An innovative external fixator for the management of trochanteric fractures of the femur

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Purpose
Recent published studies have compared the use of external fixation in elderly patients with trochanteric fractures with the more conventional methods of fixation such as a sliding hip screw. This is the first prospective study to report the outcomes of external fixation in a larger patient population that includes young and healthy adults.

Materials and methods
A total of patients with intertrochanteric fractures were treated using a newly developed uniplanar external fixator (AlexFix). All patients received local anaesthesia in the form of femoral and lateral cutaneous nerve blocks. There were 60 men and 140 women, mean age 71.09 (24–91) years. Patients were followed up for a period of 24 ± 2.1 months.

Results
The average operative time (and SD) was 26.22 ± 5.9 min. The average use of radiation intraoperatively was 16.67 ± 3.5 s. Hospital stay was short, with an average of 4.3 ± 1 days. No intraoperative complications were encountered. Blood loss was negligible and none of the patients received any blood transfusion. The mean time for union was 10.5 ± 1.1 weeks. The most common postoperative complications encountered were superficial pin-tract infection in 16 patients (8%) and deep pin-tract infection in seven patients (3.5%). Varus malunion occurred in five patients (2.5%). No implant failure or refracture was recorded.

Conclusion
External fixation of trochanteric fractures is an effective, safe and reliable treatment method. It offers minimal operative and anaesthetic risks, no blood loss, early mobilization and a short hospital stay, with low morbidity and mortality.

Keywords:
external fixation, fracture healing, hip fracture, intertrochanteric fracture, nerve block, trochanteric fracture

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Introduction

The sliding hip screw has been the treatment of choice for trochanteric hip fractures [1–3]. Nevertheless, the functional results are sometimes unsatisfactory because of failure of fracture reduction, fixation or re-establishment of acceptable hip biomechanics [3–5]. Although external fixation was introduced for the management of trochanteric fractures at about the same time as the first sliding internal fixation devices [6,7], its use in clinical practice has decreased considerably in recent years. The development of new external fixators and the improvement in the management of complications have encouraged many surgeons to reconsider its use as a possible treatment option. Studies comparing external fixation to sliding hip screws have reported superior outcomes in favour of external fixation [3,8,9]. We developed a new external fixator (AlexFix) specifically for the management of these fractures. It utilizes a minimally invasive approach together with improved biomechanical features. The aim of this prospective study was to evaluate the results of this method and device in the treatment of trochanteric femoral fractures.

Materials and Methods

Between 2007 and 2009, 200 consecutive patients with intertrochanteric hip fractures were included in this study, mean age 71.09 (24–91) years, median 72.5, mode 76 and SD 10.76 years. Exclusion criteria included pathological fractures, basicervcal fractures, reversed obliquity fractures and surgically high-risk patients with an American Society of Anesthesiologists (ASA) score of more than 3 [10]. In our department, surgically high-risk patients (ASA>3) are treated with external fixation even before the introduction of the new AlexFix (Medical Co., Egypt); hence, they were excluded from the study. Patients with dementia were also excluded as they could not provide consent. All operations were performed in Alexandria University Hospital by the two reporting authors. A full workup including history, clinical examination, radiological examination and routine laboratory investigations was performed for every patient involved in this study.

Of these patients, 60 were men (30%) and 140 were women (70%). The right side was affected in 93 patients (46.5%) and the left side was affected in 107

patients (53.5%). Two fractures (1%) were the result of road traffic collisions and 198 were a result of mechanical falls. The ASA scale was used to classify comorbidities [11]. Of the patients, 37 (18.5%) were classified as grade I, 87 (43.5%) as grade II and 76 (38%) as grade III. The fractures were classified according to the Evans classification of trochanteric fractures of the femur [12]. In all, 46 fractures were classified as stable (I and II) and 154 as unstable (III, IV and V). The mobility status was carefully assessed and documented before and 6 months after surgery. Patients were operated on an average of 2.63 days (1–13) following admission.

The study protocol and design were approved by our ethics committee. An informed consent was obtained from all patients involved in this study.

Statistical analysis

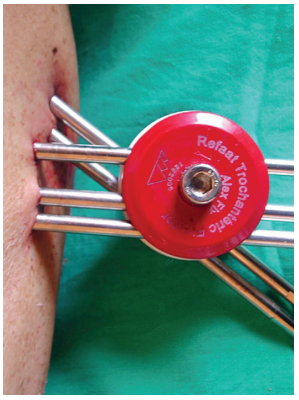
The tests used for comparison of means were the Mann–Whitney nonparametric nonpaired two-tailed and Kruskal–Wallis nonparametric analysis of variance tests. The nonparametric Spearman correlation test was used for correlations.

Implant and surgical technique

The AlexFix intertrochanteric fixator (Fig. 1) consists of a superior and an inferior clamps rotating in a horizontal plane with a polyethylene plate in the middle. The two clamps are made of aluminium alloy and each incorporates four pin seats. This fixator is of a small size, with an outer diameter of 48 mm and a thickness of 24 mm.

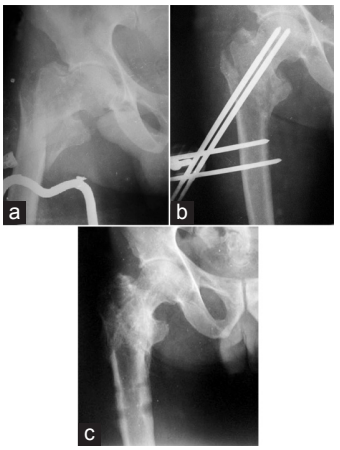
All patients included in this study received sedation and local anaesthesia in the form of femoral and lateral cutaneous nerve blocks. The patient was positioned supine on a traction table and the fracture was reduced. The reduction was considered to be anatomical if the neck-shaft angle was reproduced and the gap at the fracture site was less than 2 mm in both anteroposterior and lateral views. Following satisfactory closed reduction, a self-tapping pin (Schanz screw) of 5 or 6 mm diameter was introduced under fluoroscopy at an angle of ~130° through the femoral neck and into the femoral head to lie inferior and central on anteroposterior and lateral views, retrospectively. It is crucial that the first pin passes through the calcar femorale, which would add to the mechanical stability of the construct. The inferior clamp was advanced onto the first pin so that the pin was situated in the inferior pin-seat and the second pin was inserted parallel to the first, guided by the inferior clamp. Two Schanz screws were inserted into the femoral diaphysis guided by the superior clamp and checked by fluoroscopy. (Figures 2 and 3) show two case presentations for the use of external fixation to stabilize trochanteric fractures.

Figure 1



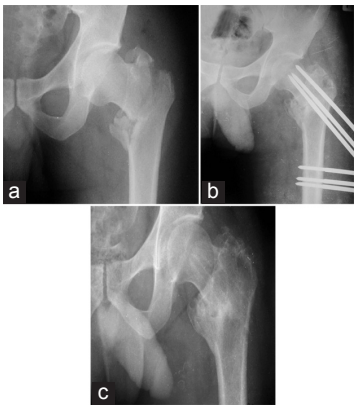
Photograph of a 62-year-old man with the external fixator in-situ postoperatively.

Figure 2



(a) Anteroposterior radiograph of the right hip in a 59-year-old man showing an unstable intertrochanteric fracture. (b) Immediate postoperative radiograph of the right hip showing fracture reduction and stabilization. (c) Removal of the external fixator at 3 months postoperatively, showing good fracture union with a maintained satisfactory fracture reduction.

Figure 3



(a) Anteroposterior radiograph of the left hip in a 27-year-old man, who was involved in a road traffic collision, showing an unstable intertrochanteric fracture. (b) At 2 months postoperatively. (c) Removal of the external fixator at 4 months postoperatively, showing fracture union.

Patients were allowed to sit in bed on the day of the surgery and full weight-bearing with crutches commenced on the first postoperative day as tolerated. Patients were discharged from the hospital when they were able to safely mobilize full weight-bearing and after being instructed on how to care for the pin sites. The follow-up protocol included review on weeks 1, 4, 8, 10 and 12 following discharge. At 10–12 weeks, when union was proved radiologically, the fixator was removed in the outpatient clinic without the need for anaesthesia. All patients were then followed up at 6-month intervals for a period of 2 years.

Results

A total of 200 patients were treated using our newly developed external fixator. Patients were followed up for an average of 24 ± 2.1 months from the date of surgery. No patients were lost to follow-up. No mortalities occurred in the perioperative period (within the first 30 days postoperatively), whereas two patients died because of other medical reasons (one at the 6-month follow-up and one before the removal of the fixator at 14 weeks from the operative date because of cardiopulmonary reasons). Operating times were short and exposure to radiation was minimal. Patients were discharged home in under a week. The mean operative time was 26.22 ± 5.97 min, ranging from 14 to 39 min. The mean time for exposure to radiation was short and the fixator itself acted as a guide for the insertion of all the pins except for the first, where its accurate placement required the use of intraoperative fluoroscopy. The mean fluoroscopy time was 16.67 ± 3.56 s, ranging from 11 to 26 s. The mean hospital stay was 4.3 ± 1.04 days, ranging from 3 to 7 days.

No intraoperative complications were encountered. There was no need for intraoperative blood transfusion in any of the patients as blood loss was negligible. None of the patients received any postoperative blood transfusion and those with chronic anaemia were treated with iron supplements and referred for medical follow-up. The mean time to clinical and radiological union was 10.5 ± 1.1 weeks, ranging from 9 to 14 weeks. External fixators were removed after a mean period of 13.29 ± 2.06 weeks. The nature and incidence of postoperative complications are presented in (Table 1).

Superficial wound infection occurred in 16 patients and all of these resolved with oral antibiotics where indicated. Although deep pin-tract infection occurred in seven patients, no external fixator was removed before union was achieved and any persistent infection disappeared when screws were finally removed at the time of fracture consolidation. Osteomyelitis was not encountered in any of our patients. At the 6-month follow-up assessment, 134 patients (67%) were walking independently and 64 patients (32%) required a walking aid compared preoperatively with 171 (85.5%) and 29 (14.5%), respectively.

Table 1 Nature and incidence of postoperative complications

Complications	Number of patients (%)
None	161 (80.5)
Superficial pin-tract infection	16 (8.0)
Deep pin-tract infection	7 (3.5)
Varus malunion	5 (2.5)
Pin loosening	4 (2.0)
Shortening	4 (2.0)
Death	2 (1.0)
Migration	1 (0.5)
Total	200 (100.0)

We used the Foster rating system created for the assessment of treatment results in traumatic fractures of the trochanteric region of the femur to the assess the outcomes of surgery [13]. Patients were assessed at six months postoperatively and four gradings, four functional and four anatomical, were used (Table 2).

Discussion

Although the sliding hip screw is widely accepted as the 'gold standard' for the treatment of intertrochanteric fractures, the ideal treatment remains a subject of considerable debate. This may be attributed to the associated high morbidity and mortality of up to 60% with sliding hip screw fixation [5,14,15] and an average failure of fixation of about 10% in unstable fractures [16]. Elderly patients with significant comorbidities and high anaesthetic risk, who sustain trochanteric fractures, are a big challenge to treat. For these patients, nonoperative treatment means prolonged hospitalization and immobility, which has a high mortality rate. External fixation provided an excellent alternative for the treatment of these patients. Stable fixation is achieved without surgical trauma, with early mobilization and reduced morbidity and mortality [15].

Recent studies using new fixators have shown that external fixation provides superior results to those obtained with the previously mentioned conventional internal fixation technique [3,8,9,17–19]. Our study included 200 patients, which is by far the largest sample size in the literature. We did not restrict the population to the elderly and less independent but also included young and healthy patients, as young as 24 years of age. To our knowledge, no study has as yet assessed the use of trochanteric external fixators in this

Table 2 Functional and anatomical results (Foster rating system)

Functional grading		Anatomical grading	
Grade	Frequency (%)	Grade	Frequency (%)
Excellent: Walks as well as before the operation. No limp or pain	129 (64.5)	Excellent: Union in perfect position	129 (64.5)
Good: Walks well, uses stick to go out	49 (24.5)	Good: With less than 10° of varus and minimal shortening	65 (32.5)
Fair: Requires stick, considerable limp or pain	19 (9.5)	Fair: With 10–25° of varus, and half an inch to one inch of shortening	3 (2.5)
Poor: Bedridden or confined to chair	3 (1.5)	Poor: Severe malunion, varus deformity of 25° or more, or over an inch of shortening	1 (0.5)

young patient population. This is of great significance as several published studies aimed at early immobilization on the expense of quality of reduction, which is a major determinant of the end functional outcome. Tomak *et al.* [18] argued that in elderly patients, providing a perfect fracture reduction fracture is not of primary importance, and it is more important to operate with the least blood loss in the shortest time and using low-risk anaesthetic procedures. Our study has proved that anatomical reduction and better functional outcomes can be achieved easily, which is of utmost importance, especially in younger patient groups who have more physical demands. The mean operative time in the present study was 26.22 ± 5.97 min, which was similar to that recorded by Kazakos *et al.* [20], Boghdady *et al.* [19] and Vossinakis and Badras [9]. Operating time is likely to be reduced significantly with greater familiarity with the fixator and surgical technique, and decreasing learning curve. Vossinakis and Badras [9] explained the superior results of external fixator when compared with the use of a sliding hip screw.

The mean hospitalization time in our study was 4.30 ± 1.04 days, which is shorter than the average time recorded in published studies (6–8 days) [3,8,9,18,21,22]. This could be attributed to the minimally invasive surgery and early mobilization that external fixation offers, which in turn reduces the medical comorbidities associated with relatively delayed mobilization reported with internal fixation. In this study, patients were encouraged to fully weight bear from postoperative day 1 through a strict rehabilitation programme. The short average time between hospital admission and operative fixation in this study (2.63 ± 1.76 days), together with the short operative time and early postoperative mobilization, all contributed towards early hospital discharge, faster recover, reduced morbidity and mortality and considerable decrease in the overall cost of treatment [15,23].

All published studies have reported negligible blood loss intraoperatively without the need for blood transfusion, except for the correction of pre-existing anaemia [20]. No blood transfusion was required in any of the 200 patients included in this study. The postoperative haemoglobin did not decrease in any patient to the level where transfusion was deemed required. All fractures showed union, with an average union time of 10.5 weeks ± 1.42, which is consistent with the published average range (11–14 weeks) [3,15,17]. We did not find any statistically significant difference in the union time between stable and unstable fracture patterns. Nonunion in trochanteric fractures is very rare because of the rich blood supply and copious cancellous bone [18].

Complications such as pin-tract infection, varus malunion (>10°) and limb shortening have been encountered in previous studies. In recent similar studies, pin-tract infection has been reported in up to 60% of cases and varus malunion with angulation of more than 10° in 8–27.3% [23]. Superficial pin-tract infection occurred in 8% of our patients. This is well below the published average owing to a newly implemented programme of patient education on pin-site care together with daily cleaning of the fixator and pins. Moroni and colleagues [3,23,24] did not encounter any superficial infections on using hydroxyapatite-coated pins and although we did not use these pins in our study, we strongly believe that their use would considerably improve the outcome and reduce the risk of pin-tract infection. The only drawback to the use of hydroxyapatite-coated pins would be the increased cost of treatment.

Other complications noted in our study included deep pin-tract infection in 3.5% of cases, with subsequent loosening of at least one pin in 2% of cases. These were managed successfully with daily dressings and oral antibiotics. Chronic sinus formation or sequestrum was not observed. There was a statistically significant increased incidence of deep pin-tract infection and loosening in patients with uncontrolled diabetes mellitus. Varus malunion was recorded in 2.5% of cases, shortening in 2% and femoral pin migration into acetabulum in 0.5%. The pin was readjusted in the outpatient environment with no anaesthesia. Retrospective analysis of the radiographs of shortened and malunited fractures showed inadequate fracture reduction intraoperatively rather than mechanical failure of the construct to maintain the reduction, which was initially speculated.

Patients were assessed for knee and hip range of movements at 6 months after the fixator had been removed. No restriction or joint stiffness was reported. All fractures were fixed using sedation and local anaesthetic femoral and lateral cutaneous nerve blocks administered by the operating surgeon. This has proved sufficient for fracture reduction on traction table as well as for pin fixation. Many authors have reported similar successful results using local anaesthesia, especially in high-risk surgical patients [8,15,18,25]. The mortality rate in our study was considerably low at 1%, which is lower than the average reported in similar published studies. Perhaps, this could be attributed to the relatively younger patient population and lower comorbidities in our study.

Conclusion

Our study strongly proves that external fixation of trochanteric fractures provides a reliable, effective and safe treatment option and could be considered as an alternative for conventional methods of fixation in all patient populations. The operative technique is simple and available to the patient at significantly less cost compared with alternative procedures such as intramedullary nailing. Moreover, the surgical stress for the patient was minimal and antibiotic administration was very rare. Postoperative pain was minimal and easily controllable, making the nursing and mobilizing of the patients easier.

External fixation offers minimal operative and anaesthetic risks, no blood loss, early mobilization and a short hospital stay, with low morbidity and mortality. It can be done under local anaesthesia, and yields equivalent union rates and final functional outcomes.

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A.R.A. designed the AlexFix external fixator but does not receive any financial gain from its use.

Conflicts of interest

There are no conflicts of interest.

References

1 Doppelt SH. The sliding compression screw — today's best answer for stabilization of intertrochanteric hip fractures. Orthop Clin North Am 1980; 11:507–523.

2 Hardy DC, Descamps PY, Krallis P, Fabeck L, Smets P, Bertens CL, *et al.* Use of an intramedullary hip-screw compared with a compression hip-screw with a plate for intertrochanteric femoral fractures. A prospective, randomized study of one hundred patients. J Bone Joint Surg Am 1998; 80:618–630.

3 Moroni A, Faldini C, Pegreffi F, Hoang-Kim A, Vannini F, Giannini S. Dynamic hip screw compared with external fixation for treatment of osteoporotic pertrochanteric fractures. A prospective, randomized study. J Bone Joint Surg Am 2005; 87:753–759.

4 Jensen JS, Tondevold E, Mossing N. Unstable trochanteric fractures treated with the sliding screw-plate system. A biomechanical study of unstable trochanteric fractures. III. Acta Orthop Scand 1978; 49:392–397.

5 Larsson S. Treatment of osteoporotic fractures. Scand J Surg 2002; 91:140–146.

6 Scott IH. Treatment of intertrochanteric fractures by skeletal pinning and external fixation. Clin Orthop 1957; 10:326–334.

7 Pugh WL. A self-adjusting nail-plate for fractures about the hip joint. J Bone Joint Surg Am 1955; 37-A:1085–1093.

8 Karn NK, Singh GK, Kumar P, Shrestha B, Singh MP, Gowda MJ. Comparison between external fixation and sliding hip screw in the management of trochanteric fracture of the femur in Nepal. J Bone Joint Surg Br 2006; 88:1347–1350.

9 Vossinakis IC, Badras LS. The external fixator compared with the sliding hip screw for pertrochanteric fractures of the femur. J Bone Joint Surg Br 2002; 84:23–29.

10 Owens WD, Felts JA, Spitznagel ELJr. ASA physical status classifications: a study of consistency of ratings. Anesthesiology 1978; 49:239–243.

11 White BL, Fisher WD, Laurin CA. Rate of mortality for elderly patients after fracture of the hip in the 1980s. J Bone Joint Surg Am 1987; 69:1335–1340.

12 Evans EM. Trochanteric fractures; a review of 110 cases treated by nail-plate fixation. J Bone Joint Surg Br 1951; 33B:192–204.

13 Foster JC. Trochanteric fractures of the femur treated by the Vitallium McLaughlin nail and plate. J Bone Joint Surg Br 1958; 40-B:684–693.

14 Kenzora JE, McCarthy RE, Lowell JD, Sledge CB. Hip fracture mortality. Relation to age, treatment, preoperative illness, time of surgery, and complications. Clin Orthop Relat Res 1984; 186:45–56.

15 Karn NK, Singh GK, Kumar P, Singh MP, Shrestha BP, Chaudhary P. Management of trochanteric fractures of the femur with external fixation in high-risk patients. Int Orthop 2009; 33:785–788.

16 Lunsjo K, Ceder L, Thorngren KG, Skytting B, Tidermark J, Berntson PO, *et al.* Extramedullary fixation of 569 unstable intertrochanteric fractures: a randomized multicenter trial of the Medoff sliding plate versus three other screw-plate systems. Acta Orthop Scand 2001; 72:133–140.

17 Vossinakis IC, Badras LS. Management of pertrochanteric fractures in high-risk patients with an external fixation. Int Orthop 2001; 25:219–222.

18 Tomak Y, Kocaoglu M, Piskin A, Yildiz C, Gulman B, Tomak L. Treatment of intertrochanteric fractures in geriatric patients with a modified external fixator. Injury 2005; 36:635–643.

19 Boghdady GW, Shalaby M. Safety and reliability of external fixation for basicervical and intertrochanteric fractures in high-risk elderly patients. Strategies Trauma Limb Reconstr 2007; 2:83–89.

20 Kourtzis N, Pafilas D, Kasimatis G. Management of pertrochanteric fractures in the elderly patients with an external fixation. Injury 2001; 32:SD115–SD128.

21 Christodoulou NA, Sdrenias CV. External fixation of select intertrochanteric fractures with single hip screw. Clin Orthop Relat Res 2000; 381:204–211.

22 Kazakos K, Lyras DN, Verettas D, Galanis V, Psillakis I, Xarchas K. External fixation of intertrochanteric fractures in elderly high-risk patients. Acta Orthop Belg 2007; 73:44–48.

23 Petsatodis G, Maliogas G, Karikis J, Christodoulou AG, Venetsanakis G, Sachinis N, *et al.* External fixation for stable and unstable intertrochanteric fractures in patients older than 75 years of age: a prospective comparative study. J Orthop Trauma 2011; 25:218–223.

24 Moroni A, Faldini C, Pegreffi F, Hoang-Kim A, Giannini S. Osteoporotic pertrochanteric fractures can be successfully treated with external fixation. J Bone Joint Surg Am 2005; 87:42–51.

25 Devgan A, Sangwan SS. External fixator in the management of trochanteric fractures in high risk geriatric patients — a friend to the elderly. Indian J Med Sci 2002; 56:385–390.