Endoprosthetic replacement for failed internally fixed intertrochanteric hip fractures

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Introduction
Hip arthroplasty may be indicated for certain complications of intertrochanteric hip fractures, such as failed fixation, nonunion, post-traumatic osteoarthrosis, perforation of the acetabulum by an internal fixation device and, rarely, avascular necrosis of the femoral head. The technique of hip arthroplasty after failed fixation is technically demanding, and it may introduce difficulties that are not ordinarily encountered with the procedure. The difficulty of the procedure is attributed to the presence of a previous implant, poor bone stock, bone deformity, scarred tissues and increased risk of infection. The challenges include the selection of the type of prostheses and managing the discontinuity of the greater trochanter. Moreover, the loss of anatomical landmarks makes assessment of limb length more difficult.

Aim of the work
The study was conducted to assess the results and complications of hemiarthroplasty or total hip arthroplasty after mechanical failure of internally fixed intertrochanteric hip fractures.

Patients and methods
Fifteen patients with failed treatment of intertrochanteric hip fractures were treated with hip arthroplasty. There were 10 women and five men with a mean age of 63 years (range 59–72 years). The study includes fractures that were primarily stabilized with dynamic hip screw in 13 patients and with condylar AO blade plate in two patients. The mean interval from initial fracture fixation to conversion arthroplasty was 7 months (range 3–19 months). In 11 out of 15 patients, bipolar hemiarthroplasty with cemented long-stem and calcar substitution design was performed, whereas cemented total hip arthroplasty was carried out in four cases.

Results
One patient died within 2 months, and the remaining 14 patients were followed up for a mean duration of 18 months (average, 7–30 months). There was marked pain relief in all the patients, but five patients had mild to moderate pain concentrated around the greater trochanter. Before surgery, all patients were unable to walk or had minimal walking ability with crutches; however, after surgery, only one patient needed the help of a walker, whereas four used a walking stick for ambulation. The mean Harris hip score was 34 (range 30–44) preoperatively and 83 (range 64–86) postoperatively. A statistically significant improvement was found on comparing preoperative and postoperative conditions ($P < 0.05$). One patient suffered a fracture in the proximal femoral canal during reaming and was treated with cerclage wires. Two patients presented an early dislocation after bipolar hemiarthroplasty: one patient was successfully treated by closed reduction, whereas the other underwent revision with an antidislocatable acetabular (constrained liner) cup because of recurrent dislocation. Deep wound infection was seen in one patient, which was treated with surgical debridement. Superficial wound infection was seen in another case and was treated conservatively.

Conclusion
Hip arthroplasty performed after failed internally fixed intertrochanteric hip fractures is a technically difficult procedure with a relatively high rate of perioperative complications and difficulties. However, despite that, it is an effective salvage procedure that markedly alleviated pain and improved function in the majority of these patients.

Keywords:
failed trochanteric fracture, hemiarthroplasty, hip arthroplasty

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Introduction

The incidence of all hip fractures is ~80 per 100 000 individuals; intertrochanteric fractures make up 45% 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 greatly increased the incidence of these fractures. Almost nine out of 10 proximal femur fractures occur in patients older than 65 years of age, and about three out of four occur in women [2]. Osteoporosis, medical comorbidities and increased incidence of trivial trauma increase the incidence and complicate the treatment of trochanteric hip fractures [3].

Although most intertrochanteric hip fractures can be treated successfully with reduction and internal

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fixation using either cortical or medullary fixation devices, in certain situations, in the presence of these devices, the fracture fails and this may require repeating the surgery. 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 [4]. The second surgery is mandatory because this failure leads to severe functional disability and pain, and it helps avoid the risks of complications affecting bedridden patients. Factors contributing to treatment failure include the initial fracture pattern, comminution, suboptimal fracture fixation and poor bone quality [4].

The two main treatment options for patients with a failed treatment of an intertrochanteric hip fracture are revision of internal fixation [5–7] and salvage treatment with hip arthroplasty [8–11]. Conversion of failed internally fixed trochanteric fractures to hip arthroplasty is indicated when the bone quality is poor, the head is damaged because of previous internal fixation, the quality of bone stock is poor or when there is significant limb shortening [12]. After hip arthroplasty, patients can bear weight immediately, 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 [13].

Despite these advantages, hip arthroplasty after failed intertrochanteric fracture is a difficult procedure, with a higher potential for complications. The difficulty of the procedure is attributed to the presence of a previous retained implant, poor bone stock that can compromise potential fixation, bone deformity, scarred tissues and increased risk of infection, as well as to the fact that these elderly patients by virtue of their age may have retarded fracture healing [14]. The challenges include the selection of the type of prostheses and managing the discontinuity of the greater trochanter. Moreover, the loss of anatomical landmarks makes assessment of limb length more difficult. The purpose of this study was to evaluate the short-term functional outcome, technical difficulties and complications associated with hip arthroplasty performed as a salvage procedure after failed internally fixed intertrochanteric hip fractures.

Patients and methods

Fifteen patients with failed fixation of intertrochanteric hip fractures owing to either established nonunion or implant failure were enrolled in the study and treated by means of hip arthroplasty at Suez-Canal university hospital between March 2008 and June 2010. Both intracapsular femoral neck fractures and extracapsular subtrochanteric fractures were excluded from the study. There were 10 women and five men with a mean age of 63 years (range 59–72 years). Fractures were primarily stabilized with dynamic hip screw (DHS) in 13 patients and with a 95° AO condylar blade plate in two patients. The mean interval from initial fracture fixation to conversion arthroplasty was 7 months (range 3–19 months). Among patients treated with a DHS, failure occurred for cut-out of the lag screw in 11 cases and for nonunion in two cases. In the two patients treated with blade-plate assembly, failure occurred owing to cut-out of the blade portion of the implant. In all cases, failure of the primary implant occurred within 1 year.

All patients underwent preoperative detailed clinical examination and were evaluated for medical comorbidities. Eight patients (53%) had a total of 12 perioperative medical complications: seven patients had hypertension, three patients had diabetes and two had ischaemic heart disease. The patients' medical history, operative notes, discharge summaries and previous and fresh radiographs were retrospectively reviewed. Occult infection as a cause of failure is always considered and a complete preoperative blood count with differential determination of erythrocyte sedimentation rate and C-reactive protein was performed.

Surgical technique

Patients were operated upon under spinal or general anaesthesia, with the patient in lateral decubitus, using the lateral direct approach of Hardinge [15]. Draping of the surgical field was done twice: first before implant extraction and second after metalwork removal. An attempt was made to incorporate the previous scar in the incision, but if this was not possible a fresh incision was made. Implants were removed and meticulous debridement of all tissues in contact with the implants was performed. Removal of fracture screws required the use of a trephine and a special set for broken screws in two cases. In another patient, difficulty was encountered in removing the screws from the plate, and the screw heads had to be cut to remove the plate. Copious irrigation with normal saline was carried out, and the bony defects in femur and acetabulum were assessed. The removed screws were impeded in antiseptic solution (Cidex solution) for later use. The surgical drapes were completely changed. A dissection of soft tissues was carried out, except for attachment of the hip abductors in the greater trochanter. The proximal fragment including the head and neck of the femur was delivered in the wound. A cut was made in the greater trochanter to facilitate dislocation of the femoral head. The acetabulum was inspected and cleaned of all contents. The implant selection depended on the condition of the bones as seen in preoperative radiographs, on intraoperative findings and on patients' general condition and affordability. Acetabular resurfacing was performed in four patients in whom there was marked damage of acetabular cartilage. In those four patients, long posterior wall acetabular cups were used. An acetabular cup was used with a cemented long-stem calcar substitution design in two patients and with a cemented standard stem in another two patients. In the remaining 11 patients, bipolar hemiarthroplasty with a cemented long-stem and calcar substitution design (Leinbach prosthesis from Orcer) was used. The stem came in 15, 17 and 20 cm lengths. Autograft from the excised bone was used in two cases: to reconstruct the femoral calcar region in a patient with a calcar defect and in another patient to fill up the bony defect in the acetabulum. To prevent cement extrusion from the holes made by the screws, the technique recommended by Patterson *et al*. [16] was used. The screw holes in the lateral femoral cortex were visualized. The screws, which had been removed earlier, were shortened to a length approximately equal to the width of the lateral femoral cortex with a large wire cutter or Harrington rod cutter. Next, they were inserted so that the cut ends were flush with the endosteal surface, as determined by observation of the medullary canal by visual inspection using an intramedullary light or by the use of a long curette to ensure that they do not encroach into the canal. A dowel-shaped bone graft from the femoral head was used to fill the defect in the cortex caused by removal of the DHS or blade portion of the device. 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. A trial prosthetic component was introduced into the canal to ensure that it clears the screws, and then traction was applied to the leg and compared with the opposite leg for limb length equality. Applied traction causes the femur to be pulled distally, and a note of 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 done after the trial head and neck were used. The intramedullary cement restrictor was placed and 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 in the femoral canal up to the mark made on the prosthesis in the previous step. This step was especially required in cases in which the lesser trochanter was separated from the main femoral portion. The screws were removed when the implant was in place and the cement had fully set. Bone graft from the femoral head remnant was packed into the screw holes, but there was some cement extrusion from the medial side. Attention was paid to maintain the integrity of the abductor mechanism; the greater trochanter fixation was performed by tension band wiring in seven patients who underwent bipolar hemiarthroplasty and in two patients who underwent total hip arthroplasty. Leinbach hemiarthroplasty prosthesis had a hole to help for stainless steel wire fixation. Attempts were not made to fix the isolated displaced fragments of the lesser trochanter. There was one femoral fracture during preparation of the femoral canal, which was successfully treated by cerclage wiring. Range of motion and 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 as deep-vein thromboprophylaxis.

Intravenous third-generation cephalosporin antibiotics were started on the day of surgery, with the first dose given preoperatively and continued until the third postoperative day. Postoperatively, the limb was kept in abduction by using an abduction wedge. Haemoglobin level and packed cell volume were assessed 12 h after surgery. Blood transfusions were given wherever required. Drains were removed after 48 h, and check films were done. The 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 begun. Gait training was started from the third postoperative day. Patients were first ambulated with a walker and then with a stick and they gradually progressed to ambulation without any support according to their recovery. Dressing was changed on the third postoperative day and at the time of discharge on the fifth day. An abduction wedge or a pillow was kept between the thighs during the night for the first 3 weeks to prevent excessive adduction. An abduction brace was used during the daytime for the nine patients with greater trochanter fixation. Stitches were removed on the 14th day of surgery. All patients were instructed to avoid excessive flexion and adduction.

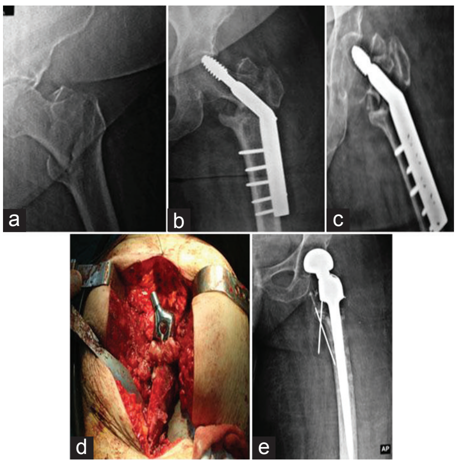
Follow-up

All patients were followed up at regular intervals of 6 weeks, 3, 6 months and at 1 year and yearly thereafter for a mean of 18 months (average, 7–30 months). A follow-up sheet was filled and clinical and radiological results were recorded at each visit. Clinical status at the time of last follow-up was evaluated by assessing pain, ambulatory status, the use of walking aids and the domestic situation. Harris hip scores (HHS) [17] were used for preoperative and postoperative evaluation. Postoperative radiographs were evaluated for component position, cemented component fixation and component loosening. Loosening of the cemented femoral component was evaluated according to the criteria described by Harris *et al*. [18] and was graded as 'definite', 'probable', 'possible' or none. Radiological loosening of the acetabular component was classified according to the criteria proposed by Hodgekinson *et al*. [19]. An acetabular component was considered to be loose if a continuous radiolucent line was evident in all three zones, or if the acetabular component had migrated. Migration of an acetabular component was defined by a change in the opening angle of more than 8° or a difference in the component position of greater than 3 mm when comparable radiographs were compared (Figs 1–3).

Results

One patient died of cardiovascular disease within the first 2 months with the implant intact. The mean operating time for hip arthroplasty was 175 min (range 130–210 min), which included the time to remove the retained hardware and to change the surgical draping. The mean estimated blood loss was 600 ml (range 400–0.1800 ml). Five patients required postoperative blood transfusion on an average, and two units were required per patient. Trochanteric wiring was carried out in nine patients.

Figure 1



(a, b) AP plain radiograph of the initial fracture and 3 months postreduction and internal fixation. (c) Plain radiograph taken 9 months after surgery revealed failed fixation. (d) Intraoperative photographs showing the long-stem calcar substitution design (Leinbach) prosthesis. (e) Plain radiograph of the same prosthesis with calcar reconstruction by part from the femoral head fixed by two Kirschner wires. AP, anteroposterior.

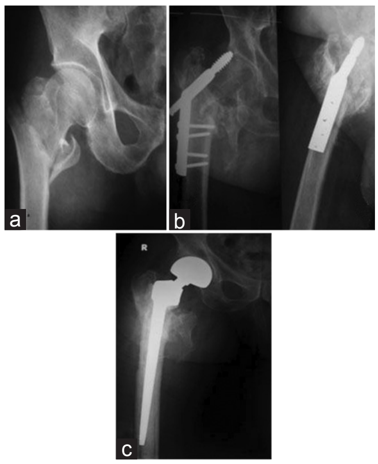
Functional outcomes

Before the hip arthroplasty, all patients had moderate or severe pain in the hip and were unable to walk or had minimal walking ability with crutches. At the time of the most recent follow-up, nine (62%) of 14 patients had no pain, whereas two patients reported moderate pain and three patients reported mild pain; in all of these patients, the pain was in the region of the greater trochanter. Nine (62%) of 14 patients were able to walk without support; one patient was using a walker, whereas four were using a walking stick for ambulation. The mean HHS was 34 (range 30–44, SD 2.4) preoperatively, and it improved to 83 (range 64–86, SD 6.1) postoperatively. In 3/14 (21.4%) cases, the postoperative HHS was between 90 and 100, in 7/14 (50%) it was between 80 and 89 and in 4/14 (28.5%) it was between 70 and 79. In no case was the HHS poor. A statistically significant improvement in both scores was found on comparing preoperative and postoperative conditions ($P < 0.05$).

Radiographic results

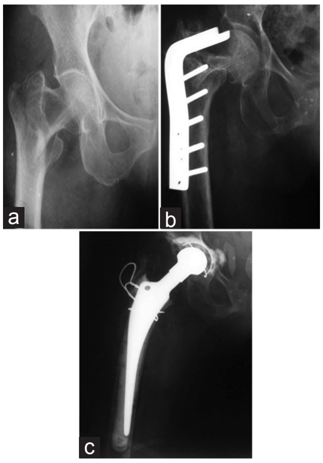
Radiographs were available for all patients at least 7 months postoperatively. In no cases were component malpositioning or dislocations and aseptic loosening detected. Stable nonprogressive radiolucent lines were found around the cup in one case and around the stem in another case with bipolar prosthesis. Clinically, the patients were asymptomatic in both cases.

Figure 2



(a) Plain radiograph of the initial fracture. (b) Plain radiograph of failed DHS fixation. (c) Plain radiograph of cemented long-stem prosthesis with calcar substitution design. DHS, dynamic hip screw.

Figure 3



(a) Plain radiograph of the initial fracture. (b) Plain radiograph of failed 95° Condylar blade-plate fixation. (c) Plain radiograph of cemented THR with sign of nonunion of the greater trochanter.

Intraoperative difficulties

In two patients, removal of fracture screws required the use of a trephine and a special set for broken screws. In another patient, difficulty was encountered in removing the screws from the plate, and the screw heads had to be cut to remove the plate. Autogenous bone grafting was required to reconstruct a defect in the acetabulum in one case. In another case, a bone graft was required to reconstruct the calcar region because of a defect in the posteromedial region despite using long-stem prosthesis with calcar substitution design.

Complications

One patient had a nondisplaced proximal femoral fracture during preparation of the femoral canal, which was successfully treated by cerclage wiring. Two patients presented an early dislocation after bipolar hemiarthroplasty. One patient was successfully treated by closed reduction, whereas the other patient underwent revision with an antidislocatable (constrained liner) acetabular component because of recurrent dislocation. Deep wound infection was seen in one patient and was treated with surgical debridement, pressure-suction lavage and insertion of an antibiotic sheet. Postoperative antibiotics were given and repeated dressings were done. The prosthesis was retained and infection was controlled in 3 months. The patient was also a known diabetic. Superficial wound infection was seen in another case and was treated conservatively with antiseptic dressings and antibiotics only.

Discussion

Although most intertrochanteric hip fractures can be treated successfully with reduction and internal fixation using either medullary or cortical fixation devices, failed treatment of these fractures typically leads to severe functional disability and pain [20]. Failure of intertrochanteric fracture fixation often occurs in patients who have poor bone quality, severe osteoporosis or unstable fracture patterns [21]. The reported failure rate with internal fixation is in the range of 3–12%, with device penetration (2–12%), nonunion (2–5%) and malunion causing varus deformity (5–11%) [4]. Salvage options consist of either revision of internal fixation or proximal femoral replacement with or without acetabular resurfacing. Factors that guide the choice of salvage treatment include the anatomic site of the mechanical failure, the quality of the remaining proximal bone and articular surface and patient factors (such as age and activity level) [21]. In the younger patients with a well-preserved hip joint, treatment typically involves revision of internal fixation with or without osteotomy or bone grafting [6,7]. However, in older patients, it is more common to encounter poor remaining proximal bone stock or a badly damaged hip joint from hardware cut-out. In this situation, salvage by replacement is more optimum [4].

In this study, the average age of the patients was 63 years (range 59–72 years); most of our patients had limited activity levels either due to failed treatment of initial fractures or due to medical comorbidities. We encountered 12 medical complications among eight patients in this study.

An intertrochanteric fracture for which treatment has failed poses a difficult and unique challenge to the orthopaedic surgeon, especially if he or she is planning to perform conversion hip arthroplasty. The challenges include the need for selecting the femoral implant, acetabular resurfacing if indicated and managing discontinuity of the greater trochanter. Furthermore, there are additional technical challenges that may be encountered, such as broken hardware, bone deformity and femoral or acetabular bone defects. Loss of anatomical landmarks, for example lesser trochanter, makes assessment of limb length more difficult. Autograft, allograft or head-and-neck substitution components should be available for reconstruction of bone defects and to restore limb length. The extrusion of bone cement from the holes of the removed screws must be considered [11]. The nonunited head-and-neck fragments are usually in a deformed position and must be mobilized before being excised. This process requires careful dissection to avoid damaging nearby neurovascular structures and muscles. Extreme care must be taken to avoid fracture and penetration of the femoral shaft [14]. Because of all these reasons, the technique is associated with a high incidence of intraoperative and postoperative complications.

In the present study, the choice of the type of prosthesis used depended on preoperative radiography and intraoperative findings besides the affordability of the prostheses. Cemented long-stem prostheses with calcar substitution were used in 13/15 cases (11 hemibipolar and two total). The rationale behind this choice was to restore the bone deficiency present at the calcar region due to failed treatment, bypass cortical defects left at the site of failed fixation devices, and bridge the hole of the distal screw. There were four patients with destruction of the articular cartilage of the acetabulum, and in those patients acetabulum resurfacing was performed. When good articular cartilage remains, bipolar hemiarthroplasty may afford better stability and will be a smaller operation for patients with multiple comorbidities and low functional demands.

The choice between hemiarthroplasty and total hip arthroplasty in patients with limited activity levels is not clear. Ch *et al.* [22] in a retrospective comparative study between total hip arthroplasty and bipolar hemiarthroplasty (nine patients in each group) postulated that THR seems to be a more reliable salvage procedure for failed fixed intertrochanteric fracture both in functional outcome and pain relief. To reach a conclusion on this issue, controlled randomized studies with a larger number of patients are required.

The surgeon who is faced with failed internal fixation of an intertrochanteric fracture should consider occult infection as a potential cause of the failure. Infection rates generally increase in already operated areas and with additional hardware [23]. To minimize the risk of infection in this study, two procedures were performed: first a preoperative complete laboratory workup was carried out, which involved a complete blood count with differential determination of the erythrocyte sedimentation rate and C-reactive protein level, and second, after hardware removal and debridement of all tissues that were in contact with the implants, a copious irrigation with normal saline was performed and the surgical draping was changed completely. Despite these precautionary measures, we encountered two cases of wound infection: deep wound infection was seen in one patient and superficial wound infection in another case. Srivastav *et al.* [8] treated 21 hips in 20 patients with total hip arthroplasty and also two cases of wound infection.

Many specific problems may occur during conversion of failed internal fixation of intertrochanteric fractures to hip arthroplasty. The anatomy of the proximal femur is usually distorted, especially if the reduction in the hip fracture is imperfect, or if there is comminution of the medial bony buttress. The bone quality is usually poor as a result of pre-existing osteoporosis, which further decreases as a result of disuse after the failure of internal fixation. All these factors can contribute to intraoperative femoral fractures during canal preparation [12]. In this study, we had one femoral nondisplaced fracture during preparation of the femoral canal, which was successfully treated by cerclage wiring. Haidukewych and Berry [23] treated 60 patients with three different types of hip arthroplasties, and they had two cases of intraoperative femoral fractures.

The potential problems associated with the voids that remain in the femoral cortex after the removal of hardware devices include the development of stress raisers, suboptimum pressurization of cement and poor remodelling of the cortical bone in the areas of transcortical extrusion of cement. That is why cortical holes left by previous screws should be plugged, if possible, when a cemented stem is used to decrease the stress risers and minimize the risk of femoral fracture [24]. In this study, we used the technique recommended by Patterson *et al.* [16] to fill the holes made by the screws. The method was easily performed with readily available materials and instruments. Until the end of an average follow-up of 18 months, there were no cases of periprostheic fractures in the patients of this study.

Dislocation is a major concern after total hip arthroplasty in patients with intertrochanteric fracture undergoing total hip arthroplasty; the reported rate of dislocation is 0–44.5% [25]. Postoperative dislocations can adversely affect the ambulatory function, and this is associated with a higher rate of pulmonary complications and bed sores [26]. One leading cause is the greater trochanter, which either is not solidly healed or can be fragmented again during hip arthroplasty, thus affecting the abduction function [11]. In this study, utmost intraoperative and postoperative precautions to minimize the risk of dislocation were considered. Intraoperatively, this included the use of an acetabular component with a long posterior wall in the four patients who underwent total hip replacement. Proper reattachment of the trochanter with tension band wiring in nine cases was performed for the stability of the hip and for proper functioning of the abductor mechanism. The design of long-stem prostheses with calcar substitution provides holes to facilitate the technique of circulage wiring. Postoperatively, for 3 weeks we used an abduction wedge or pillow at night and an abduction brace during the day, besides physiotherapy and supervision during activities of daily living. In our series there were two dislocations, out of which one was managed surgically and the other was managed conservatively. Haidukewych and Berry [23] had one patient who had two dislocations, both of which were treated with closed reduction.

In the present study, before hip arthroplasty, all patients had moderate or severe pain in the hip and were unable to walk or had minimal walking ability with crutches. The majority of our patients had good pain relief and marked functional improvement. Two patients reported moderate pain, whereas three patients reported mild pain. Pain in these patients concentrated mainly around the greater trochanter. The most common apparent cause was trochanteric bursitis or nonunion. After surgery, one patient required the aid of a walker, whereas four used a walking stick for ambulation. We had good and excellent results in 70% (10/14) of cases, which is in agreement with previous published results. The preservation of the functional continuity of the abduction apparatus during surgery and the early walking with full unrestricted weight-bearing made possible by the arthroplasty are considered to be the major contributing factors to these results. Stoffelen *et al.* [27] reported on seven patients who had undergone arthroplasty for the treatment of an intertrochanteric nonunion; five (71%) patients had good or excellent results. D'Arrigo *et al.* [8] treated 21 failed intertrochanteric fractures, using THR with long and standard stems in 19 patients and bipolar in two patients. The mean HHS was 37 preoperatively and 81 postoperatively, and in one case the HHS was poor. Haidukewych and Berry [23] treated 60 patients after the failed treatment of an intertrochanteric fracture by total, bipolar and monopolar hip arthroplasty. Only 44 patients were available for follow-up for a mean of 5 years: 39 patients had no or mild pain and five had moderate or severe pain. Forty patients were able to walk, 26 with one-arm support or less. A total of five reoperations were performed. Mehlhoff *et al.* [28] reported on 13 patients who underwent a total hip arthroplasty after failed intertrochanteric fixation. Only five patients had good or excellent results, three patients had a dislocation and two patients had a revision because of instability. Hammad *et al.* [9] treated 32 patients with total hip replacement after failed treatment of intertrochanteric fractures. Twenty-two patients had either no pain or mild pain, and 24 patients were able to walk freely with or without support. Almost 78% of their patients had either excellent or good clinical results based on the HHS.

Several authors have found THA for failed intertrochanteric fractures to be more difficult, with a higher potential for complications than primary THAs or THA for failed femoral neck fracture [8,10,29]. The reported complications from published series are deep wound infection, periprosthetic fracture, dislocation, early implant failure and a high reoperation rate. To the best of our knowledge, there is no comparative study on hip arthroplasty for the treatment of intertrochanteric fractures as a primary replacement and as salvage procedure for cases with failed treatment. Mortazavi *et al.* [6] in a recent study compared THA in patients with prior femoral neck fractures (83 patients) versus 69 patients (71 hips) with prior intertrochanteric fractures. They concluded that THA in patients with prior intertrochanteric fractures presented a more technically demanding procedure with longer operative times and larger amounts of blood loss. In a previous study conducted in our hospital (El-Ghandour, personal communication) for the treatment of unstable trochanteric fractures treated by bipolar hemiarthroplasty, the mean operative time was 115 min (range, 90–160 min), versus 175 min (range 130–210 min) in this study, whereas the average intraoperative blood loss was 450 ml (range, 300–950 ml), versus blood loss of an average of 600 ml (range 400–0.1800 ml) in this study. The average longer duration of about 60 min in this study included the time to remove the retained hardware, the time to change the surgical draping and the time to treat the voids of removed screws. The average increase of 150 ml blood loss in this study is most probably attributed to the dissection of the previously operated proximal femoral segment. The reported number of complications in the previous study was 2/13 with no reoperation, whereas the reported number of complications in this study was 5/14 with a reoperation rate of 2/14. We detected five intraoperative and postoperative complications, with two cases for reoperation, an incidence in agreement with the findings of Tabsh *et al.* [29]. We encountered five intraoperative difficulties: three during hardware removal and two cases requiring bone reconstruction for bone defects. However, despite the technical challenges and difficulties associated with the performance of hip arthroplasty in these patients, there was a surprisingly low rate of serious orthopaedic complications.

The strength of this study lies in the fact that we used two types of prostheses for the treatment of only one group of patients. The objectivity of the choice of implants is based mainly on the intraoperative findings. The study focused on failed internally fixed intertrochanteric hip fractures with exclusion of intracapsular neck and extracapsular subtrochanteric fractures. Furthermore, all procedures in this study were performed with the same surgical approach and technique. Most published studies have used either total hip arthroplasty or bipolar prostheses for failed treatment of proximal femoral fractures, including femoral neck and/or subtrochanteric fractures. Stoffelen *et al.* [27] and Hentjens *et al.* [13] used total and hemiarthroplasty for failed treatment of intertrochanteric and subtrochanteric hip fractures. Mortazavi *et al.* [11], Mehlhoff *et al.* [28], Tabsh *et al.* [29] and Srivastav *et al.* [8] used THR for the treatment of both intertrochanteric and subtrochanteric hip fractures. The weakness of this study includes the relatively small groups of patients (15 patients), the shorter follow-up time (average 18 months) and finally the diversity in the implant fixation methods in the primary treatment of the fracture (DHS in 13 patients and 95° condylar blade plate in two patients).

On the basis of the results of this study, hip arthroplasty with either bipolar or total endoprosthesis seems to be a satisfactory salvage procedure after failed treatment of an intertrochanteric fracture. However, this procedure performed as a revision of an intertrochanteric fracture is technically more demanding with a longer operative time and increased incidence of perioperative complications. Despite the technical challenges, in this study there were surprisingly no serious orthopaedic complications and the clinical outcomes were acceptable.

Conclusion

Hip arthroplasty is an effective salvage procedure after the failed treatment of an intertrochanteric hip fracture. A calcar replacement and long-stem implants were often required for these patients. It is technically more difficult than routine primary total hip arthroplasty. Despite the technical challenges and intraoperative difficulties, there were surprisingly no serious orthopaedic complications. The majority of our patients had good pain relief and marked functional improvement. The operation allowed most patients to regain function that otherwise had been lost, which is the hallmark of an effective salvage procedure.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

References

1 Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? J Bone Joint Surg Am 2005; 87-A:483–489.

2 Kannus P, Parkkari J, Sievδnen H, Heinonen A, Vuori I, Jδrvinen M. Epidemiology of hip fractures. Bone 1996; 18:57S–63S.

3 Lorich DG, Geller DS, Nielson JH. Osteoporotic pertrochanteric hip fractures. J Bone Joint Surg 2004; 86-A:398–410.

4 Davis TR, Sher JL, Horsman A, Simpson M, Porter BB, Checketts RG. Intertrochanteric femoral fractures. Mechanical failure after internal fixation. J Bone Joint Surg Br 1990; 72-B:26–32.

5 Sarathy MP, Madhavan P, Ravichandran KM. Nonunion of intertrochanteric fractures of the femur. Treatment by modified medial displacement and valgus osteotomy. J Bone Joint Surg Br 1995; 77-B:90–92.

6 Wu CC, Shih CH, Chen WJ, Tai CL. Treatment of cutout of a lag screw of a dynamic hip screw in an intertrochanteric fracture. Arch Orthop Trauma Surg 1998; 117:193–196.

7 Said GS, Farouk O, El-Sayed A, Said HG. Salvage of failed dynamic hip screw fixation of intertrochanteric fractures. Injury 2006; 37:194–202.

8 Srivastav S, Mitta V, Agarwal S. Total hip arthroplasty following failed fixation of proximal hip fractures. Indian J Orthop 2008; 42:279–286.

9 Hammad A, Abdel-Aal A, Said HG, Bakr H. Total hip arthroplasty following failure of dynamic hip screw fixation of fractures of the proximal femur. Acta Orthop Belg 2008; 74:788–792.

10 D'Arrigo C, Perugia D, Carcangiu A, Monaco E, Speranza A, Ferretti A. Hip arthroplasty for failed treatment of proximal femoral fractures. Int Orthop 2010; 34:939–942.

11 Mortazavi SMR, Greenky M, Bican O, Kane P, Parvizi J, Hozack WJ. Total hip arthroplasty after prior surgical treatment of hip fracture is it always challenging? J Arthroplasty 2012; 27:31–36.

12 Laffosse JM, Molinier F, Tricoire JL, Bonnevialle N, Chiron P, Puget J. Cementless modular hip arthroplasty as a salvage operation for failed internal fixation of trochanteric fractures in elderly patients. Acta Orthop Belg 2007; 73:729–736.

13 Hentjens P, Castelejens PP, Opdecam P. Hip arthroplasty for failed internal fixation of intertrochanteric and subtrochanteric fractures in the elderly patient. Acta Orthop Trauma Surg 1994; 113:222–227.

14 Patterson BM, Lieberman JR, Salvati EA. Intraoperative complications during total hip arthroplasty. Orthopedics 1995; 18:1089–1095.

15 Hardinge K The direct lateral approach to the hip. J Bone Joint Surg 1982; 64-B:17–19.

16 Patterson BM, Salvati EA, Huo MH. Total hip arthroplasty for complications of intertrochanteric fracture: a technical note. J Bone Joint Surg 1990; 72-A:776–777.

17 Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg 1969; 51-A:737–755.

18 Harris WH, McCarthy JCJr, O'Neill DA. Femoral component loosening using contemporary techniques of femoral stem fixation. J Bone Joint Surg Am 1982; 64-A:1063–1067.

19 Hodgekinson JP, Shelly P, Wroblewsky BM. The correlation between the roentgenographic appearance and operative findings at the bone-cement junction of the socket in Charnley low friction arthroplasty. Clin Orthop Relat Res 1988; 228:105–109.

20 Jeffrey O, Anglen JO, Weinstein JN. Nail or plate fixation of intertrochanteric hip fractures: changing pattern of practice. J Bone Joint Surg Am 2008; 90-A:700–707.

21 Kim WY, Han CH, Park JI, Kim JY. Failure of intertrochanteric fracture fixation with a dynamic hip screw in relation to pre-operative fracture stability and osteoporosis. Int Orthop 2001; 25:360–362.

22 Ch C, Sh Y, Sy K. Better functional outcome of salvage THA than bipolar hemiarthroplasty for failed intertrochanteric femur fracture fixation. Orthopedics 2010; 33:721–726.

23 Haidukewych GJ, Berry DJP. Hip arthroplasty for salvage of failed treatment of intertrochanteric hip fractures. J Bone Joint Surg Am 2003; 85-A:899–905.

24 Eschenroeder HCJr, Krackow KA. Late onset femoral stress fracture associated with extruded cement following hip arthroplasty. A case report. Clin Orthop Relat Res 1988; 236:210–213.

25 Haentjens P, Casteleyn PP, De Boeck H, Handelberg F, Opdecam P. Treatment of unstable intertrochanteric and subtrochanteric fractures in elderly patients. Primary bipolar arthroplasty compared with internal fixation. J Bone Joint Surg Am 1989; 71-A:1214–1225.

26 Haentjens P, Lamraski G. Endoprosthetic replacement of unstable, comminuted intertrochanteric fracture of the femur in the elderly, osteoporotic patient. Disabil Rehabil 2005; 27:1167–1180.

27 Stoffelen D, Haentjens P, Reynders P, Casteleyen PP, Broos P, Opdecam P. Hip arthroplasty for failed internal fixation of intertrochanteric and subtrochanteric fractures in the elderly patient. Acta Orthop Trauma Surg 1998; 117:193–196.

28 Mehlhoff T, Landon GC, Tullos HS. Total hip arthroplasty for complications of intertrochanteric fractures. Clin Orthop Relat Res 1991; 269:32–37.

29 Tabsh I, Waddell JP, Morton J. Total hip arthroplasty for complications of proximal femoral fractures. J Orthop Trauma 1997; 11:166–169.