Factors affecting the management of failed internal fixation of trochanteric hip fractures with conversion to hip arthroplasty

Ahmed H. Abdelazeem, Sherif A. Khaled, Mahmoud Abdel Karim, Hazem Abdelazeem

Department of Orthopaedics, Kasr Al Ainy Hospital, Cairo University, Giza, Egypt

Correspondence to Sherif A. Khaled, MD, 18 Omar Ibn El Khattab Street, Dokki, Giza, 11211, Egypt; Tel: +20 374 200 49/+20 279 500 27/+20 279 266 90/+20 279 563 39; fax: +202-27956339; e-mail: sherifakhaled@yahoo.com

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Purpose
Failed internal fixation of intertrochanteric fractures typically leads to profound functional disability and pain. Conversion hip arthroplasty in this situation is technically demanding. The purpose of this study was to evaluate the results, technical problems and complications, as well as the impact, of different factors on such procedure.
Patients and methods
From May 2009 to October 2011, 30 patients (23 female and seven male) with a mean age of 66 years (range: 50–90 years old) were included in the study. Total hip replacement was used in all cases. Cemented stems were most commonly used because of poor bone quality (standard length in 10, long stems in 14 and calcar replacing in two). Cementless standard length stems were used in four patients. The mean follow-up was 25 months (range: 12–33 months).
Results
A statistically significant improvement was found comparing preoperative and postoperative conditions ($P<0.05$). When comparing different factors, the age was the only statistically significant factor affecting the functional outcome, denoting better results with patients younger than 65 years of age ($P=0.002$). We had four intraoperative fractures, one postoperative fracture, three dislocations, a single case of infection and two cases of implant loosening.
Conclusion
Although conversion hip arthroplasty is technically demanding, it is associated with a high success rate with good functional outcome and pain relief especially in younger age groups.

Keywords:
conversion hip arthroplasty, failed internal fixation, hip arthroplasty, intertrochanteric fracture

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Introduction

Most intertrochanteric hip fractures can be treated successfully with internal fixation. Nevertheless, in a small percentage of patients, the fracture fails to heal because of the initial fracture pattern, comminution, suboptimal fracture fixation or poor bone quality [1].

Failed fixation typically leads to profound functional disability and pain. The two main treatment options are revision of internal fixation or salvage with hip arthroplasty. Most surgeons prefer revision internal fixation for physiologically young patients and some active old patients with a well-preserved articular cartilage and bone [2]. Frequently, the patients have poor bone quality, damaged femoral head and articular cartilages, making salvage with hip replacement the best option. There are a number of specific technical hurdles in this setting: the presence of failed internal fixation devices, bone deformity, bone loss and poor bone quality [3].

To our knowledge, only few reports on this form of treatment are present in the current literature [4–12]. The purpose of this study was to evaluate the results, technical problems and complications, as well as the impact of different variable factors, age and BMI, associated with hip arthroplasty performed as a salvage procedure after failed treatment of intertrochanteric hip fractures in our institute.

Patients and methods

From May 2009 to October 2011, 30 patients with a mean age of 66 years (range: 50–90 years old) (Table 1) were treated in our hospital. Ethical Committee approval was obtained for our study. An informed consent was obtained from all patients.

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The indications for replacement were as follows: 22 patients lag cutout (Fig. 1), two had complete neck resorption with avascular necrosis of the head, two (above 70 years of age) had complete nonunion at the fracture site as indicated by hardware failure, two had hardware failure associated with osteoarthritis of the hip and two had associated neck fracture. In all cases, infection and pathological fracture were excluded using history, clinical examination and laboratory and radiological investigations.

Figure 1

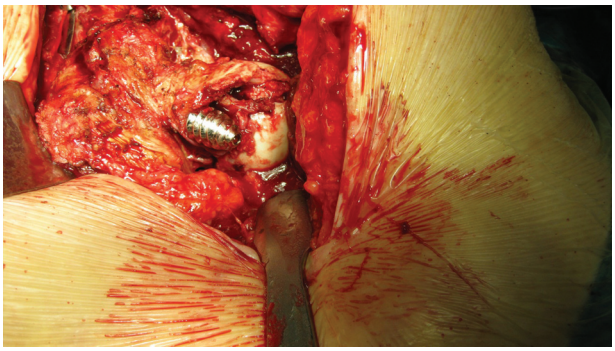


Photo showing lag screw cutout, as well as a trial of hip dislocation with the implants still present.

Table 1 Patients' demographics and frequencies according to different factors

	Category	Frequency [*n* (%)]
Sex	Female	23 (76.7)
	Male	7 (23.3)
Age	≤65	13 (43.3)
	>65	17 (56.7)
BMI	Normal (18.5–24.9)	4 (13.3)
	Overweight (25–29.9)	7 (23.3)
	Obese (30–34.9)	12 (40)
	Severe obese (35–39.9)	5 (16.7)
	Morbid obese (>40)	2 (6.7)
Fracture type (AO classification)	31-A1	9 (30)
	31-A2	4 (13.0)
	31-A3	17 (56.7)
Number of previous trails of fixation(s)	1	25 (83.3)
	2	5 (16.7)
Last fixation-replacement time interval	<6 months	9 (30)
	>6 months	21 (70)
Method of fixation	DCP	3 (10)
	DCS	6 (20)
	DHS	18 (60)
	IMN	1 (3.3)
	Locked plate	2 (6.7)

Regional anaesthesia and lateral position were used in all patients. In 25 patients the same skin incision was used with proximal extension when required. In five cases, a more posterior skin incision was used with no skin complications. In five cases, AO broken screw removal set was used to extract the former implants. Modified Hardinge lateral approach was used in 25 patients, transtrochanteric approach in four and posterior approach in one patient. Hip dislocation was done after femoral neck in-situ osteotomy, as we found that in most cases the proximal fragment was in a severe retroversion. In a few cases, the implants fixing the fracture were left in place during dislocation and the neck was cut in a circumferential manner around the lag screw and was removed from the medial aspect with the head (Fig. 1).

Acetabular cartilage erosion was found in all cases. In four cases, small cavitary acetabular bony defects were identified to be caused by the lag screw penetration (Paprosky type I) [13], and no bone graft was needed in any case. The choice of using a cemented or a cementless cup was based on the patient age and bone quality. Cemented nonconstrained cups were used in twenty-three cases and semiconstrained cups (snapping fit) in four patients for fear of dislocation in the following special situations: two morbidly obese patients, one patient with neglected hip dislocation with absent abductors and lastly in a 77-year-old patient with an ipsilateral hemiplegia. On the other hand, cementless cups were applicable in only three cases.

The initial step in femoral preparation was to evaluate the fracture site and the trochanteric fragments. A prophylactic cerclage wire was used around the proximal part of the femoral shaft if the bone quality was considered poor to avoid intraoperative fractures during the canal preparation. In most fractures, the proximal fragment was in varus deformity with the femoral shaft in various degrees of medialization; this made the entry point one of the difficult steps in this operation. In many cases, the entry point was totally obliterated by sclerotic bone, and opening the medullary cavity required using large drill bits of different diameters or flexible and/or rigid intramedullary reamers. Four intraoperative cracks were detected and all were managed successfully with long-stem prosthesis together with a cerclage wiring. The proximal femoral defects created by the lag screw and the barrel of the plate were grafted by an autogenous bone from the head of the femur.

Cementless standard-length stems were used in four patients (Fig. 2); all were below the age of 65 years and

had a good bone quality. Cemented stems were the most commonly used type, as most of the patients had poor bone quality and required immediate mobilisation. 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. Long stems (Fig. 3) were used to bypass the big defects created after screw removal or when long plates were used or when the proximal diaphysis bone quality was questionable. Calcar replacing cemented prosthesis (Fig. 4) was used in only two situations in which the whole proximal diaphysis was defective.

In cases in which cemented femoral stem was used, cement extrusion was avoided either by unicortical reinsertion of the cortical screws to temporarily plug the holes during application of the cement or by applying a piece of gauze or the stitch foil cover over the screw holes and held in place by the help of the assistant fingers pressing on it. Cement extrusion from the medial side was minimal in most cases and was neglected. In all cases, 28-mm metal femoral heads-on-polyethylene bearing surface were used.

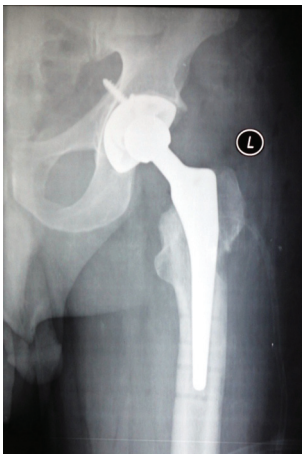
Fixation of the greater trochanter was done as anatomical as possible using cerclage wiring in 10 cases, screws in two cases (one revised with longer screws and tension band principle) and plate in only one case. In the remaining 17 cases, either the trochanter was united or it was felt stable after insertion of the prosthesis.

All patients preoperatively received the same prophylactic antibiotics and the same postoperative anticoagulation therapy with low-molecular-weight heparin. They were followed up at regular intervals of 2 weeks, 1, 3, 6 and 12 months and then yearly. Clinical evaluation was done by Harris Hip scores (HHS). Postoperative radiographs were evaluated for changes of component position and loosening. Heterotopic bone was graded using the classification system of Brooker.

Statistical analysis

Data were statistically described in terms of mean±SD, median and range or frequencies (number of cases) and percentages when appropriate. Comparison of numerical variables between the study groups was done using Student's *t*-test for independent samples in comparing two groups when normally distributed and Mann–Whitney *U*-test for independent samples when not normally distributed. Comparison of numerical variables between more than two groups

Figure 2



Anteroposterior hip radiograph of a 52-year-old man with a cementless Total Hip Arthroplasty (THA).

Figure 3

Anteroposterior hip radiograph of a 68-year-old woman with a cement THA using a nonconstrained acetabular component and long-stem femoral component.

Figure 4

Anteroposterior radiograph of a 75-year-old woman with cemented THA using a snapping fit cup and a calcar replacing femoral component.

was done using one-way analysis of variance test with post-hoc multiple two-group comparisons when normally distributed and Kruskal–Wallis test when non-normally distributed. Comparison of HHS over time was done using repeated-measures analysis of variance through a general linear model analysis, and then paired *t*-test was used as a post-hoc test. *P*-values less than 0.05 were considered statistically significant. All statistical calculations were done using computer programs SPSS (statistical package for the social science; SPSS Inc., Chicago, Illinois, USA) version 15 for Microsoft Windows.

Results

The mean operative time was 154 min (range: 60–300 min), blood loss was 1038 ml (range: 335–2600 ml) and the mean intraoperative replacement for allogeneic blood was 1.8 U (range: 0–4 U) and 2.3 U (range: 0–8 U) for fresh frozen plasma. The mean follow-up was 25 months (range: 12–33 months).

Functional outcomes

The mean HHS improved from 13.83 preoperatively to 74.90 at 12 months of follow-up and 79.90 at the last follow-up (Table 2). A statistically significant improvement was found comparing preoperative and postoperative conditions at 12 months and at last follow-up ($P<0.05$).

Concerning the pain, preoperatively, seventeen patients were totally disabled with pain in bed, eight had marked pain and only five had moderate pain. At the last follow-up, nine patients had no pain, 16 had occasional pains, four had mild pain and only one had moderate pain.

Concerning the mobility, preoperatively, 17 patients were bedridden, 10 walked with two crutches and three with one crutch (10 walked indoors only). At the last follow-up, three patients were still not able to walk but were able to sit comfortably (two were morbidly obese and one was 90 years old with a poor general condition). Seventeen patients were able to walk for unlimited periods with a cane for long distance, seven used a cane all of the time and three used a walker for mobilisation indoors only.

Radiographic results

Two female patients presented with radiographic signs of loosening at the last follow-up. One gave a history of falling down the stairs 2 weeks before the follow-up radiograph. This patient had an associated fracture of the proximal humerus, which was treated conservatively. A cement fracture was detected near the tip of the long-stem femoral component; however, she was clinically fine and refused any surgery, and accordingly close follow-up was decided. The other patient reported drop in her activity level and increase in pain, and her radiographs showed subsidence of the stem. Revision surgery was done at 29 months of the index surgery. Five patients had Brooker type-1 heterotopic bone, five had type-2 and two had type-3.

Complications

Four intraoperative fractures were detected. One shaft perforation was detected during the introduction of the stem and was treated with long stem bypassing the defect. One had a crack in the proximal femur during placement of the cementless stem and was treated with cerclage wiring. Two patients had longitudinal cracks between the screw hole that was not displaced during the canal preparation and were treated with immediate cerclage wiring and long-stem cemented prosthesis. Three months postoperatively, a morbidly obese female stem when she started weight bearing had torsional femoral shaft fracture distal to the tip of the prosthesis 3 months. This was treated with open reduction and internal fixation.

We experienced three cases of postoperative dislocation. One case was closely reduced with no recurrence. Open reduction was needed in the other two. One needed a revision of fixation of the greater trochanter with screws and tension band wiring and the other (only case opened posteriorly) needed placement of antiluxation ring. The latter case suffered

Table 2 Comparing the Harris Hip score preoperatively, 12 months postoperatively and at last follow-up

	HHS		
	Preoperative	12 months postoperative	Last follow-up
Mean	13.83	74.90	79.90
SD	9.006	10.701	12.357
Minimum	1	54	50
Maximum	43	94	95
Median	13.50	76.00	83.00

HHS, Harris Hip scores.

postoperative infection (only case with postoperative infection) with type-3 heterotopic bones and poor general condition, and was treated until the last follow-up by antibiotic suppression.

Discussion

Management of failed pertrochanteric fracture fixation is challenging. Various options include revision internal fixation with or without bone grafting and conversion to either hemi or total hip arthroplasty. Patients after failed fixation of trochanteric hip fractures are in pain with severely restricted function. 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 mobilisation. 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 [3,5].

To our knowledge, few studies have been published about this topic. Surprisingly, most of these papers reported a good functional outcome with a low orthopaedic complication rate. However, no paper had pointed out the impact of different factors on the functional outcome either on short term or long term [4–12].

In this study, we evaluated the results of thirty patients with a mean age of 66 years who were operated upon after failed internal fixation of pertrochanteric fracture femur (AO type 31-A) from May 2009 to October 2011. A statistically significant improvement in the mean preoperative and last follow-up HHS with 66.07 points was found ($P<0.05$), with a high patient satisfaction, especially pain relief. This was comparable to other similar studies (Table 3).

Intraoperative fracture was reported in four cases. Most of the studies reported this as the most common complication. Zhang *et al.* [6] reported that fracture of the greater trochanter was his most common complication, attributing it to the combination of severe osteoporosis, the stress riser effect of the big hole over the proximal part of the lateral cortex. Haidukewych and Berry [5] reported two cases of nondisplaced proximal femoral fracture during preparation of the femoral canal; both were treated successfully with cerclage wiring. Mortazavi *et al.* [12] reported five cases of intraoperative fractures.

In our study, we had three cases of postoperative dislocation. All the previous studies in literature, except that conducted by Mortazavi, reported the occurrence of this complication, and in most cases it was managed with closed reduction only [4–12]. Mortazavi *et al.* [12] 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.

We had a low rate of infection (only one case) with similar rates as compared with Mortazavi *et al.* [12] study (two in 71 hips). This was because of our proper preoperative preparation and exclusion of infection preoperatively. All patients were subjected to full history taking and examination, as well as laboratory tests, including complete blood count with differential leukocytic count, erythrocyte sedimentation rate and C-reactive protein evaluation. Only four patients had a high level of erythrocyte sedimentation rate as compared with their reference age population (with negative C-reactive protein). From these patients, routine 5 intraoperative specimens were taken and sent to bacteriological

Table 3 Comparing the different studies demographics, mean Harris Hip score at last follow-up and complications

References	Number of cases	Mean age	Sex	Mean BMI	Mean HHS	Orthopaedic complications
Zhang *et al*. [6]	19	64.9	More females	–	79.8	7 fractures 3 dislocation
Hammad *et al.* [8]	32	64	More females	–	84	1 fracture 1 dislocation 3 DVT
Cho *et al.* [9]	18	>70	More females	–	82 in THA68 in HA	1 infection 4 fractures 1 dislocation
D'Arrigo *et al.* [10]	21	75.8	More females	–	81	1 infection 1 fracture
Thakur *et al.* [11]	15	80.6	More females	–	83.01	1 DVT
This study	30	66.9	More females	Obese	79.9	1 infection 5 fractures3 dislocations

DVT, deep venous thrombosis; HHS, Harris Hip score.

Table 4 Mean Harris Hip score at 12 months and last follow-up and its *P*-values of different groups

	Groups	Mean HHS at 12 months	Mean HHS at last follow-up	*P*-value	
Sex	Female	73.3	78.91	12 months	0.271
	Male	78.86	83.13	Last follow-up	0.438
Age	≤65	81.46	86.92	12 months	0.002
	>65	69.88	74.53	Last follow-up	0.004
BMI	<29.9	80.55	83.73	12 months	0.025
	>30	71.63	77.69	Last follow-up	0.202
AO type	31-A1	80.22	87.02	12 months	0.135
	31-A2	68.25	80.00	Last follow-up	0.098
	31-A3	73.65	76.11		
Fix-replacement interval	<6 months	77.67	84.02	12 months	0.363
	>6 months	73.71	78.14	Last follow-up	0.239
Fixation implant	DCP	88.33	91.00	12 months	0.125
	DCS	70.83	73.17	Last follow-up	0.188
	DHS	74.00	80.49		
	IMN	65.00	65.00		
	Locked plate	80.00	85.58		

HHS, Harris Hip score.

assessment. The results were considered positive if more than two were positive and having the same organism. In all four patients, negative results were found and no infection was encountered in their follow-up. This was supported by Haidukewych and Berry [5] and his group who mentioned that although the preoperative evaluation was not standardized during their study period, this is their current protocol now.

We analysed our results to study the impact of different factors on the final outcome. Although dealing surgically with complex types of intertrochanteric fractures (Evans reversed obliquity and AO type-3) is more technically challenging and requires more experience as they are associated with more comminuted fragments and sometimes bone loss requiring reconstruction or special type of femoral prosthesis, we found no statistically significant difference between the results of arthroplasty in different types of fracture (AO type-1, 2 and 3), as well as different sexes, fixation-replacement time intervals (less and more than 6 months) and type of implant used for fracture fixation at 12 months or last follow-up (Table 4). We attribute this to the improved types of prosthesis available that allows for replacement of proximal bone deficiencies, as well as bypassing the proximal bone defect as allowing diaphyseal stable fixation.

A statistically significant factor was the patients' age, denoting better results with patients below the age of 65 years both at 12 months (P=0.002) and at last follow-up (P=0.004).

When comparing the BMI, a statistically significant difference was found between the groups denoting better results in lower BMI (<29.9) at 12 months of follow-up (P=0.025). However, this was not significant at the last follow-up, denoting improvement of obese patient (BMI>30) function after 12 months (P=0.202) (Table 4).

The strength of our study includes statistically analysing and relating different factors to the final outcome. We standardized the size of the femoral heads (28 mm) and bearing surface (metal on polyethylene) used. However, its weakness relays in having short-term follow-up period, as well as the procedure being done by a diversity of surgeons.

Conclusion

In conclusion, hip replacement after failed fixation of intertrochanteric fracture results in significant improvement in the functional outcome with better results obtained in younger age groups.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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