Unipolar Versus Bipolar Hip Hemiarthroplasty in the Treatment of Femoral Neck Fractures in the Elderly

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ABSTRACT:

BACKGROUND:

Hip fractures are associated with high morbidity and mortality, which require a treatment plan that ensures a good outcome with minimal complications. Different treatment modalities and arthroplasty prosthesis are available and widely used.

OBJECTIVE:

The aim of this study was to compare the short outcome of surgical treatment of femoral neck fractures in elderly using unipolar and bipolar hip hemiarthroplasty.

PATIENTS AND METHODS:

Thirty four patients with intracapsular femoral neck fractures ranging from Garden's class II to class IV were enrolled in the study for surgical intervention using either unipolar hemiarthroplasty (Group A: 14females, 6 males) or bipolar hemiarthroplasty (Group B: 10 females, 4 males). Patients were followed up for up to 2 years by Harris Hip Score to assess the outcome of the surgery.

RESULTS:

The average hip score for patients per group over the whole follow-up period showed better results in group B than in group A. Average score results were higher in all grades among group B patients. However, the difference from scores of group A patients was statistically insignificant ($p>0.05$). Patients of both groups had a negative correlation of age to score outcome regardless of sex and grade of fracture. In group A patients, score points for pain, stiffness, range of motion and support/locomotion were all higher during the first six months of follow up. The scores started to decline gradually after 18 months towards the end of the follow up period. In group B patients, the score points for the same parameters were all significantly lower than Group A patients during the first 3-6 months of follow up but started to increase to significantly higher levels towards the end of the follow up period.

CONCLUSION:

The short-term advantages of unipolar hemiarthroplasty may outweigh its long-term complications in elderly patients with limited daily activities and/or associated serious medical illnesses. In younger age patients with more ambulatory activities and greater life expectancy, bipolar hemiarthroplasty offers a better solution.

KEYWORDS: femoral neck fractures, unipolar/bipolar hemiarthroplasty, austen-moore.

INTRODUCTION:

The hip (coxofemoral) joint is a large and stable diarthroidal ball-and-socket joint formed by the articulation between the femoral head and the acetabulum of the pelvis [(1)]. It has a great deal of mobility, which allows normal locomotion in the performance of daily activities [(2)]. With great stability, the joint bears the body weight and permits standing upright with little expenditure of energy in the form of muscle contraction. With good range of movement, it permits bipedal movement and acceleration [(3)].

Hip fracture refers to a fracture occurring in the area between the edge of the femoral head and 5 centimeters below the lesser trochanter. Femoral neck fractures tend to occur in elderly patients who fall. In younger individuals, femoral neck fractures generally occur as a result of major trauma due to axial loading on the femur[(4)]. Proximal (intracapsular) femoral neck fractures are estimated

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to be ten times more common than extracapsular fractures [5]. Intracapsular femoral neck fractures have a relatively high rate of complications compared with extracapsular fractures. Potential complications following such fractures with or without surgical intervention include: infection, chronic pain, dislocation, nonunion, avascular necrosis, and posttraumatic arthritic changes [6]. Because of lack of muscular attachment to the femoral neck and head, displaced femoral neck fractures are commonly associated with retinacular tearing and avascular necrosis of the femoral head [7].

There is a continuous debate as to whether; open reduction with internal fixation (ORIF) or arthroplasty is the best treatment for appropriate adult surgical candidates with femoral neck fractures. Arthroplasty has three main advantages: (1) it allows early weight bearing and avoidance of complications of recumbency, (2) it eliminates avascular necrosis and nonunion as potential complications and, (3) it has significantly lower reoperation rates [8].

Another ongoing controversy is related to the type of arthroplasty, partial or total, that is best suitable for a selected category of patients. Uncertainty as to which type of endoprosthesis is the ideal choice for treatment of fractures in older patients leads to significant variation in the use of each intervention internationally [9].

The aim of this study was to compare the short outcome of surgical treatment of femoral neck fractures in elderly using unipolar and bipolar hip hemiarthroplasty.

PATIENTS AND METHODS:

The study was conducted in Al-Yarmouk Teaching Hospital, Department of orthopedic Surgery over the time period extending from February 2012 to February 2014. Thirty nine patients with femoral neck fractures were enrolled in the study but five of them passed away at different times postoperatively due to causes not related to the surgical procedure, and were excluded from the study. The 34 patients included in the study were divided into two groups according to the type of hip hemiarthroplasty. Group A patients underwent unipolar hip hemiarthroplasty surgery while group B patients had bipolar hemiarthroplasty. Group A consisted of 20 patients (14 females, 6 males) with an average age of 70.7 years. Group B consisted of 14 patients (10 females, 4 males) with an average age of 64.6 years. The selection of a patient for the type of surgery was made on the basis of age and associated medical illnesses. Patients < 60 years were excluded from the study. Those who were > 60 years and had no associated serious medical illnesses were included in group B. Those who were > 60 years and had serious chronic illnesses were included in group A, because of less operative time in unipolar surgery with less exposure to anesthesia, less bleeding risk and less reaming with subsequent less risk of fat embolism.

All the patients had the same mechanism of injury, a trivial fall causing femoral neck fracture. None of the patients had acetabular fractures or other bone pathology. The fracture was graded according to Garden's classification [10] as shown in table 1. Most patients had type III or IV Garden's fracture (figure 1).

Table 1: Distribution of patients with femoral neck fracture undergoing unipolar (group A) or bipolar (group B) hip hemiarthroplasty according to age, sex and fracture grade.

Group	Mean Age (years)	Sex		Garden's Classification of femoral neck fracture			
		Male	Female	I	II	III	IV
A (n=20)	70.7	6	14	-	2	9	9
B (n=14)	64.6	4	10	-	1	9	4

Garden's Classification of femoral neck fractures[10]:
Garden I: incomplete or impacted fracture, in which the trabeculae of the inferior neck are still intact; femoral head is tilted in a posterolateral direction, causing vaglus angulation.
Garden II: complete but undisplaced fracture with varus deformity.
Garden III: complete fracture with partial displacement; the two fragments still in contact.
Garden IV: complete fracture with total displacement; no continuity between proximal and distal fragments;femoral head assumes its normal position within the acetabulum.

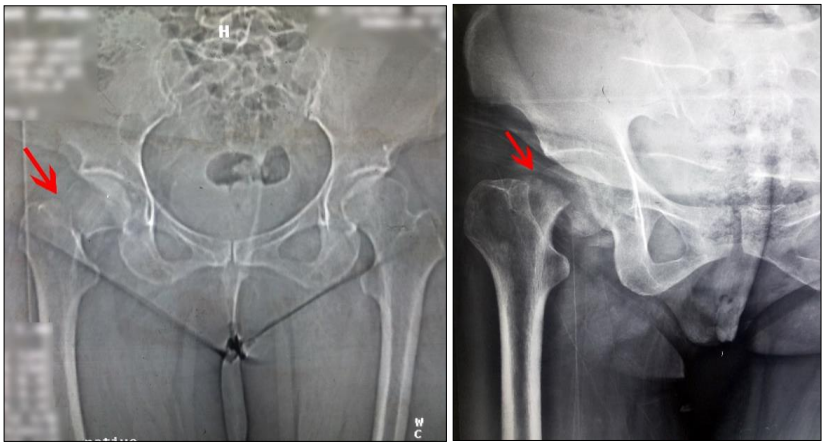

Figure 1: AP X-ray of two patients with Garden's class III (left) and class IV (right) femoral neck fractures indicated by the red arrow.

Surgical Procedure

All the patients underwent surgery with a standard posterior approach in lateral position under general or spinal anesthesia within two weeks of the time of injury. For the unipolar hip hemiarthroplasty, the Austin Moore approach was used. An incision was made from a point 5cm inferolateral to the posterior inferior iliac spine and extended anterior to the greater trochanter where it continued vertically downwards over the line of the femur for about 10 cm, the gluteus maximus was split in the direction of its fibers and its margins were retracted to reveal the short transverse muscles of the hip that were then divided near their insertion and reflected to expose the back of the joint capsule. The joint capsule was opened close to the greater trochanter. The fracture was shown by internal rotation of the lower limb and the head of femur became obvious. A corkscrew was used to remove the head from the acetabulum. After the femoral head was removed, the diameter of the head was measured to determine the approximate size of the head of the chosen prosthesis. The neck was then cut according to the template of the used surgical set. The femoral canal was carefully detected with a long curette and then was prepared by graduated reaming using broaches. A non-cemented Austin Moore prosthesis (TREU-INSTRUMENTE®, Germany) of appropriate size was inserted with 20º of internal rotation in relation to the lesser trochanter (figure 2). Hip examination was done to ensure stability and suturing in layers was done with suction drain left.

Figure 2: The unipolar (Austin-Moore) prosthesis inserted in position.

For the bipolar hemiarthroplasty, the same surgical approach was used but with the head removed, acetabular sizers were used to verify the correct diameter of the prosthesis cup. Two types of broaches were used for preparing the femoral canal: type A for distal femoral canal reaming and type B for proximal femoral trochanteric reaming. In the last reaming broach, a trial head with different offsets has been assembled with a trial cup and reduction was done to determine the joint stability. The appropriate head offset was chosen according to this maneuver. After removal of the trial prostheses, an appropriate size cementless femoral stem and 28 mm head of appropriate offset were assembled in a modular fashion. Finally, a polyethylene acetabular shell component (B BRAUN AESCULAP®, Germany) was secured (figure 3) on the assembly and the hip joint was reduced as mentioned above.

All patients were encouraged to become ambulatory on the second day of the operation with the aid of a walker and minimum weight bearing. AP X-rays were taken at that day (figure 4).

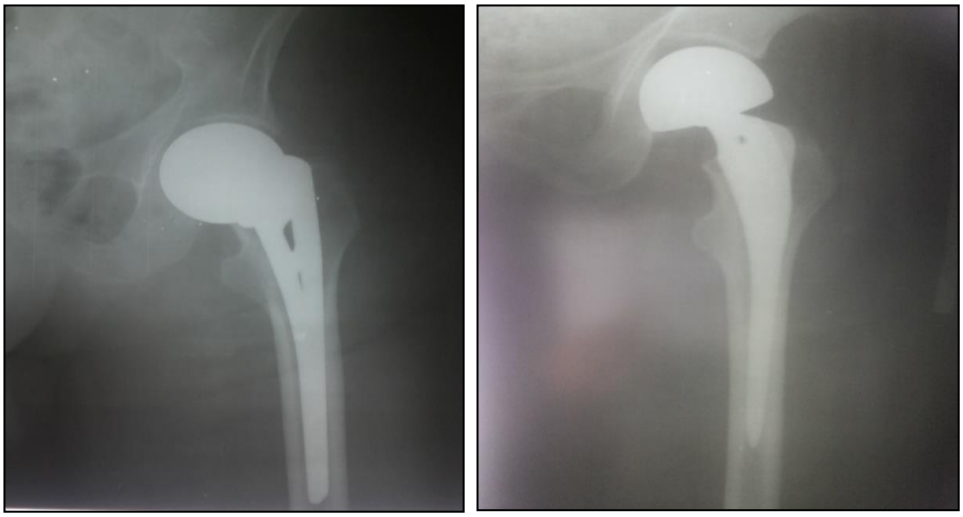

Figure 3: The bipolar (Aesculap) prosthesis inserted in position.

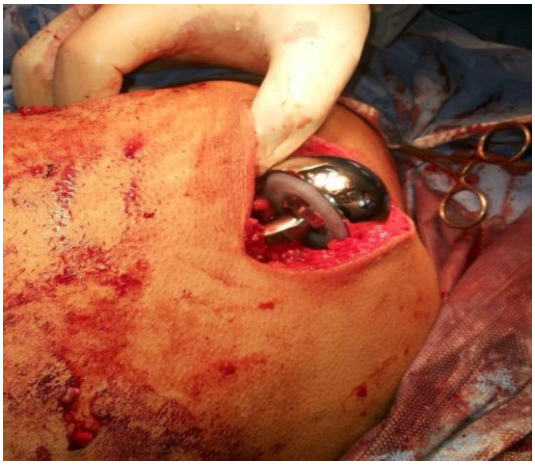

Figure 4: Postoperative AP X-ray of the hip after unipolar (left) and bipolar (right) hemiarthroplasty.

The drains were removed 48 hours postoperatively and patients were discharged. Each patient was seen one week after surgery and at two weeks for suture removal.

Follow up and Hip scoring

Follow up assessment started one month after surgery. Patients were assessed every month for three months and then every 3 months for up of 2 years. Harris hip scoring system [11] was used in the assessment. It covers five main aspects that include pain (0-44 points), limb length discrepancy (0-11 points), support and locomotion (0-36 points), stiffness/deformity (0 or 4 points) and range of motion (0-5 points). The score gives a maximum of 100 points and its results have been graded as shown in table 2.

Table 2: Grading system for Harris hip score [11].

Harris hip score	Grade
90 – 100	Excellent
80 – 89	Good
70 – 79	Fair
< 70	Poor

Radiographs were also taken with each visit to assess implant stability and look for any signs of loosening or other complications (e.g. acetabular erosion).

RESULTS:

The average hip score for patients per group over the whole follow-up period showed better results in group B than in group A as shown in figure 5. In group B, half the patients maintained an excellent score, 29% had good score results and only 21% had fair results. In group A, most of the patients were equally distributed between excellent and good score results (35% each), while 30% maintained fair results.

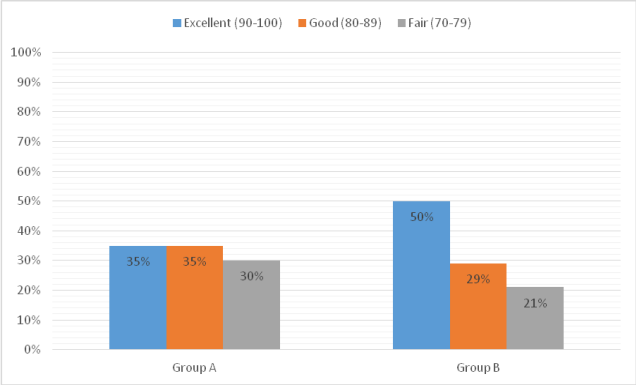

Figure 5: Patients distribution according to average Harris Hip Score grade.

The average scores for each category in each group are shown in table 3. Average score results were higher in all grade among group B patients. However, the difference from scores of group A patients was statistically insignificant ($p>0.05$).

Table 3: Number of patients (n) and average Harris hip score results according to grade between patients treated with unipolar and bipolar hip hemiarthroplasty over a period of 2 years follow up (score represents Mean± SD).

Group	Harris Hip Score Grade					
	Excellent		Good		Fair	
	Number	Score (points)	Number	Score (points)	Number	Score (points)
A (n= 20)	7	92±0.7	7	83.4±1.1	6	74.3±0.4
B (n= 14)	7	96±1.3	4	88.3±0.9	3	77±1.4

It was noted that patients of both groups had a negative correlation of age to score outcome regardless of sex and grade of fracture (figure 6).

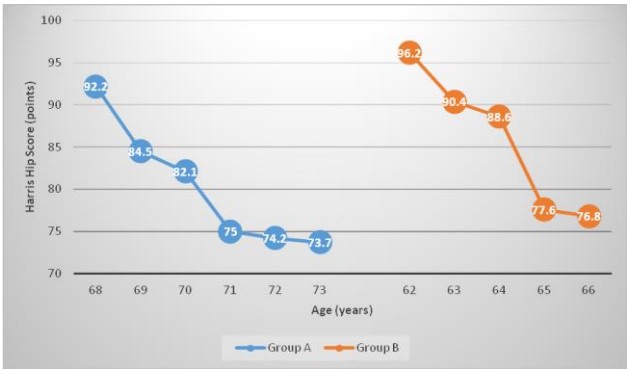

Figure 6: Correlation between patients' age and Harris Hip Score outcome after unipolar or bipolar hemiarthroplasty.

The hip score also showed considerable differences during the follow up period in each group. In group A patients (figure 7), score points for pain, stiffness, range of motion and support/locomotion were all higher during the first six months of follow

up. The scores started to decline gradually after 18 months towards the end of the follow up period. Limb length discrepancy score points were initially slightly lower than in Group B patients and maintained an almost stable level during follow up.

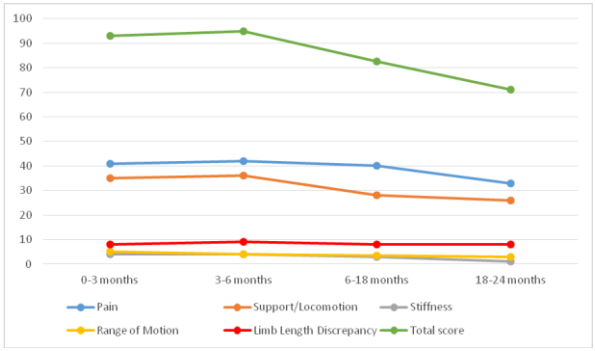

Figure 7: Time line changes in Harris Hip Score points categories in patients with unipolar hip hemiarthroplasty (group A).

In group B patients (figure 8), the score points for pain, stiffness, range of motion and support/locomotion were all significantly lower than Group A patients during the first 3-6 months of follow up but started to increase to significantly higher levels towards the end of the follow up period (especially after 12-18 months). Limb length discrepancy scores were higher than in Group A patients throughout the follow up time. However, limb length discrepancy did not exceed 1-2 cm in neither group A nor group B patients resulting in no or very slight limping. Therefore, score points for this category were not significantly different between the two groups.

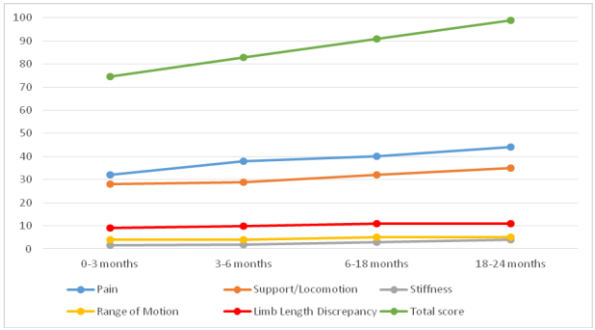

Figure 8: Time line changes in Harris Hip Score point's categories in patients with bipolar hip hemiarthroplasty (group B).

Radiological examination follow up showed good implant fitting and bone structure in all patients during the first 12-18 months of follow-up (figure 9).

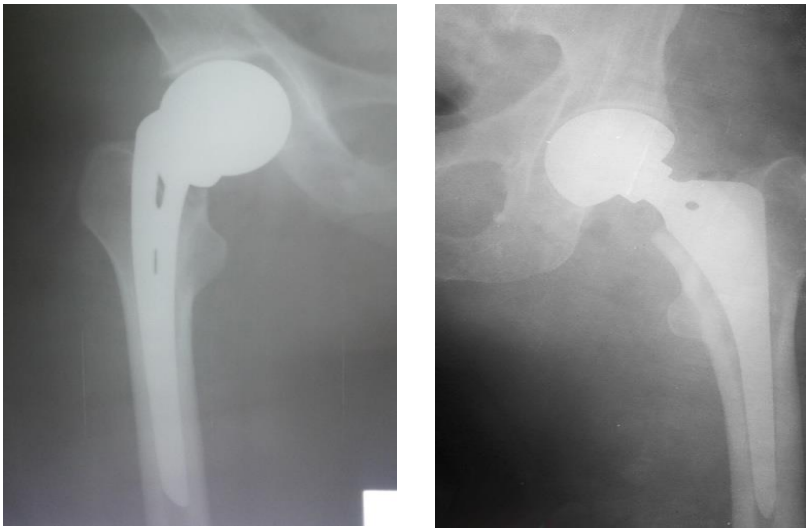

Figure 9: Follow up AP X-ray of the hip after unipolar (left) and bipolar (right) hemiarthroplasty.

However, two patients of group A showed early radiological signs of loosening after 18-20 months including radiolucent line around the prosthesis and a change in the position of the implant from neutral to varus (figure 10) but neither had any clinical complaint of loosening.

Three diabetic patients (2 from group A and 1 from group B) developed wound infection that was treated conservatively with antibiotics and good glycaemic control. This complication did not reach the level of implant removal nor require revision surgery.

Other complications commonly encountered in hip replacement surgery like joint dislocation and acetabular protrusion did not develop in any patient during the follow up period.

Figure 10: AP X-ray of a hip with unipolar hemiarthroplasty, 24 months after surgery showing a radiolucent line around the prosthesis and a change in the position of the head towards varus, considered as early radiological signs of implant loosening.

DISCUSSION:

A hip fracture is associated with high morbidity and mortality, which necessitates a treatment plan to achieve a good outcome as soon as possible. Equally important is that evaluation of different treatment modalities [12]. There is a universal agreement that unipolar or bipolar hemiarthroplasty is the preferred method for treating displaced intracapsular femoral neck fractures in elderly patients with low functional demands in the absence of degenerative disorders of the hip [13]. Reported advantages of Unipolar over Bipolar hip hemiarthroplasty are less complex surgery, shorter operation times, less blood loss, and lower initial costs [14]. Being the main treatment option for displaced femoral neck fractures, hemiarthroplasties are performed in great numbers worldwide. In spite of this, these procedures are seldom registered nationally and there is little evidence regarding the best choice of implant design and surgical technique [15].

In the current study, the same surgical approach (posterior approach) was used for all patients. This kept discrepancies limited to the type of prosthesis used. The patient groups had an age difference of 7-8 years, but in both groups, older age was always associated with lower Harris Hip Score. This may be related to the lower activity levels and association with other medical illnesses that limit mobility and ambulation.

Non-cemented prosthesis were used in all patients depending on recent reports that uncemented, modular hemiarthroplasty has given equivalent results to cemented hemiarthroplasty in terms of functional outcomes, complications, and mortality[16]. In both groups, early assisted ambulation (within 48 hr of surgery) was used because it has proven to accelerate functional recovery [17].

During the first 3-6 months of postoperative follow up, group A patients showed better hip scores than group B patients. The scores normalized over the following 6 months but started to decline for group A patients and improve for group B patients. These results are consistent with reports of Raia *et al.* & Calder *et al.* in most hip score aspects, especially pain [18 & 19].

Pain appears to be the main influential factor on other aspects of the hip score like range of motion, stiffness, locomotion and support. Development or persistence of pain may be related to the mechanism action of each of the unipolar and bipolar prostheses.

In Group A patients, pain became problematic enough to affect the hip score and its aspects in the later periods of follow up but not the early months. This is related to the proximal load transfer principle of the prosthesis. With good calcar-collar support, the stresses in the stem are small because the stem portion of the prosthesis and the bone are uncoupled and, consequently, do not share the resultant bending moment of the head and abductor forces. In later months the same load transfer principal resulted in early loosening which in turn resulted in pain and limitation of movement and support. A reduction of calcar-collar support over time with proximal fixation resulted in high stresses in the stem and stress shielding of the proximal medial cortex which may have lead to the migration of the stem tip to the valgus position [20].

In group B patients, the pain factor was influential on the hip score during the early months of follow up but faded off later on. This is also related to the mechanism of action of the prosthesis which depends on bone ingrowth for support as the psrosthesis is porous coated and requires bone ingrowth for better fixation of bone. The early inability to achieve weight-bearing capacity is most likely related to the lack of mechanical support for transferring loads from the hip to the axial skeleton in the absence of bone ingrowth in the first few months postoperatively. As bone growth proceeded, enough support existed to limit pain and increase range of movement [21]. Moreover, the bipolar prosthesis has two bearing surfaces; load and frictional torque can theoretically be absorbed in part by the metal on polyethylene inner bearing reducing the magnitude of forces between the implant and acetabulam and providing better range of motion and less stiffness [22]. Although pain scores were lower in this group in the first few months of follow up, other score categories like range of motion and locomotion were higher compared to group A due to younger age patients with more activity and ambulation. This brought the total score nearly to the same level of group A patients.

Limb length discrepancy was noticed and more pronounced in group A patients possibly due to factors related to alignment of the prosthetic stem, length of head offset and calcar seating. Individual differences exist and may be responsible for some discrepancy [23]. Contradictively, Mishra *et al.* described more limb length discrepancy with bipolar hemiarthroplasty but, similar to our study, the discrepancy was not severe to cause

troublesome limping [24]. The discrepancy was seen less in group B patients possibly due to the trials of many sizes of head offsets with subsequent choosing of the most appropriate size.

Dislocation of the prosthesis did not develop in the current study due to maintenance of the femoral head at 20°anteversion in relation to the lesser trochanter which puts the prosthesis in the nearest anatomical position. Moreover, being a hemiarthroplasty, the acetabulum maintained its normal status alignment.

Acetabular protrusion is commonly reported in Austin-Moore hemiarthroplasty due to the direct impaction of the metallic head on the arthritic acetabulum. It is less recorded in bipolar hemiarthroplasty due to the presence of the cup that transfers forces to the acetabular rim. The complication was not seen in any of our patients most probably due to their age which is associated with less physical activity and ambulation that is insufficient to cause acetabular damage during the period of the follow up of two years.

CONCLUSION:

Hemiarthroplasty is considered the optimal treatment for elderly patients with intracapsular femoral neck fractures and produce satisfactory results. While bipolar prosthesis enables reduction of acetabular wear and increase in prosthesis life and function, unipolar hemiarthroplasty using the Austin Moore's remains a popular choice. The current study shows that the short-term advantages of unipolar hemiarthroplasty may outweigh its long-term complications in elderly patients with limited daily activities and/or associated medical illnesses. In less age patients with more ambulatory activities and greater life expectancy, bipolar hemiarthroplasty offers a better solution.

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