External fixation of trochanteric fractures in elderly high-risk patients

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Background
Although open reduction/internal fixation is the gold standard for treatment of trochanteric fractures, the treatment of these fractures in elderly high-risk patients is highly challenging because of the risks associated with anaesthesia and open surgery as a result of significant comorbid factors. Closed reduction/external fixation under sedation/local anaesthesia may be an attractive solution.

Patients and methods
Twenty elderly high-risk patients [ASA 3 (nine patients) and ASA 4 (11 patients)] were treated by external fixation (under sedation/local anaesthesia) for trochanteric femoral fractures. Postoperatively, early mobilization was started.

Results
The mean time for fixator application was 20 min with no intraoperative complications. Two patients died within the first postoperative month and thus were excluded from the study. After a mean follow-up period of 11 months, 11/18 (61.1%) patients returned to their prefracture mobility level. The mean time for union was 10.5 weeks. Fixators were removed after a mean of 13 weeks. Mild pin site problems occurred in 30/85 sites (35.3%) in 17 patients. Grade IV infection occurred in one, with removal of fixator at 7 weeks postoperatively. Initial knee and hip stiffness occurred in most patients while the fixator was in place. However, most patients nearly completely gained their preoperative range of motion of the hip and knee finally. There were no iatrogenic or neurovascular complications and no pin breaking or migration. Three mortalities (15%) occurred because of underlying medical diseases.

Conclusion
External fixation of trochanteric fractures may be a wise and viable option in high-risk geriatric patients, with major advantages: it is minimally invasive, can be performed under local anaesthesia, and involves less amount of blood loss, short operative time, shorter hospital stay, fast/good functional recovery and mobilization and reasonably minor complications.

Keywords:
external fixation, high-risk elderly patients, local anaesthesia, trochanteric fractures

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Introduction

A steady increase in the life span of the normal population may explain recent reports on the increasing number of patients with trochanteric fractures [1]. The gold standard of treatment of trochanteric fractures is open reduction/internal fixation (ORIF) [2].

The treatment of these fractures in elderly high-risk patients with poor general health (due to associated uncontrolled or poorly controlled diseases) constitutes a great challenge. These patients are unable to tolerate lengthy periods of conventional anaesthesia or any appreciable blood loss associated with ORIF and are also unable to tolerate serious complications of prolonged recumbency associated with conservative treatment [2–4].

The goal of treatment remains restoration of the patient to his/her preoperative status as early as possible with low morbidity and mortality [2,5].

The technique of closed reduction and external fixation (performed under sedation and local anaesthesia) represents an attractive alternative, as it offers significant advantages in high-risk geriatric patients in the form of minimal blood loss, minimal surgical trauma, preservation of fracture haematoma, a relatively shorter hospital stay, early mobilization of the patients and removal of implant as an easy outpatient procedure [2,6].

The aim of this study was to report the results of treatment of trochanteric fractures in elderly patients susceptible to high anaesthetic and surgical risk by closed reduction and external fixation under sedation and local anaesthesia.

Patients and methods

During the period between June 2006 and July 2008, 20 elderly high-risk patients were treated by closed reduction

and external fixation for trochanteric femoral fractures. The mean age of the patients was 66 years (range: 60–80 years). Nine patients were women and 11 were men. All of them were considered high-risk patients because of associated uncontrolled or poorly controlled medical diseases. These included cardiopulmonary diseases, diabetes, severe anaemia, coagulopathy and compromised hepatic and renal function. More than one comorbidity was present in most of them. The patients were considered unfit for general or even regional anaesthesia by anaesthetists at our institution. Exclusion criteria were as follows: open fractures, pathological fractures secondary to malignancy, chemotherapy, severe obesity, fractures with subtrochanteric extension and senile dementia that would interfere with compliance of the patient to the postoperative rehabilitation programme.

Complete preoperative data were collected, including preinjury status of ambulation and activity level, medical condition and comorbid diseases/medications, as well as fracture type, displacement, comminution, neck/shaft angle of the unaffected side and bone density.

According to the American Society of Anaesthesiologists (ASA) scale [7], 11 patients were ASA 4 and nine were ASA 3 (Table 1).

According to AO/OTA classification [8], fractures were A1 (eight patients) or A2 (12 patients). Variable degrees of osteoporosis were evident in all patients (from history of minor trauma to radiological features of osteoporosis).

Three patients were operated upon on day 1 and five within 2 days. The remaining patients presented late as referrals from other centres and were operated upon within 1 week of fracture.

The fixator used, an Alex fixator, was a locally made. It is composed of a simple circular clamp and a long central bolt. The clamp has three components: a central pad and two opposing rotating components having many slots, allowing different positions and directions for pins.

Operative technique

The procedure was performed under analgesia, mild sedation and local anaesthetic infiltration (at the base of the greater trochanter and the middle of the thigh).

Reduction

All fractures were reduced on the fracture table by gentle traction and internal rotation of the slightly abducted limb and were checked by fluoroscopy. The fixator application never started before the best acceptable reduction was achieved. Reduction should achieve contact of as big as surface area of fracture as possible, in normal (or slight valgus) neck/shaft angle, as compared with the contralateral side. Excessive valgus angulation, varus angulation and internal rotation were avoided. Fractures were considered stable when contact of the posteromedial buttress could be restored.

Table 1 The American Society of Anaesthesiologists scale [7]

Grades	Description
ASA 1	A normal healthy patient
ASA 2	A patient with mild systemic disease
ASA 3	A patient with severe systemic disease
ASA 4	A patient with severe systemic disease that is a constant threat to life
ASA 5	A moribund patient who is not expected to survive without the operation
ASA 6	A declared brain-dead patient whose organs are being removed for donor purposes

ASA, American Society of Anaesthesiologists.

Application

Using an image intensifier, 5–6 mm-diameter Schanz screws were passed across the fracture site percutaneously along the axis of the neck of the femur at an angle of 125–130° with the shaft using a low-speed drill. Both pins were parallel in anteroposterior view and central in lateral view. The superior pin was passed just above the centre of the neck and the head, and the inferior pin was passed along the inferior part of the neck and the head. Pins were advanced to a point 5–10 mm short of the subchondral bone of the head. Once the fracture site was stabilized by 'trochanteric' pins, three 5–6 mm-diameter Schanz screws were introduced at a right angle to the shaft of the femur as close as possible to the fracture site; then the clamp of the fixator was tightened [2,5].

Postoperative care and follow-up

(1) Parenteral antibiotics, which were started preoperatively, continued postoperatively for 2–3 days.
(2) Thromboembolic prophylaxis by low-molecular-weight heparin, which was started preoperatively, continued postoperatively for 1–2 weeks.
(3) Pin sites were dressed daily with saline (± betadine) and the families of the patients were given instructions for continuing care after discharge. For preventing skin mobility, the pin sites were wrapped continuously. This is especially important for proximal pins.
(4) Rehabilitation:
    (a) Patients were assisted in sitting, knee bending and quadriceps exercises from the second day of surgery.
    (b) Non-weight-bearing walking with only toe touching using a frame was started 48 h after the operation in compliant patients and was continued for the first 4–5 weeks. Thereafter, patients were allowed partial weight bearing for the next 4 weeks according to pain tolerance, and full weight bearing was allowed after adequate clinical and radiological signs of fracture union were seen.
    (c) Appropriate physiotherapy was advised for hip and knee motion.
(5) The fixator was removed after a mean period of 12 weeks (range: 7–16 weeks) without anaesthesia in the outpatient clinic.

Upon discharge, the patients were evaluated clinically and radiologically on a biweekly basis for the first month,

then monthly for the next 5 months, and subsequently every 6 months.

A follow-up chart was designed for recording clinical findings on each visit (pain, range of motion, pin track condition, mobility and complications). On each radiograph, the following were measured and documented: pin site migration, penetration, loss of position or loosening, change of reduction/fixation, femoral neck shaft angle and union.

Results

Intraoperative results

The mean operative time was 30 min (range: 25–50 min), including time for closed reduction of the fracture but excluding the time taken for achieving complete anaesthesia. The mean actual time for fixator application was 20 min (range: 15–30 min). No intraoperative complications were encountered. There was no need for intraoperative blood transfusion in any patient because blood loss was negligible. However, preoperative and/or postoperative blood transfusion was needed for correction of pre-existing anaemia in six patients.

Postoperative results

Excluding two patients who died within the first postoperative month, the mean duration of follow-up of the remaining 18 patients was 11 months (range: 8–16 months). The mean duration of hospital stay was 4.5 days (range: 3–7 days).

Postoperative pain

Within 3 days after surgery, about 75% of patients reported no or mild pain. However, pain increased gradually afterwards until the time of fixator removal (probably because of discomfort and pin track infection). Upon removal, the pain decreased gradually again and 86% of patients reported no or mild pain at final assessment.

Function

Before injury, eight patients were walking freely, six were walking with the aid of a stick, and four had difficulty walking and required assistance. Postoperatively, 11/18 patients (61.1%) returned to their prefracture mobility level (three could walk freely, five could walk with the help of a stick and three, although experiencing difficulty walking, could do so with assistance or using a frame walker); no patient remained nonambulant.

Reduction

The mean femoral neck/shaft angle at the early postoperative period was normal or in slight valgus in all except four patients of varus angulation. This angle was seen to have decreased by about 5° on the final radiograph. Only in one patient who suffered pin track infection that required early removal of the fixator did the neck/shaft angle decreased by 15°, leading to varus angulation of 20°.

The mean time for union (defined by the presence of trabeculae bridging the fracture site or obvious callus within the fracture line) was 10.5 weeks (range: 9–14 weeks).

External fixators were removed after a mean period of 13 weeks (range: 7–16 weeks). They were kept for about 2 weeks after radiological union and then removed. Obligatory early removal (7 weeks postoperatively) was required in one patient because of resistant pin track infection; the fracture united but in varus.

Complications

Mortality: Three patients out of 20 (15%) died because of comorbid problems that were unrelated to the operation. Two mortalities occurred within the first month postoperatively, whereas one patient died 8 months postoperatively (after complete radiological union).

Pin track infections were graded on a scale of 1–6 according to Checketts *et al.* [9]. Grades I–III are minor infections that respond to outpatient treatment, and an external fixator can be continued. Most pin site infections are of grade 1 and include slight redness and little discharge, which settles with improved pin site care. They differ from those of grade II in having pain and tenderness, requiring, in addition to pin care, a course of oral antibiotic. Grades IV–VI are major infections that usually involve more than one pin, do not respond to treatment, and an external fixator has to be abandoned [9]. In the present study, mild pin site problems (G 1–2) occurred in one or more pin sites in 17 patients; a total of 30/85 pin sites (35.3%), the majority being proximal pins, caused problems. Grade III and IV infections occurred in three patients close to the time intended for removal and hence did not require earlier removal. Grade IV infection occurred in one patient (with poorly controlled diabetes) early before full union of fracture and required removal of the fixator at 7 weeks postoperatively.

Loosening of screws was found in one or more Schanz screws in nine out of 17 patients (52.9%) at the time of removal. This was not associated with significant loss of position or failure of fixation.

Limb shortening occurred in four patients (22.2%): 1–1.5 cm in three cases and 2.5 cm in one case of early removal of fixator. Shortening resulted from impaction and varus angulation.

Malunion in varus position occurred in four patients (22.2%): 10–15° in three patients and 20° in one patient.

Initial knee stiffness was noticed in 13/18 patients (72.2%). In these patients, while the fixator was in place, the range of knee motion was 40–70°. It improved after removal of the fixator. However, stiffness presented for a variable period of time. At the time of final follow-up, the average range of motion around the knee was 100°. Hip range of motion was initially low but it increased over a period of time. By final assessment, most patients had gained near-complete preoperative range of motion of their hips and knees.

Some patients experienced discomfort and difficulty in lying supine as the fixator was pressing against the mattress. These patients were made comfortable by some elevation under the trunk. The fixator did not interfere with sitting or lying on the unaffected side. There were no iatrogenic or neurovascular complications. There was no case of pin breaking or metal failure and no migration of pins or penetration of femoral head in this series (Figs 1 and 2).

Discussion

Trochanteric fractures (in general) can be treated conservatively or operatively, with ORIF now being the gold standard of treatment. The treatment of these fractures in elderly patients is problematic because of the high risk associated with anaesthesia and open surgery as a result of significant comorbid factors [2,10,11].

Obtaining a perfect reduction of trochanteric fractures need not be the main objective for this high-risk group; instead, the aim could be to operate with the least blood loss in the shortest possible time using a low-risk anaesthetic technique, ultimately achieving proper positioning and stable fixation of the fracture and facilitating early mobilization in the postoperative period [2,5].

The present study was conducted using the minimally invasive technique of external fixation for the management of trochanteric fractures in elderly high-risk patients with poor medical status and high ASA grade.

The present study and the series of studies conducted by many surgeons [2,10,11] showed that an external fixator can be applied under local anaesthesia with sedation and was appropriate for these vulnerable patients after our anaesthesia staff reported that these patients were unfit even for regional anaesthesia. Boghdady and Shalaby [5] used anaesthetic block of the femoral nerve and the lateral cutaneous nerve of the thigh with successful results. Others [12–14] used epidural or spinal anaesthesia. However, there is consensus to avoid general anaesthesia [13].

Many types of external fixation techniques and its modifications thereof have been introduced [2,12–16]. In developing countries, most of these types of fixators are expensive and cannot be afforded by patients or hospitals [2].

The low cost, availability, simplicity and easy application of the Alex external fixator (which is locally made) were the reasons for using it in the present study.

The mean operative time for fixator application in the present study was 20 min, which was similar to the duration recorded by Kourtzis *et al.* [3] and Vossinakis *et al.* [15] and less than those recorded by Tomak *et al.* [16] and Christodoulou *et al.* [12].

As was reported in previous studies [2,5,13,16,17], no intraoperative complications occurred and there was no need for intraoperative blood transfusion as the blood loss was negligible.

The mean period of hospital stay in the present study and in others [2,18] (3–4.5 days) was less than those recorded by Kourtzis *et al.* [3] (7.2 days), Christodoulou *et al.* [12] (6 days), Vossinakis *et al.* [15] (8 days) and Tomak *et al.* [16] (7.8 days). In this study, the decision to perform stabilization using an external fixator was made earlier and hence was performed without delay after the routine clinical and investigational assessment on admission. The patient was discharged as soon as ambulation with a walker was deemed safe and care of fixator pin sites had been taught. Thus, we can conclude that use of an external fixator is superior as it does not cause any delay in surgery [2].

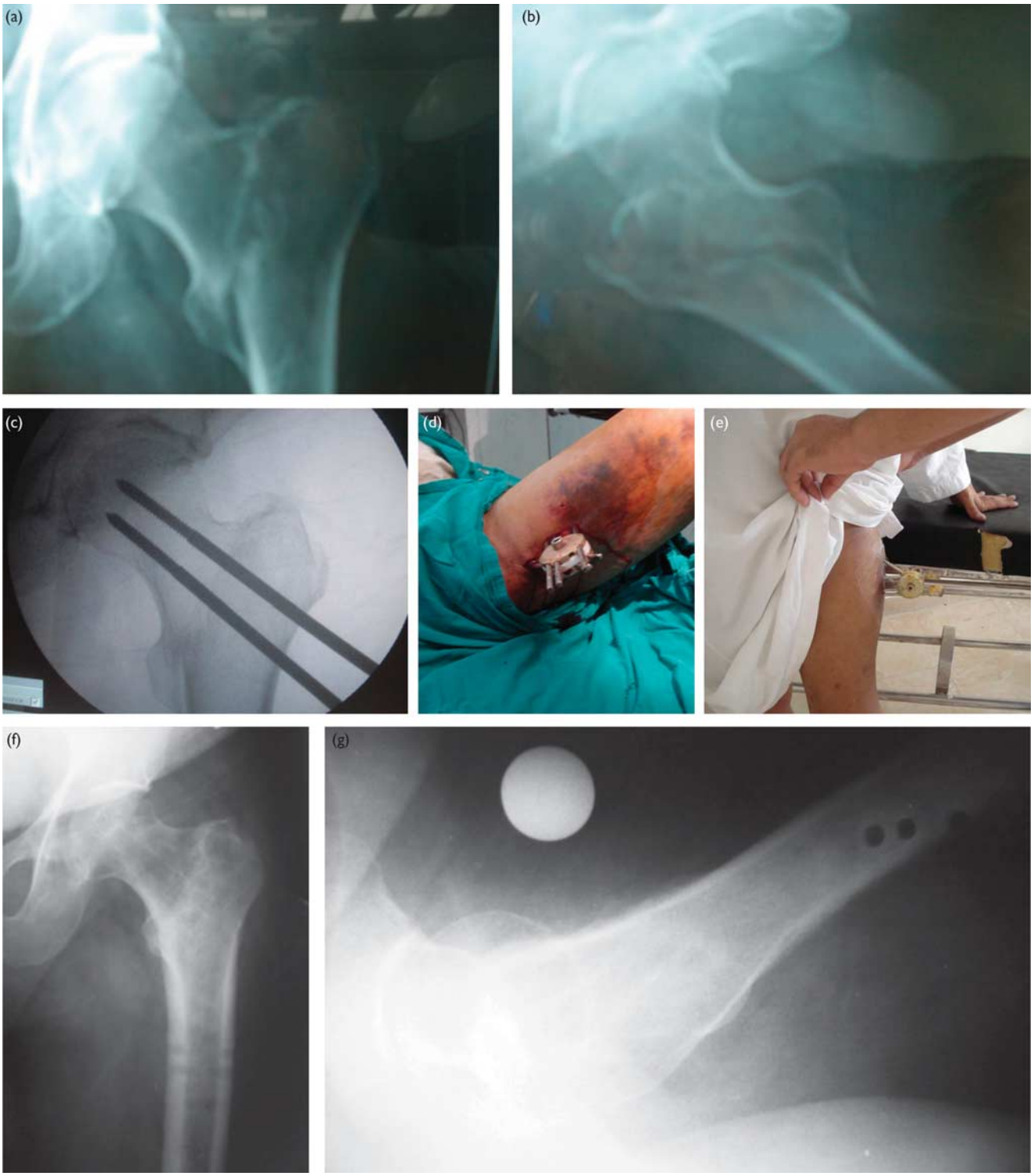
In this series, non-weight-bearing walking with only toe touching using a frame was started 48 h after the operation in compliant patients and continued for the first 4–5 weeks, followed by partial weight bearing for the next 4 weeks according to pain tolerance; full weight bearing was allowed after adequate clinical and radiological signs of fracture union were seen. This is comparable to the procedure adopted in the series by Gani *et al.* [2]. However, Mitković *et al.* [18] allowed earlier full weight bearing without detrimental effects.

The mean time needed to achieve union in the present study (10.5 weeks) was similar to that reported by Gani *et al.* [2] and Ozdemir *et al.* [19], but less than that reported by other studies [4,10,16] (12–16 weeks). The mean age of patients in the present study was relatively lower than those of the three aforementioned studies. This may account for the rapid union rate achieved. Union is not a problem, as intertrochanteric fractures are through vascular cancellous bone [2,19].

As with previous studies [2,5,10,16,19], the most common complication in the present study was mild pin site problems (G 1–2) occurring in one or more pin sites in 17 patients; 30/85 pin sites (35.3%) caused problems, the majority being proximal pins. Management by administration of oral antibiotics, application of a local antibiotic preparation and meticulous care of the skin around the pins was successfully carried out. Grade III and IV infections occurred in three patients near the time intended for removal and hence did not require earlier removal. Another patient developed a deep pin track infection that necessitated removal of the pin 7 weeks postoperatively before full union of fracture. Union was delayed to 14 weeks with varus of 20° and shortening of 2.5 cm. However, the rate of severe infection seen in the present study is less than that reported by other studies [3,4,16].

Loosening was found in one or more Schanz screws in nine out of 17 patients (52.9%) at the time of removal. This when viewed in the light of all fractures uniting with no significant loss of position or failure of fixation may indicate that loosening had gradually dynamized and increased the load sharing among fractures while neither interfering with union nor causing significant change in

Figure 1

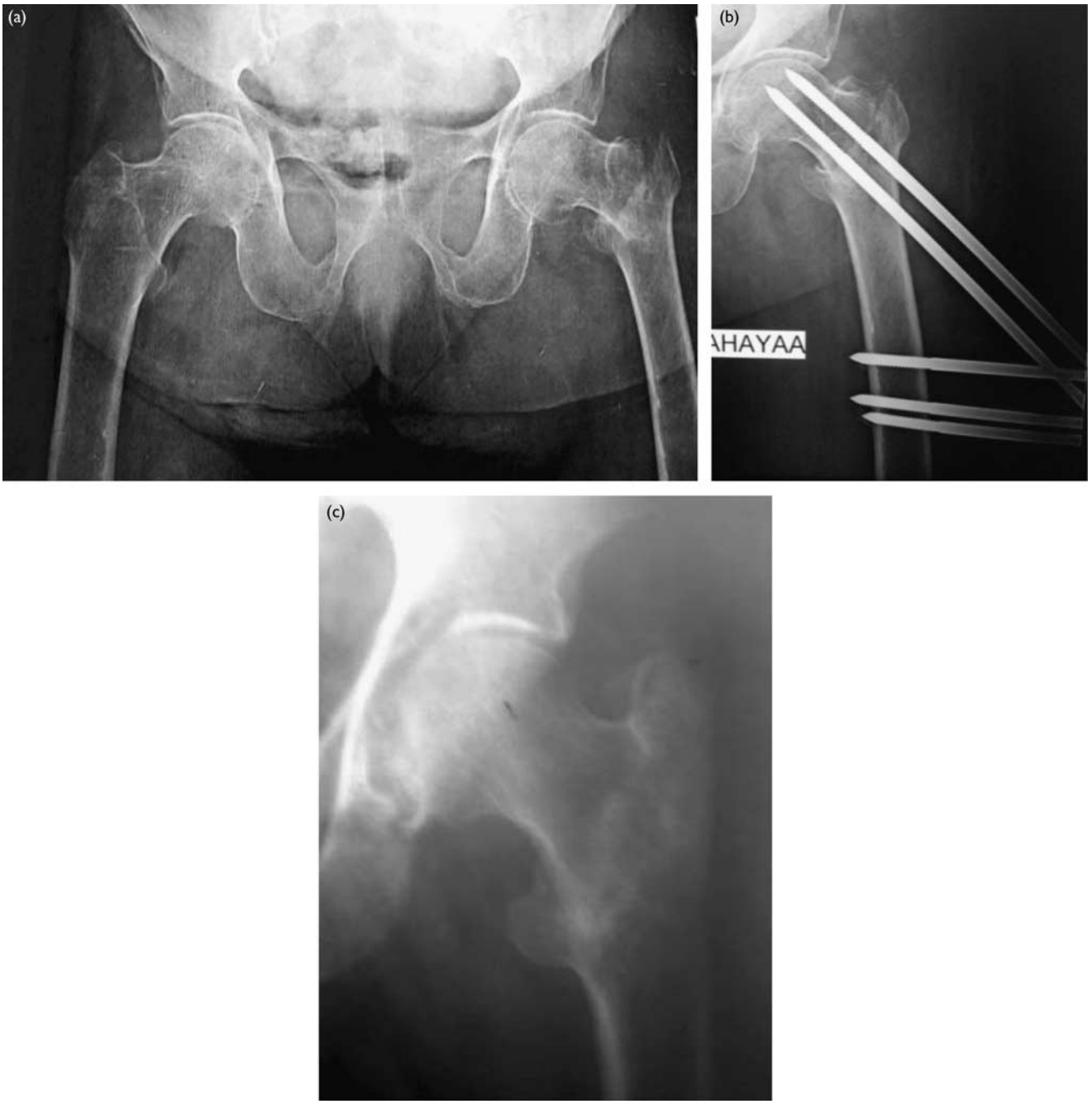


A 63-year-old male hepatic patient. The fracture united in a good position with a satisfactory clinical outcome. (a, b) Preoperative radiographs; (c) intraoperative fluoroscopic view; (d) intraoperative photo; (e) patient standing (in fixator); and (f, g) final radiographs.

position. This is comparable to that reported by El-Shafie [11].

Limb shortening (1–2.5 cm) and varus malunion (10–20°) occurred in four patients (22.2%). Shortening probably resulted from impaction and varus angulation. This incidence is comparable to that reported by many previous studies [1,4,12]. However, Gani *et al.* [2] and Kourtzis *et al.* [3] suggested that, although this seems to be suboptimal, the low demands of the elderly in terms of mobility permit this degree of shortening to be of no significant functional compromise and the main aim of returning these patients to early ambulation was served.

Figure 2



A 61-year-old female patient with hepatorenal dysfunction. Satisfactory final outcome. (a) Preoperative radiograph; (b) postoperative radiograph; and (c) final radiograph.

Postoperatively, 11/18 (61.1%) patients returned to their prefracture mobility level. This is comparable to the rate reported by many other authors [2,5,11,16].

Knee stiffness is probably the result of transfixing the vastus lateralis muscle, but it was temporary in most cases, recovering to a reasonable range after removing the pins. The range of motion of the hip was initially low, but at the final follow-up all patients had good range of motion. Similar findings were reported by many others studies [2,5,10,14,15].

Three mortalities (15%) occurred in this study: two in the first month and one after 8 months. The overall 1-year mortality rate is comparable to that of other studies [2,3,12]. The mean age of the patients and the pre-existing diseases accounted for the mortality in this patient group [2,3].

Conclusion

External fixation of trochanteric fractures may be a wise and viable option in high-risk geriatric patients, considering the morbidity and mortality associated with open reduction and internal fixation and prolonged recumbency of conservative treatment in this high-risk group.

External fixation offers major advantages in this fragile group of patients. It is minimally invasive, with no additional tissue trauma and can be performed under local anaesthesia. Further, it causes less blood loss, requires short operative time, requires a shorter hospital stay and can allow fast and good functional recovery and mobilization. This procedure is associated with reasonable minor complications, the most common being superficial pin track infections.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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