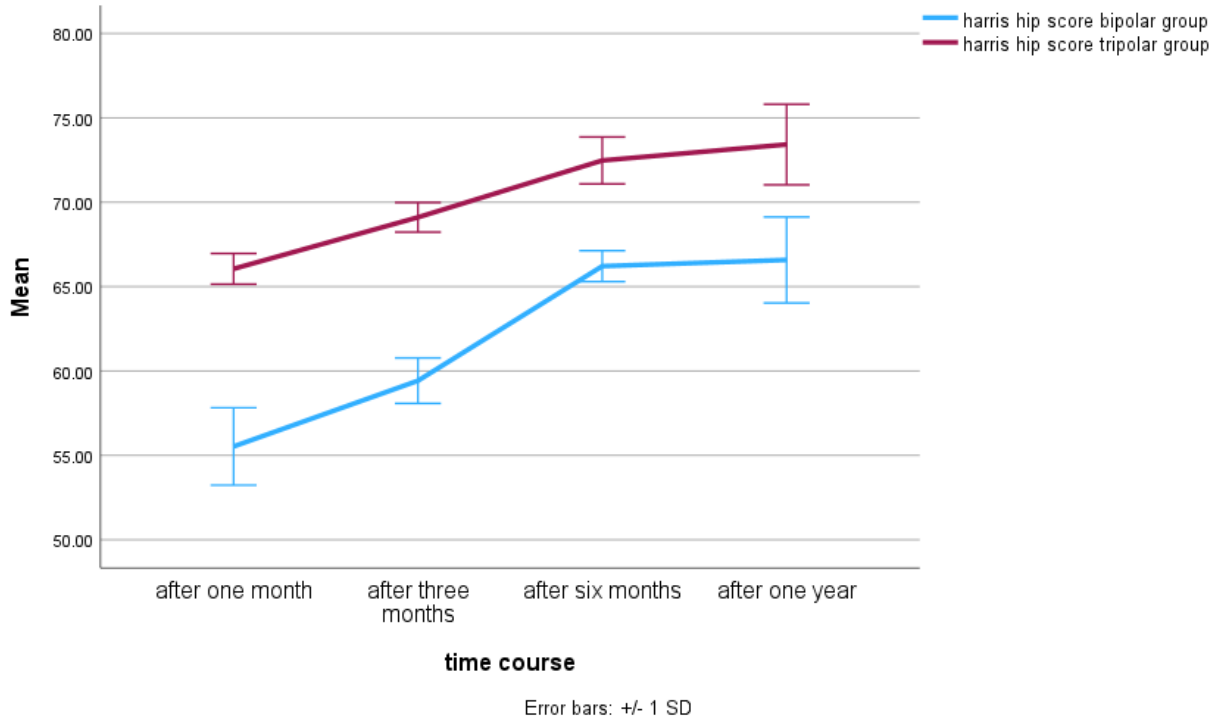


Fig. 1: Time course comparison of harris hip score in study groups in follow up visits.

Radiological outcome

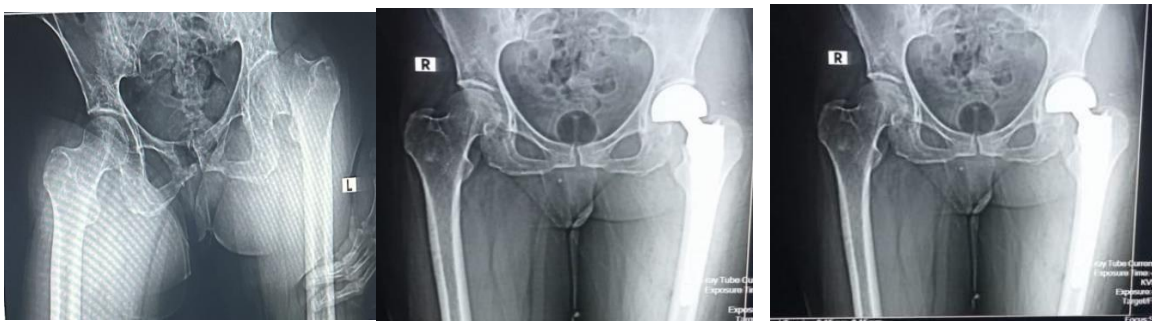
In the follow up visits, the radiological assessment showed no signs of loosening, radiolucent lines or heterotrophic ossification in the patients of the two groups. The radio graphical assessment was done by measuring femoral offset and leg length discrepancy and angle of cup inclination figures 2-8

Fig 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

C:one year after operation and prothesis well fixed



A B C

Fig 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

C:one year after operation and prothesis well fixed

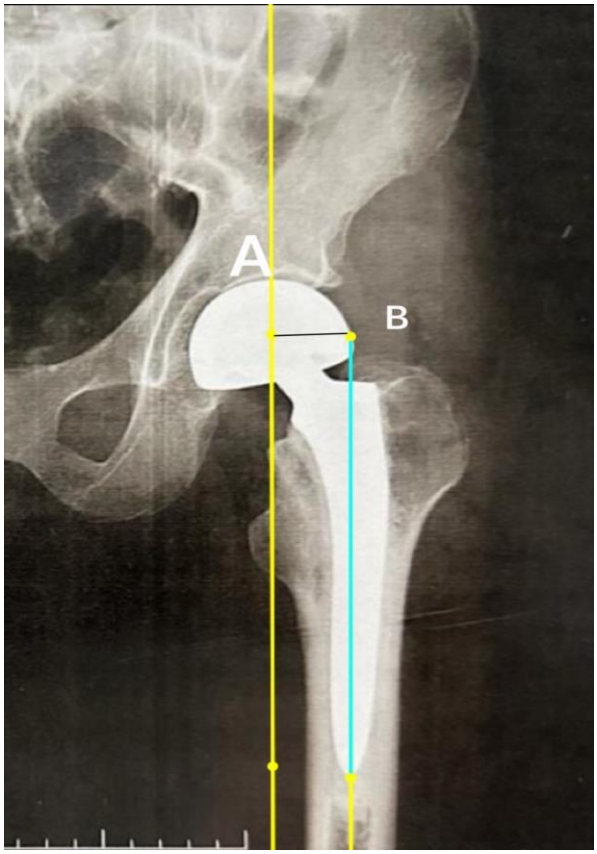


Fig 5: Femur offset measurement

A represents a line passes through the COR

B represents aline bisects long axis of femur

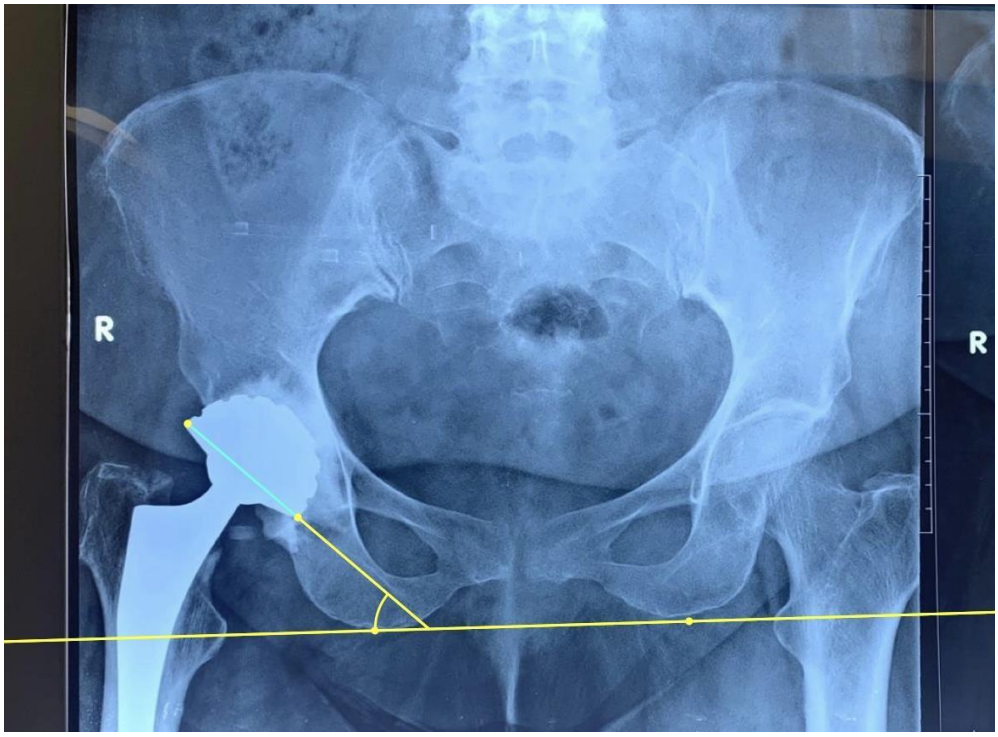


Fig.6 measuring acetabular inclination angle

The angle between transaction line and the line through cup margin

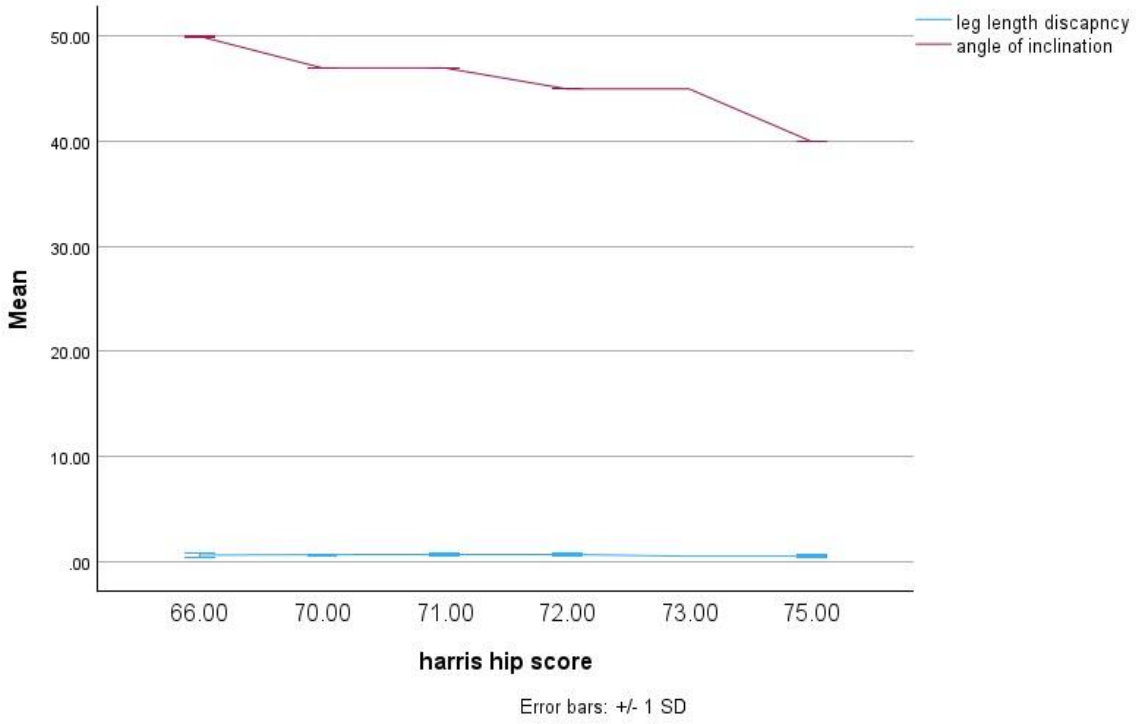


Fig.7 Relation between angle of inclination and leg length discrepancy and Harris hip score(functional outcome)

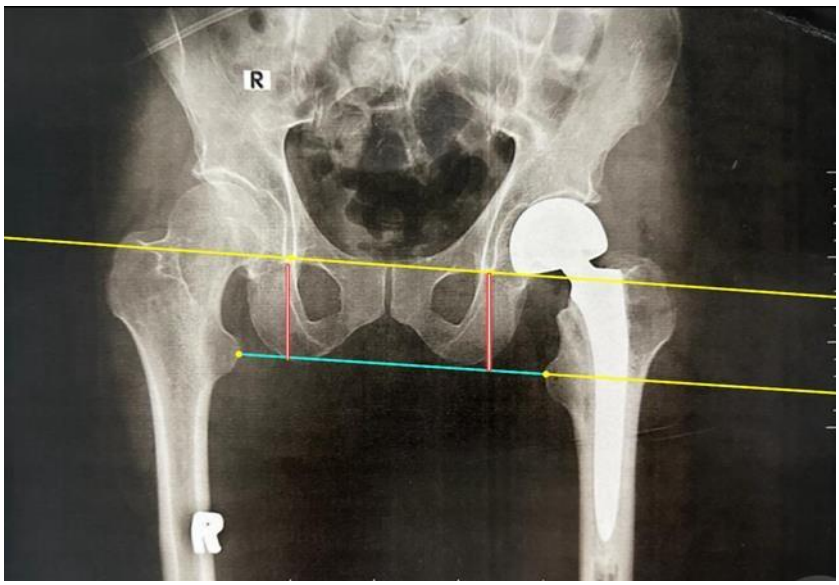


Fig 8 measuring Leg length discrepancy.

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

Complications:

Patients included in the study were able to walk with full weightbearing 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 Harris hip score. All the patients of both groups were able to do routine daily activities after one year of operation.

Case study 1:

A 70-year-male patient presented with pain of his left hip after falling while walking. During clinical examination, his left groin was tender on palpation, and hip joint motion was restricted. X ray showed left fracture neck femur. He was planned for bipolar hemiarthroplasty which was performed 3 days after initial presentation.

The anaesthesia was spinal anaesthesia, lateral decubitus position and the approach selected was modified lateral Harding approach. Amount of blood loss during surgery was 300 ml, operation time was 90 minutes. X ray immediately after surgery showed centralized well-fixed stem. femoral offset was measured and compared with the contralateral hip. We measured leg-length difference between the two hip joints.

Mobilization occurred second day after operation by a walker, duration of hospital stay was 6 days.

Good functional outcome as per modified harris hip score. During follow up period, no complications were reported and improved functioning and quality of life, the patient can walk independently without support and climb stairs and do daily activities.

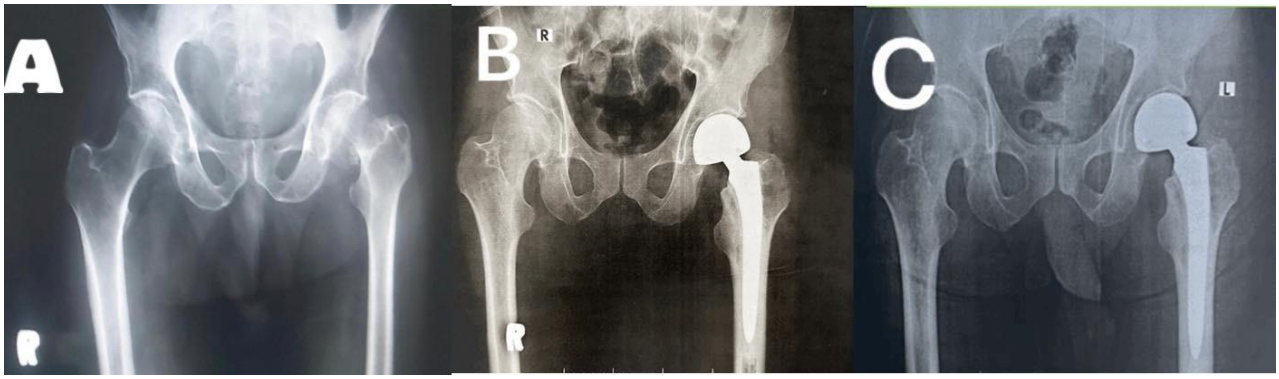


Fig 9: hip radiograph of 70 years old patient with fracture neck femur treated with cemented bipolar hemiarthroplasty

A: preoperative

B: immediately postoperative

C: one year after operation and prosthesis well fixed

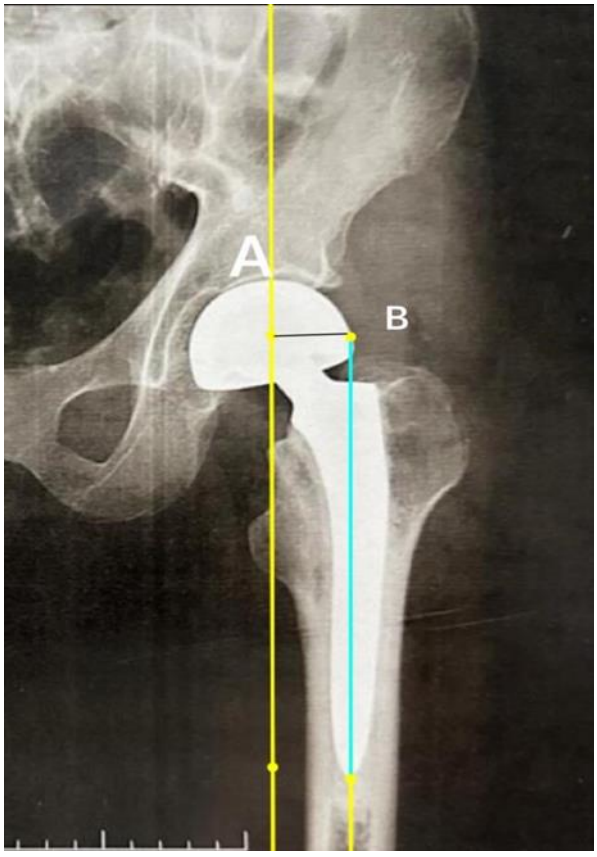


Fig.10 Femur offset measurement

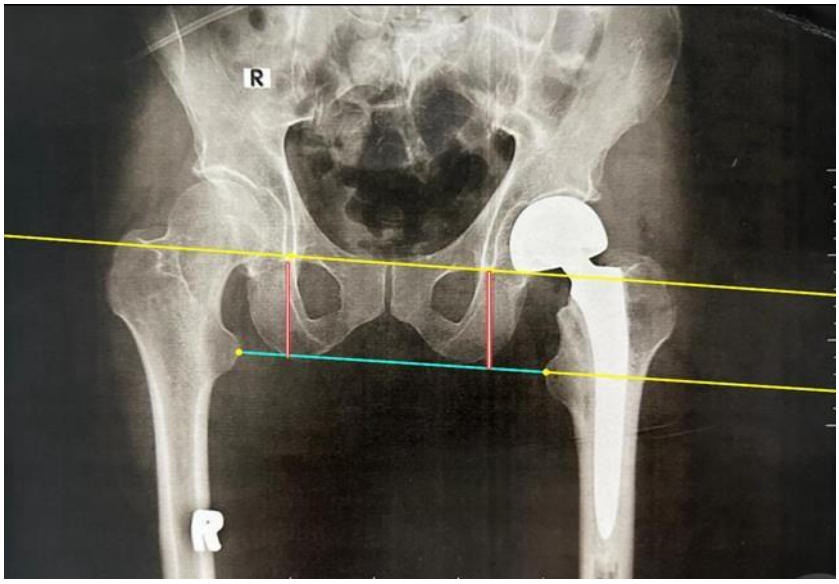


Fig. 11Leg length discrepancy

Case study 2:

A 63-years-old female patient came with complaints of the right hip pain and swelling after falling in the bathroom one year ago. She is treated for rheumatoid arthritis and on leflunomide and had history of treatment with corticosteroids. The patient had a history of falls and trauma at home, resulted in left sided fracture neck femur one year ago and she was admitted to hospital in Portsaid and underwent bipolar hemiarthroplasty which caused left side shortening and she used special riser shoes on the left side to correct this shortening.

The patient gave history of hospital admission in hospital after trauma and was discharged from hospital for being unfit for anaesthesia.

On examination, the deformity was present in the right hip in the form of external rotation of the right hip. X-ray of the pelvis with both hips showed right neck of femur fracture. We planned for tripolar hip replacement surgery with a dual mobility cup for anaesthesia consultation and was fit for spinal anaesthesia.

We used lateral decubitus positioning of the patient and and the approach selected was modified lateral Harding approach. Amount of blood loss during surgery was 450 ml, operation time was 160 minutes.

X-ray after operation showed both femoral and acetabular components was well fixed with good inclination. Weight-bearing was done in 2nd after operation with the aid of walker. Duration of hospital stay was 7 days. After 1 year of follow-up, the patient had no pain or difficulty in walking. The patient range of motion was good at the right hip. The functional outcome is good assessed by the use of Harris's hip score.

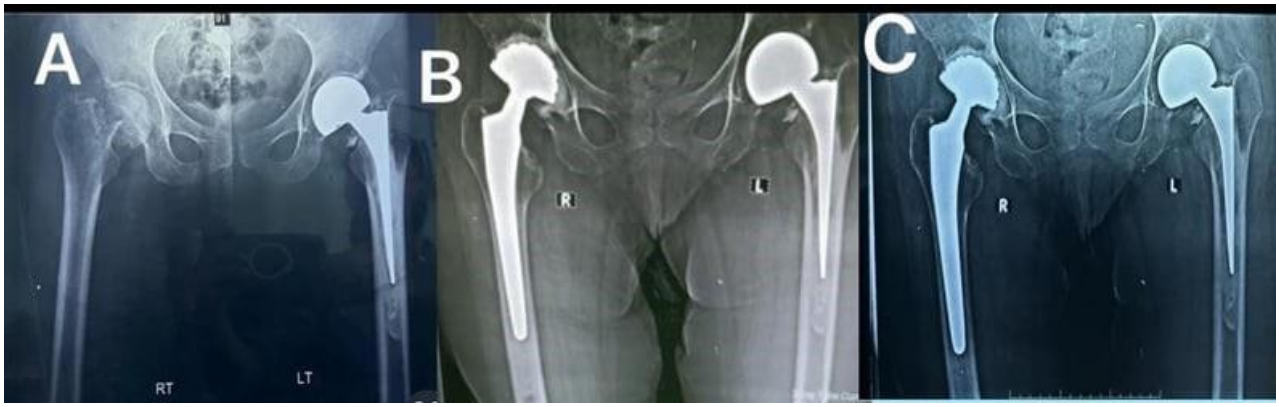


Fig. 12 AP hip radiograph of a female patient previously treated with left bipolar hemiarthroplasty presented with right neck femur fracture and treated with tripolar total hip arthroplasty A:preoperative B:immediately after operation

C:one year after operation and prosthesis well fixed 3

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 M et al [12] study group was 78 years. Philipp von Roth et al [13] reported on 20 elderly patients with a mean age of 79 years (range 60-99) who underwent bipolar arthroplasty. 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 [15] > 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. [16,17] 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 M and Abdelwahab M [19] showed in their study that 90% of the patients had no lameness and 10% had mild lameness. 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 [20] was 78.4%, which was higher in our study.

The cause of claudication may be attributed to muscle weakness, abductor insufficiency, pain or unequal leg length, but in our study all 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 hemi joint replacement in adults. Changes in abductor muscle mechanics due to neck size are the most likely cause [21].

In our study, the final Harris hip score after 1 year represents a good outcome. Burgers and colleagues studied 212 patients with intracapsular fracture 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 Harris hip score of 86 [22].

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

The Harris Hip Score 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 Harris hip score 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 [24] found non-significant difference in the hip function between hemiarthroplasty and total hip arthroplasty after five years follow-up. Their

one-year follow-up is like 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 [25]. They found that after a 3-year follow-up, no significant difference in outcome between total hip arthroplasty and hemiarthroplasty after 7 to 10 years.

Tol et al. [27] 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 total hip arthroplasty and hemiarthroplasty groups. Total hip arthroplasty is superior to hemiarthroplasty in the treatment of independent patient.

Blomfeld et al. [27] 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. 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 [28] stated that there is significant difference in hip function and decreased complication in the total hip arthroplasty group after one year of follow-up had improved functional outcome after four years of follow up.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 [29] reported non-significant difference between the hemiarthroplasty and total hip arthroplasty groups after one and four year of followup. They recommended total hip arthroplasty 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 metanalyses 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 total hip arthroplasty. But their findings need further research and they recommended this. Another review reported nonsignificant 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 total hip arthroplasty 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 [34] 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.

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. [35] studied the clinical results of 126 patients who received BHA for femoral neck fractures at 1-year follow-up. 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 total hip arthroplasty (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 by the use of 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 [36] studied 212 bipolar hemiarthropasty cases. 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

Conclusion and recommendations

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.

We recommend more studies in younger age groups as regard use of tripolar total arthroplasty and comparing it to other methods of treatment of fracture neck femur to assess rate of complications and outcomes in different age groups.

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