Conversion arthroplasty after failed dynamic hip screw fixation of intertrochanteric fractures

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Background
Failed treatment of intertrochanteric fractures typically leads to profound functional disability and pain. Factors that guide the choice of salvage treatment include the anatomic site of nonunion, the quality of the remaining bone and articular surface, and patient factors (such as age and activity level).
Patients and methods
Between 2010 and 2013, 30 patients (seven women and 23 men) with a mean age of 60 years (range: 50–70 years) were treated at the Orthopedic Department of Beni Suef University, following failure of internal fixation with dynamic hip screw of intertrochanteric fracture, using prosthetic replacement (12 bipolar hemiarthoplasty and 18 total hip replacement). The average follow-up was 14 months (range: 3–26 months).
Results
At the end of follow-up, nine hips had excellent results, 11 had good result, five had fair results, and five had poor results according to Harris hip score.
Conclusion
Hip arthroplasty is an effective salvage procedure after the failed treatment of an intertrochanteric fracture in older patients.

Keywords:
dynamic hip screw, failure, total hip arthroplasty, trochanteric fracture

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Introduction

Trochanteric fractures are the most common fractures of the hip, in the elderly patients, usually owing to low-energy trauma. These fractures are usually associated with high rate of morbidity, mortality, malunion, and implant failure [1].

These fractures are classified as stable and unstable; the most significant factors for instability and fixation failure are loss of posteromedial support, subtrochanteric extension of the fracture, severe comminution, reverse oblique fracture, shattered lateral wall, extension into femoral neck area, and poor bone quality [2].

The dynamic hip screw (DHS) is still the most common used implant in the treatment of trochanteric fractures [3].

Failure rate up to 56% has been reported, related with certain problematic fracture pattern, comminution, poor bone quality, inadequate fracture reduction without good contact of bone fragments, varus displacement, and improper placement of the lag screw [4].

The reasons for failed DHS fixation of trochanteric fractures are cutout of the lag screw from the femoral head, lift-off of the plate from the femur, and excessive lag-screw sliding with medialization of the distal fracture fragment [4,5].

Salvage procedures after failed DHS depend on the physiological age of the patient, quality of the bone, and condition of the femoral head and the acetabulum. If the patient is young and fit and there is still good bone stock in the femoral head, revision internal fixation is done. If the patient is fragile and the femoral head is found excavated from the previous internal fixation, replacement arthroplasty is decided [4].

The aim of this study is to evaluate the result of surgical salvage procedure for failed DHS fixation of intertrochanteric fractures (conversion arthroplasty).

Patients and methods

A total of 30 patients with failed DHS fixation of trochanteric fractures had been treated at Beni Suef University Hospital from January 2010 to February

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2013. The mean follow-up period was 14 months (range: 6–26 months). This study approved by the Ethical committee of Faculty of Medicine, Beni Suef University, Beni Suef, Egypt.

Indications include fracture nonunion, lag-screw cut-through, fracture collapse with hardware failure and/or femoral head, or acetabular cartilage osteoarthritis or damage. Patients with pathological fractures were not included.

Overall, 23 males and seven females with a mean age of 60 years (range: 50–70 years) were included, There were 16 (53%) right hips and 14 (47%) left hips.

A total of 19 (64%) patients developed fixation failure between 12 and 24 weeks. Meanwhile, 23% had their failure before that time, and only 13% after the same time.

Most of cases showed failure in the form of lag cutout, with 16 cases, followed by loose fixation and broken metal, with eight and six cases, respectively.

Moreover, 12 patients were managed with bipolar arthroplasty, whereas the remaining 18 cases were managed with total hip arthroplasty (THA).

Operative procedure

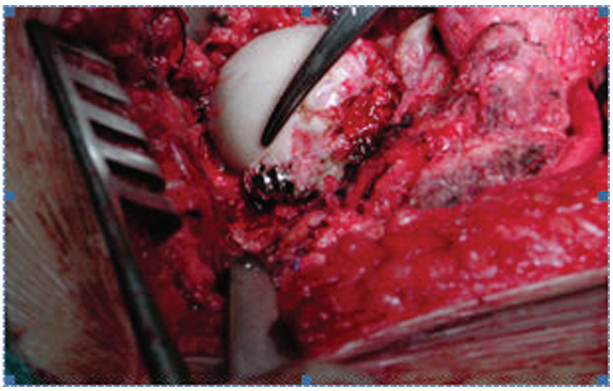
Hardinge's lateral approach was used in all patients.

The implants were removed with different techniques. In most cases (14 patients), hip dislocation was done after cutting the neck *in situ*; after removal, the implant together with proper capsular and tissue release allowed good and safe hip dislocation and acetabular exposure with no intraoperative femoral torsional fractures. In other cases, the implants fixing the fracture were left in place, and hip dislocation was done with proper soft tissue release (Fig. 1).

After hip dislocation and removal of the head, the decision centered on using hemiarthroplasty or total arthroplasty according to the condition of the acetabular cartilage. If there was a small defect, it was managed by reshaped autogenous bone graft from the femoral head with reaming if needed. The choice of using a cemented or a cementless cup depended on the patient age and bone quality (Fig. 2).

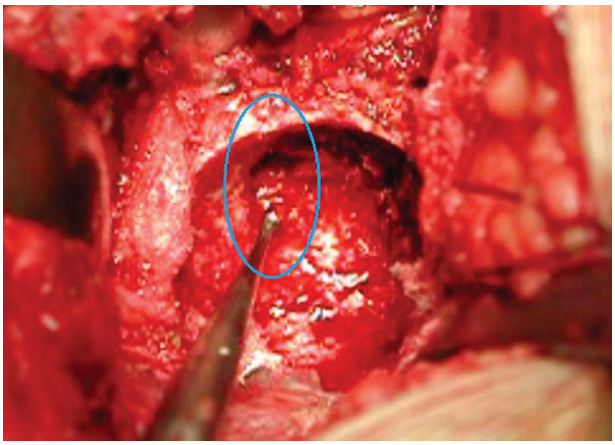
Once the acetabular component was placed, the leg was externally rotated to prepare the femur. The initial step was to evaluate the fracture site and the trochanteric fragments. Afterward, a prophylactic

Figure 1



A trial of hip dislocation with the implants still present.

Figure 2



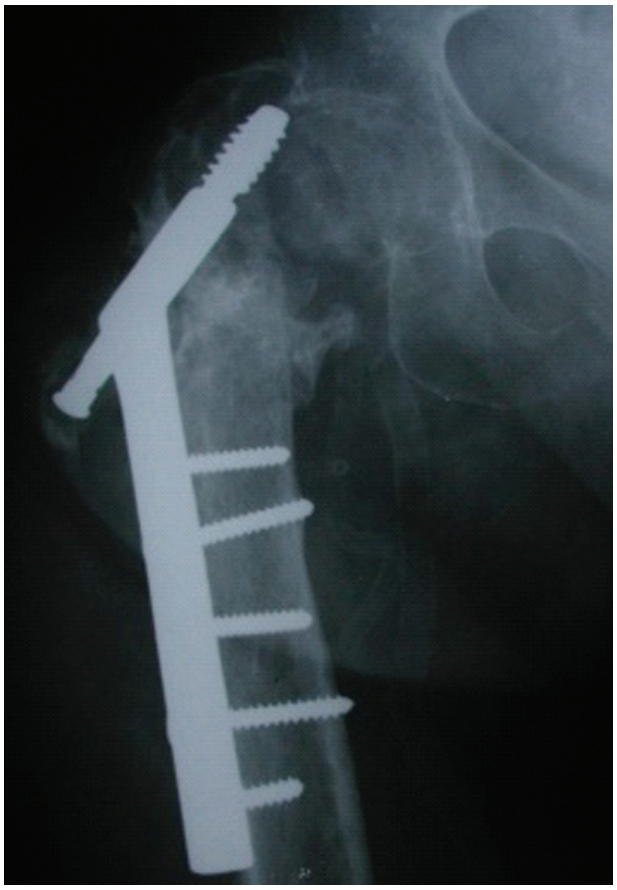
Penetration of the superior–posterior part of the acetabulum by the lag screw.

cerclage wire was used if the bone quality was considered poor to avoid intraoperative fractures during the canal preparation. In most fractures, there is a varus deformity of the proximal femur, and also the femoral shaft is mostly medialized (Fig. 3). This made the entry point one of the most difficult steps in this operation. Not paying attention to this deformity will end-up in a varus position of the stem. In many cases, the entry point was totally obliterated by cortical bone and opening the medullary cavity may require 4.5 mm drill bit.

After entering the medullary cavity, reaming was done in the usual manner but more cautiously to avoid intraoperative fracture (Fig. 4).

After proper reaming, a trial stem was applied, and if needed, intraoperative fluoroscopy was used to confirm its position, as these patients have multiple bone defects as well as osteoporosis, so perforation can occur easily. The proximal femoral defects were then evaluated and

Figure 3



Anteroposterior view of a varus deformity of the proximal fragment together with medialization of the shaft and obliteration of the proximal femoral medulla.

Figure 4

Intraoperative femoral crack managed by cerclage.

managed. The sizeable defect created by the lag crew and the barrel of the plate is grafted at that stage by an autogenous bone from the head of the femur. In most of cases, it was impacted into the defect; however, a cerclage wire was sometimes used to hold it in place.

In cases where cemented femoral stem was used, cement extrusion was avoided by reapplying the cortical screws (after cutting them short). Cement was applied under pressure by using syringe and inserted cement plug (Fig. 5).

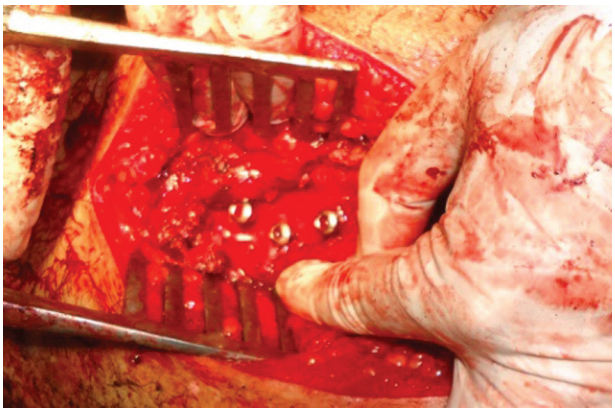
Several types of cups were used, including cementless (cases who had good bone quality) versus cemented cup (poor bone quality) and constrained cup (in patients with fear of recurrent dislocation either owing to weak abductor or those with morbid obesity) (Table 1).

A variety of stems were used, including the following (Table 2):

(1) Cementless stems were used in patients with a good bone quality.
(2) Cemented stems in patients who had poor bone quality.
(3) Standard length stems were used when only four hole plates were used and removal of the former implants did not cause any bigger defects than the 4.5 mm defect created by the screw diameter at every cortex (Fig. 6).
(4) Long stems were used to bypass the big defects created after screws removal or when long plated were used (Fig. 7).

Long modular stem (e.g. REEF or RIVITAN) was used with or without distal locking (Fig. 8).

Figure 5



The short screws inserted into the holes defect.

Table 1 The distribution according to the prosthesis used and types of acetabular components

Types	
Cementless bipolar	12
Total hip (*N*=18)	
Cementless cup	12
Cemented cup	6

Table 2 The distribution according to the femoral components

Types	
Cementless (*N*=12)	
Standard	4
Long stem	3
Reef	1
Rivitan	4
Cemented (*N*=6)	
Standard	3
Long stem	3

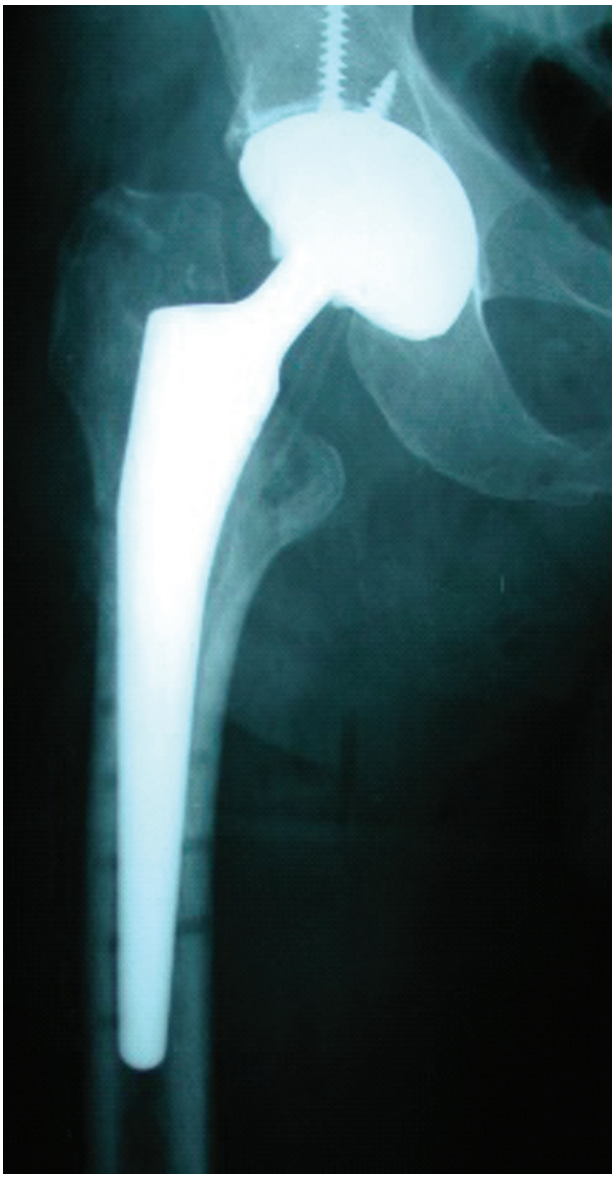
The last step in this procedure, if needed, and if it was not done at early stage, is fixation of the greater trochanter as anatomical as possible, either by cerclage wiring or screws.

Harris hip score (HHS) [6] was use for clinical evaluation preoperatively, postoperatively, and at last follow-up.

All patients were subjected preoperatively and postoperatively to a pelvis and both hips anteroposterior and hip lateral radiographs. In two patients, a computed tomography scan was done to evaluate the union of the fracture and the degree of osteoarthritis, whereas MRI was done in three cases to determine the viability of femoral head as well as evaluate the joint condition.

At each follow-up visit, new radiographs were done (whenever possible) and stability of the implants was evaluated.

Figure 6



Cementless standard femoral stem.

Results

The clinical results in this study were assessed using HHS.

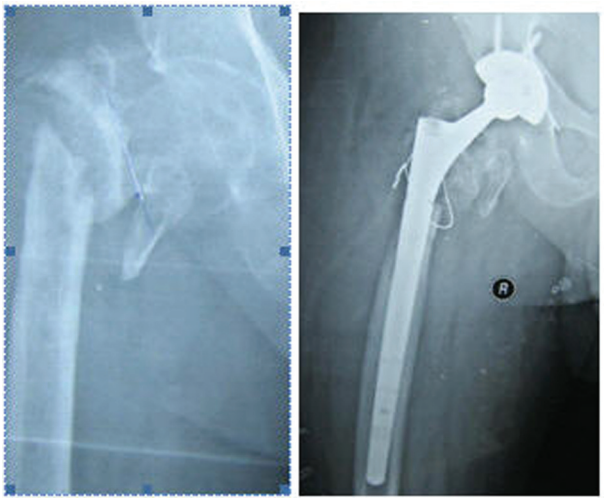
The HHS score gives a maximum of 100 points. Pain receives 44 points, function 47 points, range of motion 5 points, and deformity 4 points. Function is subdivided into activities of daily living (14 points) and gait (33 points).

Pain was the key in patient satisfaction. Preoperatively, it was the major complaint in 100% of the patients. Preoperatively, 15 patients were totally disabled, were crippled, had pain in bed, or were bedridden; 12 patients had marked pain; and three patients had moderate pain. There was a notable

Figure 7

Cementless long stem.

Figure 8



Anteroposterior radiograph taken after removal of the failed dynamic hip screw managed with conversion to total hip (Rivitan modular stem).

change in the hip pain score and the patient satisfaction especially after 3 months from the operation and onward. At the last follow-up, eight patients scored 44 (no pain), 18 scored 40 (occasional pains), three scored 30 (mild pain, and may take aspirin), and one scored 20 points (moderate pain). The most common site of pain was at the trochanteric (lateral) region. The mean improvement was 33.4 points (from 6 to 39.4).

Preoperatively, 17 patients were unable to walk, four used two crutches, five used two canes, and four with one crutch. Of the 13 patients who could walk, nine were able to walk indoors only. All patients experienced severe limping and were unable to use public transportation. However, four of them were able to put on shoes with difficulties. In total, 27 were unable to climb the stairs in any manner. In addition, five were able to sit on any chairs, 11 sat on only high chairs, whereas 14 were not able to sit comfortably on any chair.

Postoperatively, unlike the pain, the improvement in the functional scores took a longer time and notable changes with follow-up. At the last follow-up, one patient was still not able to walk; however, he was able to sit and move comfortably in a wheel chair. Overall, 19 patients were able to walk for unlimited periods.

In terms of using support, five patients did not use any aids for walking. However, 14 patients still used cane for long distance only, eight used cane regularly, whereas three still used crutches for movement.

Regarding limping, six patients had no limping (with no aids), 19 had slight limping that disappears with the use of a cane, whereas five patients had moderate limping. Meanwhile, 10 patients were able to fit the shoes with ease, 14 with difficulty, and six were not able. Overall, five patients were able to climb the stair normally, 15 patients did it with using rails, four did it in any manner, and six were still not able to do it. Although 23 patients claimed that they were now able to use public transportations; however, they never did because of its crowdedness. A total of 28 patients were able to sit comfortably on normal chairs for more than 1 h; only two patients used high chairs and sat comfortably for less than 30 min.

Passive hip range of motion showed dramatic changes 1 month after the operation; however, active movement required longer time for improvement. Preoperatively, the mean score was 1.6 points (12 patients having all

the positive data). Postoperatively, only 1 patient had a negative data (scored 0), and the other 29 scored the maximum 4 points, with a mean of 3.8 points.

The mean limb length discrepancy was −3 cm (ranged from −2 to −5 cm) postoperatively; this was improved to a mean of −0.5 cm (range: −1.5 to +1 cm).

Finally, the entire mean scores preoperatively and at the last follow-up for all the 30 patients were summated. It showed an improvement of 72.65 points (from 12.88 to 85.53). Preoperatively, HHS ranged from 0 to 43 and ranged postoperatively from 51 to 100 points (Table 3). This wide variation was because of the different patients' demographics, levels of activities, and associated medical comorbidities.

The higher the HHS, the less the dysfunctionality. A total score of less than 70 is considered a poor result, 70–80 is considered fair, 80–90 is good, and 90–100 is an excellent result.

At the end of the follow-up, we had nine hips with excellent results, 11 with good result, five was fair result, and five with poor results (Tables 4 and 5).

Table 3 The mean preoperative and postoperative (at the last follow-up) Harris hip scores

Category	Maximum score	Mean preoperative score	Mean postoperative score
Pain	44	6	39.4
Function	47	3.92	33.22
Range of motion	5	1.09	9.25
Deformity	4	1.6	3.86
Total	100	12.88	85.53

Radiography was done (immediate postoperatively, monthly till 6 months, then every 3 months till one year, and then yearly) to confirm implant stability. At the last follow-up, all prosthesis revealed no signs of loosening after comparison with the serial radiographs, except for one male patient 50 years old who was managed by cementless bipolar arthroplasty; the prosthesis developed loosening 9 months after its insertion. He was reoperated, with conversion to cementless total hip replacement, and he was followed up regularly with satisfied outcome (Fig. 9).

In our study, intraoperative fracture occurs in four cases. Management was in form of cerclage wiring and/or long-stem prosthesis to bypass the defect.

One case (diabetic with severe obesity) developed superficial infection on the second week after

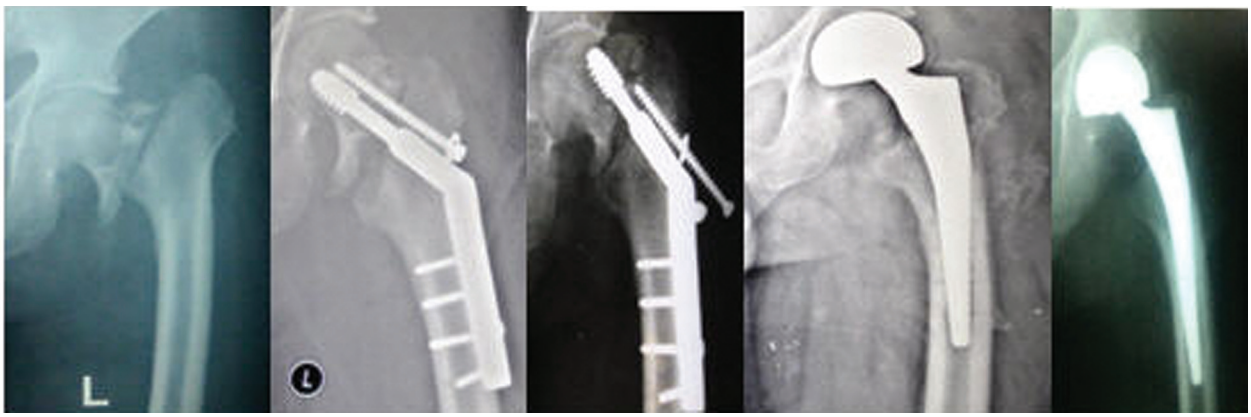
Table 4 The number and grading of the patients according to the total Harris hip scores preoperatively

Harris hip scores	Number of patients	Grade
0–10	14	Poor
11–20	8	Poor
21–30	6	Poor
31–40	1	Poor
41–50	1	Poor

Table 5 The number and grading of the patients according to the total Harris hip scores postoperatively (at the end of the follow-up)

Harris hip scores	Number of patients	Grade
51–60	1	Poor
61–70	4	Poor
71–80	5	Fair
81–90	11	Good
91–100	9	Excellent

Figure 9



Cementless bipolar was done as a management of failed dynamic hip screw; follow-up illustrated bone ingrowth around the prosthesis after 24 months.

cementless long-stem THA. This was managed with early debridement and suction drain as well as antibiotic according to culture and sensitivity. The case responded to antibiotic regimen and did not develop any late infection. Erythrocyte sedimentation rate and C-reactive protein became normal within 3 months.

There were two cases of dislocation (after cementless total hip). One of them occurred after 3 weeks, and another one happened after 10 weeks with history of falling down. Both cases were managed by open reduction and longer neck size XL was inserted (in one case). Heterotopic ossification was not found in this study.

Discussion

The treatment of failed DHS fixation in trochanteric hip fractures is challenging because of fracture deformity, bone loss, bone comminution, and retained often broken hardware from previous operations. Patients are usually markedly disabled, so reoperation usually is considered. Treatment options include prosthetic replacement and revision internal fixation. In younger patients, and active older patients with good remaining bone stock and a well-preserved hip, revision internal fixation and bone grafting have been advocated [7].

Revision fixation may entail a period of restricted weight bearing that is difficult in the elderly. Hip arthroplasty offers the advantage of early weight bearing and mobilization. It also offers the prospect of improving the biomechanical condition of the hip in malunited trochanteric fracture cases. The main concerns are of dislocation, infection, and failure of the implant secondary to aseptic loosening and fracture [8].

Few studies had been published regarding the various management option, results, success rate, and complications of DHS fixation failure.

The mean age in this study was 60 years (range: 50–70 years), which was considered lower than what most Western papers have reported (around 71 years) [7,8]. It is correlated to the lower life expectancy of the Egyptian population as compared with other Western populations.

In this study, it was found that the main cause of DHS fixation failure among our patients was misplaced lag-screw position (14 patients, 46%). This includes improper tip–apex distance (TAD) (range: 30–48 mm) and position of the lag (either anterior or superior). Meanwhile, the next factor of failure was unstable fracture fixation (nine patients, 30%). Other causes that leaded to the failure were infection and severe osteoporosis in the femoral head (with 17 and 7%, respectively).

It is correlated with Hsueh *et al.* [9]. In his study, 937 patients were evaluated to assess the risk factors of lag-screw cutout in the treatment of intertrochanteric fracture with a DHS. He concluded that the TAD was shown to be the most important predictive factor for cutout, followed by screw position, fracture pattern, reduction, and patient age.

To decrease the risk of lag-screw cutout, it is important to ensure good fracture reduction and to place the lag screw in either the middle/middle or the inferior/middle position with appropriate TAD [9].

These outcomes were confirmed by other authors; Haidukewych and Berry [10] in their search to determine the technical aspects that were considered the most reliable indicators for cutout found that the most significant difference between patients with cutout against those without was the TAD [11].

Regarding the time between initial surgery and DHS. fixation failure, our data showed that it ranged from 2 to 40 weeks, with an average of 18 weeks. In similar relation to these findings, Said *et al.* [4] showed in his study of 26 patients with failed DHS fixation, the interval time to failure was ~22 weeks [4].

In the study conducted by Mortazavi and colleagues studying the rates of dislocation after failed internal fixation of hip fractures in one 154 hips, they concluded that the use of direct lateral approach is one of the major factors responsible for the absence of the postoperative dislocation, so recommending its use [9,10].

In this study, 12 cases of 30 were managed by cementless bipolar arthroplasty. In relation to this, Cho *et al.* [12], in their comparison between bipolar and THA concluding a better functional outcome and pain relief with THA. Haidukewych *et al.* [10], reported acetabular replacement in 32 of 60 patients, stating that THA was performed routinely if the acetabular cartilage was found to be markedly damaged at the time of surgery, and it also was done at the surgeon's discretion in some cases in which the acetabular articular cartilage was of good quality [10].

In terms of management of the failed DHS with total hip (18 cases), cementless cups were the most commonly used in our study (12 patients), whereas six patients managed with cemented cup. Meanwhile, we used constrained cup in two cases, one of them had marked weak abductors and the other one experienced morbid obesity.

On the femoral side, Mortazavi and colleagues [8,10] reported the use of calcar-replacement implants in almost 60 and 86%, respectively, to make up for bone deficiency and to restore limb length. Moreover, Haidukewych and Berry reported the use of the long-stem implants in 50% of patients to bypass cortical defects left at the site of failed fixation devices. On the contrary, Zhang *et al.* [13] had reported they used standard stems in all cases with no fractures reported. In this study, we used long stem in ~33% (seven out of 18 patients) and four were modular stem.

Although this procedure is technically challenging and more demanding.

In this study, intraoperative fracture was reported in four cases, the management was in the form of cerclage wiring and/or long-stem prosthesis to bypass the defect. Most of the studies reported this as the commonest complication. Zhang *et al*. [13] reported that fracture of the greater trochanter was the commonest complication observed, attributing it to the combination of severe osteoporosis and the stress riser effect of the big hole over the proximal part of the lateral cortex. Haidukewych *et al.* [10] reported two cases of nondisplaced proximal femoral fracture during preparation of the femoral canal; both were treated successfully with cerclage wiring.

In this study, we got two cases of dislocation (after cementless total hip). One of them occurred after 3 weeks and another one happened after 10 weeks with history of falling down. Both cases were managed by open reduction, with reapplying longer neck size XL (in one case).

All the previous studies in literature [10,13], except the one conducted by Mortazavi *et al.* [8], reported the occurrence of this complication, and in most cases, it was managed with closed reduction . Mortazavi *et al.* [8] was the only one reporting no postoperative dislocation and correlating this to several factors: the experience and expertise of the operating surgeon, the use of direct lateral approach with delicate soft tissue dissection, the use of 32 or 36 mm femoral heads rather than 28 mm, and the limited external rotation these patients have.

Concerning the outcome, we detected an improvement in the mean HHS of 72.65 points (from 12.88 to 85.53). We attributed this improvement to some factors: the lower mean age of our patients (60 years), less number of obese patients, high advanced technology, and availability of new types of prosthesis.

In this study, there was a significant relation between the age and outcome. We noticed a statistically significant difference between the HHS preoperatively and postoperatively in relation with different age groups, denoting a better outcome with younger age groups than in older groups.

On the contrary, there was no significant changes between male or female patients in HHS either preoperatively or postoperatively.

When arthroplasty is performed as a salvage procedure for failed internal fixation of intertrochanteric fractures, a number of technique difficulties must be overcome. Dislocation of the hip may carry the risk of shaft fractures as the hip is usually stiff, so it is safer to dislocate the hip before implant removal [14].

Cortical holes left by the previous screws should be plugged when cemented stem is used. Patterson *et al.* [15] described a method to sort this problem by blocking these holes by short cortical screws till cement is injected and pressurized. Cortical holes as well as parallel holes should be grafted with the bone from excised proximal fragment. In our study, we do the same technique.

The proximal fragment is usually in a distorted position owing to fracture mobilization, and understanding this is important to allow preparation of the femoral canal without perforation. Bone loss below the level of resection of standard total hip replacement is a common occurrence [16], so a calcar replacement may be needed to restore leg length and to achieve hip stability [17]. In our study we did not use a calcar replacement.

The greater trochanter warrants special care as it may be a separate ununited fragment or a malunited fragment that prevents entrance into the medullary canal [17]. Under these circumstances, the use of a trochanteric slide technique may be of great help.

At the end of the follow-up, we had nine hips with excellent results, 11 with good result, five was fair result, and five hips with poor results according to HHS compared with the study of Hammad *et al.* [17] who had 21 (77.7%) hips with good or excellent results, four (14.8%) hips with fair results, and two hips with poor results.

The weakness of this study includes the multiple prosthetic designs used and the subjectivity of the choices between the methods of fixation made by the surgeon.

Conclusion

Hip arthroplasty is effective salvage procedure after failed treatment of an intertrochanteric fracture and technically more difficult than primary THA; however, it provides quicker walking ability and more independence in activities of daily living.

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Conflicts of interest

There are no conflicts of interest.

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