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Original Article

Outcomes of trochanteric external fixation for geriatric inter-trochanteric hip fractures

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ABSTRACT

Introduction: Trochanteric fractures are a leading cause of disability among the elderly. Internal fixation is the gold standard treatment. However, it may be challenging in the high-risk population. We present our results using external fixator in trochanteric fractures in the elderly.

Patients and methods: During 2005–2012, twenty-three high-risk elderly patients (average age 70 years) with trochanteric fracture were managed using percutaneous external fixation (EF).

Results: At one year follow-up, 86% returned to pre-fracture ambulatory status. Average time to fixator removal was 14 weeks. There were no cases of pin loosening, breakage, or penetration of femoral head.

Conclusion: Advantages of EF include avoidance of delay, use of local/regional anesthesia, and shorter duration of surgery, blood loss and hospital stay. EF is an acceptable alternative in this patient population, given the associated co-morbidities and especially due to limited resources in developing countries.

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1. Introduction

Trochanteric hip fractures are one of the most common fractures and a leading cause of disability among the elderly.^{1–3} Management of these fractures in elderly, high-risk population is challenging.^{4–6} Operative goals for this patient cohort are restoration of anatomical alignment, stable fixation, achieving high union rates, minimizing blood loss, shortening operative time and early weight bearing.^{1,7,8} Various methods

of fixation are described for trochanteric fractures – sliding hip screw, compression plating, fixed angle blade-plate, intramedullary nailing and external fixation.^{8–10} Internal fixation using a sliding hip screw is common; however the functional outcomes following sliding hip screw fixation in osteoporotic bone are not always satisfactory.^{8,10,11} Internal fixation may also add to the burden of disease in elderly, high-risk patients and may adversely affect the clinical outcomes.⁴ External fixation was introduced several decades ago for the management of intertrochanteric fractures. However a high prevalence of

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postoperative complications such as pin-loosening, infection, and mechanical failure of the fixator resulted in discontinuation of its use.^{3,12} In the last decade, the advancement of external fixators and the introduction of new materials such as hydroxyapatite coated pins as well as better understanding of the mechanics of fracture healing in osteoporotic bone has prompted surgeons to reconsider external fixation as an alternative method for trochanteric fracture management.^{13–16} The purpose of this study is to describe our outcomes of external fixation in management of trochanteric fractures in high-risk elderly patients.

2. Patients and methods

We retrospectively reviewed medical records for elderly patients presenting with trochanteric fracture and managed with external fixation, between 2005 and 2012. Inclusion criteria included age above 60 years, radiographic diagnosis of trochanteric fracture and American Society of Anesthesiologists (ASA) grades III or IV (Table 1). Exclusion criteria included dementia, reverse obliquity fractures, previous hip fracture, and pathological fractures. Diabetes mellitus was considered a relative contraindication due to the increased risk of pin-track infection and these patients were operated after glycaemia control. Twenty three patients met the inclusion criteria. The fractures were classified according to the modified Evans classification as stable ($n = 15$) and unstable ($n = 8$), all reducible under image intensifier.^{17,18}

2.1. Surgical technique

The medical co-morbidities allowed the use of spinal anesthesia in 16 cases. The other 7 patients received a combination

of an intramuscular injection of a sedative (5–10 mg diazepam) and analgesics (50 mg tramadol), 20 min before surgery. Immediately pre-operatively, 1% xylocaine was infiltrated at the proposed site of pin insertion besides applying a lateral cutaneous nerve block. With the patient supine on the fracture table, the fracture was reduced by gentle traction in hip flexion and abduction in moderate external rotation followed by gentle extension and internal rotation. The reduction was checked by image intensifier in both planes. Fracture reduction was assessed by evaluating major fragment translation and the femoral neck-shaft angle. Less than 5 mm of translation or gap and a neck-shaft angle with minor valgus ($<15^\circ$) compared with the contralateral side were considered as a sufficient reduction on the antero-posterior view. In the lateral view less than 20° of angulation was considered acceptable.⁷

Under image intensifier, two hydroxyapatite coated 6.5 mm Schanz screws were inserted along the femoral neck from the lateral aspect of the thigh in convergent or parallel fashion with attention to ensure that the tip of the screws were at least 5 mm shy of the articular surface to prevent penetration (Fig 1a).¹⁹ Two 6 mm Schanz screws were then inserted perpendicular to the proximal part of the femoral shaft and were positioned up to two screw thread depths through the opposite cortex. The external fixator frame (Orthofix, Verona, Italy) was then mounted and tightened. The operative time was measured from the time of incision for the implantation of the first pin to when the fixator was completely mounted. Blood loss was estimated on the basis of the number of soaked sponges. All patients received pre-operative subcutaneous enoxaparin, which was stopped 6 h before surgery and restarted post-operatively until regular ambulatory status was regained.

Table 1 – Demographic data of all patients in the study.

Order of pt.	Age (years)	Gender	Side	ASA grade	Time (min)	Follow-up (months)
1	64	M	RT	IV	40	38
2	77	F	RT	III	20	32
3	68	F	RT	IV	33	32
4	65	M	LT	IV	15	30
5	72	F	LT	IV	25	28
6	71	M	RT	IV	28	Died
7	73	F	RT	III	15	24
8	70	M	RT	III	30	24
9	65	F	LT	IV	25	23
10	70	M	LT	III	32	Died
11	64	M	LT	III	35	22
12	66	F	RT	III	20	20
13	63	F	RT	III	20	20
14	62	F	RT	IV	40	18
15	77	F	RT	III	20	16
16	68	M	LT	IV	18	16
17	78	M	RT	III	42	16
18	74	M	RT	III	22	15
19	68	F	LT	IV	30	15
20	69	F	RT	IV	30	14
21	74	M	RT	III	28	14
22	63	F	RT	III	18	12
23	81	M	RT	III	38	12

Fig. 1 – a. Radiograph showing intra-operative reduction of left trochanteric fracture. b. Patient with left trochanteric external fixation during post-operative follow-up visit. c. Antero-posterior radiograph of left hip showing radiographic union of trochanteric fracture at latest follow-up. d. Frog-leg view of left hip showing radiographic union of trochanteric fracture at latest follow-up.

2.2. Post-operative protocol

Post-operative mobilization was started for all patients within 6–12 h of surgery. Patients with stable fractures ($n = 15$) were allowed immediate partial weight bearing (25%–50%) followed by full weight bearing after adequate clinical and radiological signs of fracture union were present. In unstable fractures ($n = 8$), patients were allowed toe-touch weight-bearing with crutches for the first six weeks, followed by partial weight bearing for the next four weeks. All patients were seen in the clinic every two weeks for the first four weeks and then monthly except if there were any signs of pin tract infection. At each visit, patient satisfaction and function were assessed through verbal assessment. Clinical exam of the pin entry sites, hip and knee range-of-motion (ROM) and quadriceps strength along with ability to ambulate with or without support were also evaluated. Standard two-view hip radiographs were also obtained at each visit to document fracture union. Pin sites were dressed daily with saline and the families of the patients were given instructions for continuing care after discharge. Appropriate rehabilitation was advised for hip and knee ROM. External fixators were removed in the outpatient department after radiographic union was achieved (Fig. 1c, d).

Radiographic union was defined by the presence of trabeculae bridging the fracture site or obvious periosteal callus within the fracture line.

3. Results

There were 11 male and 12 female patients ($n = 23$), with an average age of 70 years (62–81 years). The right hip was involved in 16 cases and the left in seven. Ten patients belonged to ASA IV group and 13 patients belonged to ASA III group. Two patients died (two males, both fulminant liver failure, two months post-operative) during follow-up, leaving only 21 patients (12 females and 9 males) available for final assessment. The average time for surgery was 27 min (range 15–42 min) and average blood loss was 30 ml (range 20–40 ml). Average follow-up was 21 months (range 12–38 months), and average postoperative hospital stay was three days (range 2–4 days). The average time to fixator removal was 14 weeks. There were no cases of pin loosening, breakage, or penetration of femoral head. Grade I pin-track infection was observed in 18 patients (78%).²⁰ No grade II, III, or IV infections were observed. The infections were successfully treated and resolved within 2

weeks on oral antibiotics and daily cleansing with antiseptic solutions. Upon removal of the pins, no residual infection was detected. The fixator was well accepted and no patient had any difficulties while sitting or lying (Fig. 1b). Twelve patients (57%) had an average limb shortening of 15 mm (range 5 mm–20 mm). This was the result of impaction and/or collapse in varus that occurred in all unstable fractures and some stable fractures. At final follow-up, eight patients (38%) had an average varus angulation of 10° (range 5°–15°). Functional results were graded using Judet's grading system.²¹ There were 17 (81%) excellent, 3 (14%) good, 1 (5%) fair results and no poor results. At 1 year, 18 of the 21 (86%) surviving patients had returned to their pre-fracture functional status and were able to walk using a walking aid.

4. Discussion

Trochanteric hip fractures are one of the most common fractures and a leading cause of fracture related death and disability among the elderly.^{1–3} When managed conservatively, these fractures are associated with high mortality (up to 60%), and hence operative management is necessary except in terminally ill or non-ambulatory patients.^{4,6,22} Internal fixation using sliding hip screw or intra-medullary nailing remains the gold standard for management. However, elderly population with co-existing morbidities may not be the most suitable candidates for definitive internal fixation of these fractures.^{4–6} Geriatric patients with co-morbidities who sustain an intertrochanteric fracture may require prolonged hospital stay following conventional fixation of their fracture. The need to reduce risks of open fracture fixation, permit early mobilization, and reduce hospital stay has prompted several authors to propose external fixation as an alternative treatment option for these elderly high-risk patients.^{5,6,9,23}

We retrospectively reviewed our experience of treating elderly patients with trochanteric fracture using external fixation. We found that functional outcome at one year in most of our patients was good to excellent; 86% returned to pre-fracture functional level, as was seen in various other studies.^{2,3,5–7,11,14} The mean operative time was short (27 min) and the average blood loss was minimal (30 ml) with no cases requiring blood transfusion, similar to prior studies.^{10,19} Fixator acceptance and absence of any significant difficulties while sitting or lying were in agreement with previous reports.^{14,24,25} No morbidity directly attributable to external fixation of trochanteric fractures was identified; however, two patients died of medical reasons and were excluded (Table 1).

Scott first described the use of external fixation in trochanteric fractures in 1957. However its use fell out of favor due to failures related to pin-loosening, infection, and mechanical failure of the fixator.¹² With advancements in types of external fixators and introduction of hydroxyapatite coated pins in recent decades, trochanteric fractures treated with newly-developed external fixators have shown better results than those reported previously.^{2,3,5–7,14} Trochanteric external fixator has been mainly used in elderly high-risk patients, as well as in multiple injury patients with complex fractures of the trochanteric region.²⁴ Advantages of external fixation include quick and simple application, minimal blood loss,

possibility of performing the procedure under local anesthesia, less radiation exposure, pain reduction, satisfactory stability, and early weight-bearing compared to conventional fixation techniques.^{2,3,5–7,14}

One of the many challenges in managing elderly patients with hip fractures are the risks associated with general anesthesia – mainly post-operative mortality and cognitive dysfunction.^{26,27} Studies have shown a decrease in early post-operative mortality and cognitive dysfunction as well as shorter length of hospital stay in elderly patients undergoing major non-cardiac surgery under regional anesthesia compared to general anesthesia.^{26,27} We believe that the use of regional anesthesia in this patient cohort is particularly beneficial as it may facilitate early post-operative mobilization, co-operative participation in physical therapy and hence early return to pre-fracture functional level. The ability to quickly apply external fixator using local anesthesia and its easy removal in the outpatient clinic makes it a worthy alternative in elderly, high-risk patients with trochanteric fractures compared to gold standard internal fixation techniques that may require general anesthesia.^{1,11,25}

Pin-track infection has been reported to be a common complication.^{2,3,6,15} The incidence of pin-track infection is decreased with the use of hydroxyapatite coated pins compared to conventional pins.¹⁵ Grade I pin-track infection was seen in 18 patients (78%) and was treated with regular saline washes, antiseptic dressing, oral antibiotics, and finally with the removal of pins and frame after complete fracture union. Vossinakos and Badras³ reported that pin-track infection developed in 15 of their 50 patients (30%) treated with the orthofix external fixator using standard pins. In similar studies, 45% and 60% had pin-track complications.^{2,6}

Varization and limb shortening due to varus collapse are mechanical complications commonly reported after either internal or external fixation of unstable or severely osteoporotic trochanteric fractures. However, fracture non-union is uncommon as trochanteric fractures occur through the vascular cancellous bone. In our study involving high-risk, elderly patients, most had poor bone quality. Varization of an average of 10° was noted in 8 cases (38%), which is close to results reported previously.²⁴ Use of hydroxyapatite coated pins has shown to decrease the incidence of varus collapse in a similar study, this was attributed to presence of bone ingrowth into the coating.¹⁴ External fixation enhances fracture stability in stable trochanteric fractures by its tension band effect and in unstable trochanteric fractures it enhances load sharing by promoting callus formation.^{1,24}

In summary, our study shows that external fixators are appropriate for trochanteric fractures in geriatric, high-risk patients with multiple co-morbidities, as they can be applied under local anesthesia with sedation. They avoid delay in surgery and reduce the duration of the procedure and blood loss. The complications of the procedure are minimal. Reduction can be maintained until healing with minimal amount of varus and collapse. These advantages are of considerable importance given the co-morbidities associated with these fractures and especially the limited availability of resources in developing countries.

Conflicts of interest

All authors have none to declare.

REFERENCES

1. Petsatodis G, Maliogias G, Karikis J, et al. External fixation for stable and unstable inter-trochanteric fractures in patients older than 75 years of age: a prospective comparative study. *J Orthop Trauma*. 2011;25:218e23.
2. Christodoulou NA, Sdrenias CV. External fixation of select intertrochanteric fractures with single hip screw. *Clin Orthop*. 2000;381:204–211.
3. Vossinakis IC, Badras LS. The external fixator compared with the sliding hip screw for pertrochanteric fractures of the femur. *J Bone Joint Surg*. 2002;84–B:23–29.
4. Kenzora JE, McCarthy RE, Lowell JD, Sledge CB. Hip fracture mortality: relation to age, treatment, preoperative illness, time of surgery and complications. *Clin Orthopedics*. 1984;186:45–56.
5. Vossinakis IC, Badras LS. Management of pertrochanteric fractures in high-risk patients with an external fixation. *Int Orthop*. 2001;25:219–222.
6. Karn Navin Kumar, Singh Giris Kumar, Kumar Pankaj, Singh Mahi Pal, Shrestha Bikram Prasad, Chaudhary Pashupati. Management of trochanteric fractures of the femur with external fixation in high-risk patients. *Int Orthop*. 2009;33:785–788.
7. Baumgaertner MR, Curtin SL, Lindskog DM, Keggi JM. The value of the tip apex distance in predicting failure of fixation of peritrochanteric fractures of the hip. *J Bone Joint Surg Am*. 1995 Jul;77:1058–1064.
8. Lorch DG, Geller DS, Nielson JH. Osteoporotic pertrochanteric hip fractures: management and current controversies. *J Bone Joint Surg Am*. 2004;86:398–410.
9. Lindskog DM, Baumgaertner MR. Unstable intertrochanteric hip fractures in the elderly. *J Am Acad Orthop Surg*. 2004;12:179–190.
10. Bridle SH, Patel AD, Bircher M, Calvert PT. Fixation of intertrochanteric fractures of the femur. A randomised prospective comparison of the gamma nail and the dynamic hip screw. *J Bone Joint Surg Br*. 1991;73:330–334.
11. Kazemian GH, Manafi AR, Najafi F, Najafi MA. Treatment of intertrochanteric fractures in elderly high risk patients: dynamic hip screw vs. external fixation. *Injury*. 2014;45:568–572.
12. Scott IH. Treatment of intertrochanteric fractures by skeletal pinning and external fixation. *Clin Orthop Relat Res*. 1957;10:326–334.
13. Magyar G, Toksvig-Larsen S, Moroni A. Hydroxyapatite coating of threaded pins enhances fixation. *J Bone Joint Surg Br*. 1997 May;79:487–489.
14. Moroni A, Faldini C, Pegreff 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 Apr;87:753–759.
15. Moroni A, Heikkilä J, Magyar G, Toksvig-Larsen S, Giannini S. Fixation strength and pin tract infection of hydroxyapatite-coated tapered pins. *Clin Orthop Relat Res*. 2001 Jul;388:209–217.
16. Atici T, Şahin N, Öztürk A, Yaray O. Treatment of intertrochanteric femur fractures in high-risk geriatric patients (≥65 years) with external fixation. *Ulus Travma ve Acil Cerrahi Derg*. 2010;16:413–420.
17. Evans EM. The treatment of trochanteric fractures of the femur. *J Bone Joint Surg Br*. 1949;31B:190e203.
18. Jensen JS, Michaelsen M. Trochanteric femoral fractures treated with McLaughlin osteosynthesis. *Acta Orthop Scand*. 1975;46:795–803.
19. Parker MJ. Cutting-out of the dynamic hip screw related to its position. *J Bone Joint Surg Br*. 1992;74:625.
20. Dahl MT, Gulli B, Berg T. Complications of limb lengthening. A learning curve. *Clin Orthop Relat Res*. 1994;301:10–18.
21. Stinchfield FE, Cooperman B, Shea CE. Replacement of the femoral head by Judet or Austin Moore prosthesis. *J Bone Joint Surg*. 1957;39A:1043–1058.
22. Aufrane OE, Jones WN, Truner RH. Severely comminuted intertrochanteric hip fractures. *JAMA*. 1967;199:140–143.
23. Karn NK, Singh GK, Kumar P, Shrestha BP, Singh MP, Gowda MJ. Comparison between external fixation and sliding hip screw in the management of trochanteric fractures of the femur in Nepal. *J Bone Surg*. 2006;88-B:1347–1350.
24. Vekris MD, Lykissas MG, Manoudis G, et al. Proximal screws placement in intertrochanteric fractures treated with external fixation: comparison of two different techniques. *J Orthop Surg Res*. 2011;6:48.
25. Gotfried Y, Frish E, Mendes DG, Roffman M. Intertrochanteric fractures in high risk geriatric patients treated by external fixation. *Orthopedics*. 1985;6:769–774.
26. Rasmussen LS, Johnson T, Kuipers HM, et al. Does anaesthesia cause postoperative cognitive dysfunction? A randomised study of regional versus general anaesthesia in 438 elderly patients. *Acta Anaesthesiol Scand*. 2003;47:260–266.
27. Neuman MD, Rosenbaum PR, Ludwig JM, Zubizarreta JR, Silber JH. Anesthesia technique, mortality, and length of stay after hip fracture surgery. *JAMA*. 2014;311:2508–2517.