Bipolar hemiarthroplasty with calcar substitution for unstable osteoporotic extracapsular hip fractures

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Received 11 November 2012
Accepted 05 October 2012

Egyptian Orthopedic Journal 2014, 49:202–208

Background
Hip fractures are the most frequent cause of morbidity in elderly people, and as the world's population ages, these fractures pose a significant healthcare problem. The management of unstable osteoporotic intertrochanteric fractures is challenging because of the difficult anatomical reduction, poor bone quality and sometimes a need to protect the fracture from stresses of weight bearing. Internal fixation in these cases usually involves prolonged bed rest or limited ambulation to prevent implant failure, and this might result in higher chances of complications.

Aim of the work
The purpose of this study was to analyse the role of primary bipolar hemiarthroplasty with the calcar substitution design for the treatment of unstable osteoporotic intertrochanteric hip fractures.

Patients and methods
Seventeen patients with A2-type and A3-type unstable osteoporotic intertrochanteric fractures according to the WHO criteria and according to the System of the Orthopedic Trauma Association (AO/OTA) were treated with primary bipolar hemiarthroplasty with the calcar substitution design. There were 12 female and five male patients with a mean age of 66 years (range 62–74 years). The patients were followed up to a mean of 14 months (range 9–24 months) and evaluated according to the Harris Hip Score System.

Results
Two patients died in the third and the fifth months postoperatively after myocardial infarction and another two patients were lost for unknown causes. These four patients were excluded from the study, and the remaining 13 patients were followed up. The mean operative time was 115 min (range 90–160 min), and the average intraoperative blood loss was 450 ml (range 300–950 ml). Three patients needed blood transfusion postoperatively. The patients walked on an average of 3.2 days after surgery (range 2–8 days), and the average time taken to return to normal daily activities was 28 days (range 24–33 days). At the last follow-up, a total of 10 patients were graded as excellent or good and three as fair; nine patients were walking without any aid, three patients had a limp and used a stick for walking and one patient used a walker. One patient had superficial skin infection and another one had dislocation due to trauma 4 months postoperatively. Follow-up radiographs revealed acetabular erosion in two patients and nonunion of the greater trochanter in one patient. These three patients were ranked to have fair results.

Conclusion
Bipolar hemiarthroplasty with calcar substitution for unstable osteoporotic intertrochanteric fractures may allow early weight bearing and offers quick recovery with little risk of mechanical failure. It may also avoid the risks associated with internal fixation and enable the patient to maintain a good level of function immediately after surgery.

Keywords:
calcar replacement, hemiarthroplasty, unstable trochanteric fractures

Egypt Orthop J 49:202–208

1110-1148

Introduction

The incidence of all hip fractures is ~80 per 100 000 persons; intertrochanteric fractures make up 45% of all of them, and these figures are expected to double over the next 50 years [1]. Increase in the average lifespan and improved medical facilities have increased the incidence of these fractures considerably [2]. The mechanism of injury is mostly trivial trauma: low-energy trauma (fall <1 m) caused 53% of all fractures in persons 50 years of age and older and more than 80% of all fractures in those over 75 years of age [3]. Hip fractures in the elderly are associated with impaired mobility, poor balance, delayed reaction times and compromised vision [4]. The contribution of osteoporosis-related fractures is more important than previously thought [5]. The goal of treatment is to return the patient to his or her premorbid status of function. The management ranges from conservative methods to osteosynthesis with intramedullary or extramedullary devices or even primary replacement

arthroplasty in certain situations. Nevertheless, the 'gold standard' and the most appropriate treatment for these fractures remains controversial, particularly for unstable multifragmentary fractures [1]. Unstable intertrochanteric fractures in elderly patients are associated with high rates of morbidity and mortality. In these elderly patients, a period of restricted mobilization is suggested, and a prolonged recovery time after surgery is expected [6]. Several factors must be considered in choosing the most appropriate management method for these fractures, including the patient's general health, the prefracture ambulatory status, the fracture pattern and the type of implant. The associated medical problems, comminution, osteoporosis and instability often preclude early full weight bearing, and this is the most important factor leading to unsatisfactory results [7,8]. The overall failure rate with internal fixation in intertrochanteric fractures has been reported to be 3–16.5%, and the rate is higher in unstable fractures that are associated with a considerably high incidence of complications such as atelectasis, bed sores, pneumonia and deep vein thrombosis [9].

Various authors have reported successful outcomes after the use of either total or hemi-hip arthroplasty as a primary treatment of unstable intertrochanteric hip fractures [10–17]. They concluded that after hip arthroplasty, patients can bear weight immediately, and they can be encouraged to walk early and exercise the involved limb, thus reducing the period of bed rest and rate of complications. The hospital stay is shortened and the incidence of secondary operations is reduced [18].

One important issue during hip arthroplasty in cases of intertrochanteric hip fractures is whether to reconstruct or to substitute the area of the calcar femoral, which is usually defective in unstable fractures. This step is crucial for the stability of the prosthesis and to restore the length of the operated limb.

Our study was conducted to evaluate the clinical and radiological results that were obtained with bipolar hemiarthroplasty with the calcar substitution design as a primary treatment for unstable osteoporotic intertrochanteric fractures and to review the results reported in the literature.

Patients and methods

In a retrospective study conducted between December 2009 and April 2011, a total of 17 consecutive patients having unstable osteoporotic intertrochanteric fractures (A2 and A3 types) were treated by primary bipolar hemiarthroplasty with the calcar-replacement design (Samo Company, 51 Sandgate Road, Albion QLD 4010) (Fig. 1f). The fracture type was classified according to the System of the Orthopedic Trauma Association (AO/OTA) [19]. Pertrochanteric two-part fractures are classified as A1-type, multipart fractures as A2-type and reversed oblique intertrochanteric fractures as A3-type fractures. Whereas all A1-type fractures are considered to be stable, most of the A2-type and all A3-type fractures are unstable. There were 12 female and five male patients. All patients were above the age of 60 years, with an average age of 66 years (range 62–74 years). All patients had confirmed osteoporosis on the preoperative bone mineral density scan (DEXA scan), confirming the WHO criteria [20].

Patients with associated fractures that might significantly affect the final functional outcome, patients who were nonambulatory before injury and patients with psychiatric disorders were excluded from the study. All patients were community ambulators before trauma and none of our patients had any significant pre-existing hip pathology. The follow-up period ranged from 9 months to 2 years, with a mean duration of 14 months. Nine of our patients had associated comorbidities (hypertension, $n = 5$ and diabetes, $n = 4$). Two patients had ischaemic heart disease.

The operative technique

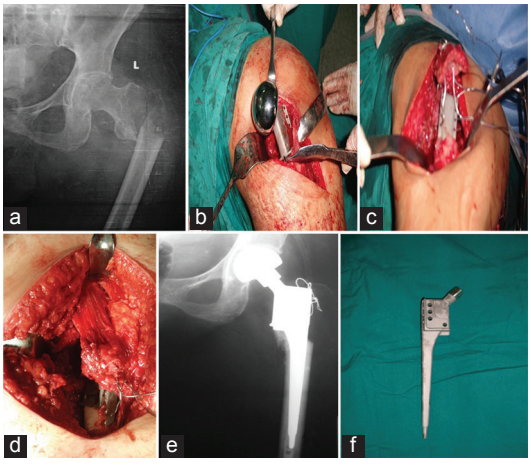
Patients were operated upon under spinal or general anaesthesia with the patient in the lateral decubitus using the lateral direct approach of Hardinge [21]. One assistant held the limb in traction to avoid further displacement of the fragments. The fracture anatomy was assessed, and the proximal fragment including the head and neck of the femur was delivered in the wound. Dissection of soft tissues was carried out, except of the attachment of the hip abductors in the greater trochanter (Fig. 2b). A cut was made in the greater trochanter to facilitate the dislocation of the femoral head. With removal of the proximal fragment, the fracture now had three main fragments, namely the greater trochanter, the lesser trochanter and the shaft. The acetabulum was inspected and cleaned from all contents. The femur was positioned by internal rotation and adduction. After careful detection, the femoral canal was prepared by graduated reaming using rasps with appropriate anteversion. With the trial prosthesis, in-situ traction was applied to the leg and compared with the opposite leg for limb length equality. The traction applied causes the femur to be pulled distally; a note of the distraction between the prosthesis and the femoral cut was made, and the level on the prosthesis was marked. This gives an idea of how much the femoral implant should sink into the proximal femur so as to achieve limb length at the time of final

cementing of the implant. The final confirmation of the leg length was made after the trial head and neck were used. The final prosthesis was inserted and positioned inside the femoral canal using a manual cementing technique. During the final fixation of the stem, the cemented stem was allowed to sink into the femoral canal up to the mark made on the prosthesis in the previous step. This step was especially required in cases where the lesser trochanter was fractured separate from the shaft portion. Fragments of the greater trochanter were fixed with the help of a stainless steel wire using the holes of the prosthesis (Fig. 1c and d). The calcar portion of the prosthesis comes with 3.5, 4.5 and 4.5 cm lengths, respectively, to substitute the defect of the calcar region. Isolated displaced fragments of the lesser trochanter were not reduced, but substituted with the prosthesis with the suitable calcar length. The range of motion and the stability were checked after reduction. All wound closures were carried out over the closed suction drain after achieving hemostasis.

Postoperative regimen

Perioperatively, all patients received the same prophylactic antibiotics and the same anticoagulation therapy with low-molecular-weight heparin and support stockings such as deep-vein thromboprophylaxis. Intravenous third-generation cephalosporin antibiotics were started on the day of surgery, with the first dose given preoperatively and continued till the third postoperative day. Postoperatively, the limb was kept in abduction using an abduction wedge. The haemoglobin level and the packed cell volume were assessed after 12 h of surgery. Blood transfusions were given wherever required. Drains were removed after 48 h and check films were performed. Breathing exercises and static exercises for calves, quadriceps and gluteal muscles were taught from the first day. Patients were allowed to sit and stand out of bed twice daily from the second postoperative day and range-of-motion exercises were started. Gait training was started from the third postoperative day whenever the general condition permitted. Patients were first ambulated with a walker, and then with a stick, and gradually progressed to ambulation without any support according to their recovery. All patients were instructed to avoid excessive flexion and adduction. A pillow was kept between the thighs during the night and an abduction brace was used during the daytime for the first 3 weeks to prevent excessive adduction. Dressing was changed on the third postoperative day and at the time of discharge. The patient was discharged after complete rehabilitation usually on the fifth day. Stitches were removed on the 14th day of the surgery. The period needed for each patient to full weight bearing and to return to the preoperative status were recorded.

Figure 1

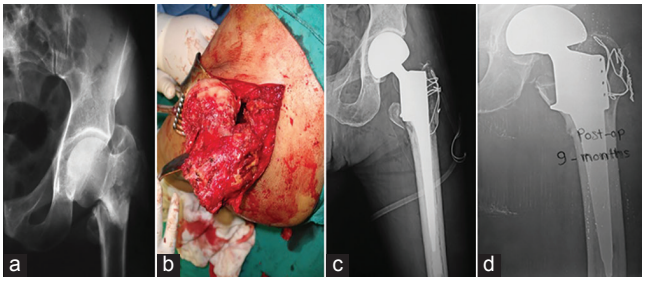


(a) Plain radiograph of the initial fracture. (b–d) Intraoperative photographs showing the bipolar hemiarthroplasty, the holes of the prosthesis with circulage wires for fixation of the greater trochanter and the reconstruction of the abductor mechanism. (e) Plain radiograph 9 months postoperatively. (f) A stem of the bipolar hemiarthroplasty.

Follow-up

All patients were followed up at regular intervals of 6 weeks, 3 months, 6 months and at 1 year and yearly thereafter for a mean of 14 months (average 9–24 months). At each follow-up visit, a clinicoradiological examination was performed, and the patient was evaluated using the Harris Hip Score (HHS) [22] and graded as <70 (poor), 70–79 (fair), 80–89 (good) and 90–100 (excellent). Anteroposterior radiographs of the hip were analysed at each follow-up to note the evidence of loosening. The clinical status at the time of the last follow-up was evaluated by assessing pain, the ambulatory status, the use of walking aids and the domestic situation. Measurement of both lower limbs was performed to detect any limb discrepancy. Loosening of the cemented femoral component was evaluated according to the criteria described by Harris

Figure 2



Plain radiograph of the initial fracture. (b) Intraoperative photographs showing the dissection of the proximal fragment except of abductors muscles. (c) Immediate postoperative plain radiograph of cemented bipolar prosthesis with the calcar substitution design. (d) Results 9 months postoperatively with signs of union.

et al. [23] and was graded as 'definite', 'probable', 'possible' or none.

Results

All patients were operated within 15 days (mean delay of 5 days; range 2–14 days), with delay due to patients presenting late or the time taken for patients to be fit for anaesthesia. The mean operative time was 115 min (range 90–160 min). The average intraoperative blood loss was 450 ml (range 300–950 ml). Three patients requiring postoperative blood transfusion; on an average, 2 U were required per patient. Patients walked on an average of 3.2 days after surgery (range 2–8 days). The average time taken to return to the preoperative status was 28 days (range 24–33 days). Two patients, who were known cases of ischaemic heart disease, died in the third and the fifth months postoperatively after myocardial infarction. Another two patients were lost due to unknown causes. The remaining 13 patients having a minimum of 9 months' follow-up were evaluated, and data were further analysed for only these 13 patients. The HHS was 72 at 6 weeks, 76 at 3 months, 79 at 6 months and 82 at 1 year. At the latest follow-up (mean 14 months; range 9–24 months), the mean HHS was 83 (range 58–97). A total of four patients were graded as excellent, six patients as good and three as fair. At the last follow-up, nine patients were walking without any aid, three patients had a limp and used a stick for walking and one patient used a walker. None of the patients showed implant loosening, femoral subsidence or deep wound infection up to the last follow-up. No patients had either shortening or lengthening of the operated limb. One patient had dislocation of the affected hip after 4 months of surgery caused by significant trauma and was managed by closed reduction. Another patient had superficial wound infection that settled down with a course of intravenous antibiotics for 2 weeks. Follow-up radiographs revealed acetabular erosion in two patients and nonunion of the greater trochanter in one patient. These three patients were ranked as having fair results.

Discussion

Many of the intertrochanteric fractures are stable two-part fractures that can be managed successfully with operative reduction and fixation, whereas about 35–40% are unstable three-part and four-part fractures or reverse oblique fractures that are associated with high rates of morbidity and mortality [6]. The reported overall failure rate with internal fixation in intertrochanteric fractures is 3–16.5%, and the rate is higher in unstable fractures, which is associated with a considerable incidence of complications [7,9]. The complications are related to restricted weight bearing and prolonged bed rest. In elderly patients, instability of the fractures and osteoporosis result in poor fixation, which cannot allow immediate weight bearing [9], and in these patients, there are some definite advantages of prosthetic replacement over reduction and fixation. Comparative studies found that rehabilitation was easier and faster, and the incidence of postoperative complications such as pulmonary embolism, deep venous thrombosis, pressure sores, pneumonia and atelectasis were significantly lower with arthroplasty [24–27]. These authors attributed their good results to early walking with full weight bearing.

Primary hip arthroplasty offers a modality of treatment that provides adequate fixation and allows early mobilization, thus preventing postoperative complications [11,17]. In addition, it eliminates the possibility of excessive collapse compromising walking function, malunion and the uncommon problems of nonunion and avascular necrosis [12].

Hemiarthroplasty has been used for unstable intertrochanteric fractures since 1971, although less frequently as compared with femoral neck fractures. Its initial use was as a salvage procedure for failed pinning or other complications [28]. Tronzo [29] claimed to be the first to use long, straight-stemmed prosthesis for the primary treatment of intertrochanteric fractures. Since then, there are multiple studies showing good results using this technique. Stern and Goldstein [30] used the Leinbach prosthesis for the primary treatment of 22 intertrochanteric fractures, and found early ambulation and early return to the prefracture status as a definite advantage. Harwin *et al.* [31] reported good results with the use of the Bateman-Leinbach bipolar prosthesis. Grimsrud *et al.* [13] studied 39 consecutive patients of unstable intertrochanteric fractures treated with a cemented bipolar hip arthroplasty. They concluded that these fractures can be treated with a standard femoral stem and cerclage cabling of the trochanters, and the technique allows safe and early weight bearing on the injured hip and had a relatively low rate of complications. Faldini *et al.* [14] reported the use of hemiarthroplasty and total hip replacement in 54 patients. They concluded that hip replacement permits a more rapid recovery with immediate weight bearing and facilitates better nursing care than other fixation techniques.

In the present study, as all of the patients were out of bed on an average of 3.2 days (range 2–8 days) postoperatively, and the recumbency time was minimal,

there were no complications related to bed rest among our patients.

Rodop *et al.* [11], in a study of primary bipolar hemiprosthesis for unstable intertrochanteric fractures in 37 elderly patients, obtained 17 (45%) excellent and 14 (37%) good results after 12 months according to the HHS system.

In our study, a total of 10 (77%) out of 13 patients had good to excellent results. Patients of this study showed progressive improvement in the HHS with time. All patients demonstrated good functional achievement despite their advanced age. Patients were able to perform their normal activities within 4 weeks postoperatively with the average time taken to return to preoperative status of 28 days (range 24–33 days). All our patients were community ambulators before injury and were nondependent for self-care. Postoperatively, 9/13 patients could walk without aid and 4/13 used an aid (n = 3 used stick, n = 1 used walker).

In this study, bipolar hemiarthroplasty with the calcar-replacement design was used in all patients. The advantage of this type of prostheses is that it replaces the deficient area at the calcar zone without the need for any reconstruction procedure. Hence, the prosthesis yields immediate stability without fear of subsidence. The design of the prosthesis offers three different lengths for the reconstructed area: 3.5, 4.5 and 5.5 cm, respectively. Hence, it restores the length of the injured limb. In this study, no patients had either shortening or lengthening of the operated limb. Sidhu *et al.* [16] treated 53 patients with unstable intertrochanteric fracture with total hip replacement, and a limb lengthening of 0.5–1.0 cm was noticed in 13 patients. Sancheti *et al.* [17] treated 37 cases with osteoporotic unstable intertrochanteric fractures with primary hemiarthroplasty, and they had 10 patients with shortening of the operated limb with an average of 1.1 cm (range 5–15 mm). The prosthesis also had the advantage of the presence of multiple side holes permitted for the fixation of the greater trochanter and the reconstruction of the abductor apparatus. In this study, only one patient had signs of nonunion of the greater trochanter and was ranked as having a fair result.

Acetabular erosion is a major risk associated with hemiarthroplasty [32]. Among the patients of this study, follow-up radiographs of two patients revealed acetabular erosion. These two patients had hip pain, and limited hip motion ranked them as having fair results, but none of them required any further surgical intervention till the end of the follow-up time. There is to date no study available that compares the outcomes of bipolar hemiarthroplasty and total hip replacement (THR) as a primary treatment for intertrochanteric hip fractures. However, the data from neck of femur fractures suggests that total hip arthroplasty is a better implant than hemiarthroplasty. Total hip arthroplasty demonstrates superior longevity when compared with hemiarthroplasty [33]. Compromised articular cartilage in the hips of normal elderly patients puts them at a greater risk [34]. Repeated articulations may lead to lesions in the acetabular cartilage severe enough to limit the activity, resulting in higher revision surgery [32].

The results of this modality of treatment are definitely promising, especially in view of the variable results of osteosynthesis in this group. The opponents of the technique stated increase blood loss, mechanical complications such as dislocation and infection as possible complications compared with conventional internal fixation. The earliest comparison of internal fixation and hemiarthroplasty was carried out by Haentjens *et al.* [24], showing a significant reduction in the incidence of pneumonia and pressure sores in those undergoing prosthetic replacement. In another comparative study of cone hemiarthroplasty against internal fixation, Kayali *et al.* [25] reached the conclusion that clinical results of both groups were similar, but patients with hemiarthroplasty were allowed full weight bearing significantly earlier than the internal fixation patients. Broos *et al.* [35] concluded that the operative time, blood loss and mortality rates were comparable between the two groups, with a slightly higher percentage (73 vs. 63%) of those receiving a prosthesis considered to be pain free. The functional outcome was comparable between both groups. Stappaerts *et al.* [26] found no difference between the two groups except a higher transfusion need in the replacement group. However, in the study of Kim *et al.* [36], which compared the calcar replacement prosthesis with intramedullary nailing in a prospective study involving two groups of 29 patients, they could not find any significant difference concerning the functional outcomes, but the cut-out rate of the hip screw was 7% in their patients.

In our series, the average intraoperative blood loss was 450 ml (range 300–950 ml) with only three patients requiring postoperative blood transfusion. There was one patient with superficial wound infection, which settled down with a course of intravenous antibiotics for 2 weeks.

Dislocation is a major concern after hip arthroplasty, and in patients with intertrochanteric fracture undergoing total hip arthroplasty, the reported rate of dislocation is 0–44.5% [25]. Postoperative dislocations are associated with a higher rate of pulmonary complications and

bed sores [12]. In this study, utmost intraoperative and postoperative precautions to minimize the risk of dislocation were considered. Intraoperatively, the proper reattachment of the greater trochanter with tension band wiring for the stability of the hip and proper functioning of the abductor mechanism was performed whenever indicated. The design of the prosthesis used in this study provides holes to facilitate the technique of circulage wiring. Postoperatively, for 3 weeks, we used an abduction wedge or pillow at night time and an abduction brace at day time besides physiotherapy and supervision in activities of daily living. None of our patients had dislocation in the immediate postoperative period. Dislocation was seen in one patient 4 months after surgery and it was caused by significant trauma and was managed by closed reduction and rest. The usage of this type of prosthesis aiming to neutralize muscle power around the hip and reconstruction of the abductor mechanism may be a contributing factor.

Conflicting reports about postoperative mortality in cases with primary hemiarthroplasty are cited in the literature. Kesmezacar *et al.* [27] reported postoperative mortality in 34.2% of the cases after a mean of 13 months and in 48.8% of the cases after a mean of 6 months in patients treated with internal fixation and endoprosthesis, respectively. Other studies have shown no differences in the postoperative mortality in the two groups [24–26]. Sidhu *et al.* [16] reported that only two patients out of the 37 (5.4%) died within 6 months of surgery due to unrelated causes, whereas Sancheti *et al.* [17] reported a 1-year mortality rate of 17%. In the present study, there was a mortality rate of 15% (2/17), which is comparable to that reported by other authors with the use of replacement or internal fixation [14,37]. Delay in surgery is an important predictor of mortality in patients with proximal femur fracture and also of the postoperative morbidity. However, in our study, we could not comment on this point because of the small sample size, and this is one of the limitations of our study. Further, inhomogeneous population in terms of the existing comorbidity and the prospective nature of our study are other limitations.

Conclusion

Primary hemiarthroplasty with calcar replacement is a valid treatment option for mobile and mentally healthy patients. The procedure offers quick recovery with little risk of mechanical failure, avoids the risks associated with internal fixation and enables the patient to maintain a good level of function beginning in the immediate postoperative period. It does provide a stable, pain-free and mobile joint with an acceptable complication rate as seen in our study; however, larger randomized control trials comparing the use of total hip arthroplasty with primary hemiarthroplasty for unstable osteoporotic fractures will be needed.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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