ORIGINAL ARTICLE

Acta Orthop Traumatol Turc 2014;48(1):32-36
doi: 10.3944/AOTT.2014.3084

Use of femoral nail with spiral blade in subtrochanteric fractures

Masood UMER, Haroon RASHID, Idrees SHAH, Irfan QADIR

Department of Orthopedic Surgery, Aga Khan University Hospital, Karachi, Pakistan

Objective: The aim of this study was to evaluate the outcome of acute subtrochanteric fractures managed with intramedullary nail and spiral blade fixation of the proximal fragment.

Methods: Charts of 33 patients (17 males and 16 females) with acute subtrochanteric fractures operated with intramedullary nail and spiral blade at our institution between March 2006 and February 2011 were retrospectively reviewed. The most common (67%) mechanism of injury was ground-level fall, predominantly involving elderly patients. Results were evaluated in terms of union time, implant failure rate, infection rate and functional outcome.

Results: Mean duration of surgery was 2.4 hours and average length of hospital stay was 7 days. Mean radiological healing time was 16 weeks. Good healing occurred in 31 (94%) patients within 6 months of surgery. Uneventful healing occurred in 28 (85%) patients and 3 (9%) had delayed healing requiring dynamization in two patients and bone grafting in one. Implant failure occurred in 2 (6%) patients within 2 months of index surgery requiring repeat surgery. One (3%) patient had varus malunion.

Conclusion: Intramedullary nailing with spiral blade is a good option for acute subtrochanteric fractures with promising results. We think that this is a superior device compared to conventional methods of fixation for subtrochanteric fractures.

Key words: Femoral nail; spiral blade; subtrochanteric fracture.

Subtrochanteric fractures involve the proximal femur between the lesser trochanter and 5 cm below. They account for 10 to 34% of all hip fractures, usually resulting from high-energy trauma, pathologic fracture or low-energy injury involving osteoporotic bone in the elderly.[1] Such fractures can be difficult to fix and the risk of failure is high, especially in cases with loss of the lesser trochanter and medial buttress.[1,2] Due to anatomical and biomechanical factors, subtrochanteric femoral fractures remain a challenge for orthopedic surgeons. The subtrochanteric region of the femur is mainly cortical due to which poor healing area and vascularity, prolonging the healing time. This region of the femur is subjected to many stresses resulting from bending movements and compressive forces generated by body weight and the hip muscles.[3]

Satisfactory results in adults with non-operative treatment have been reported as 56% as compared to 70 to 80% for operative methods, leading to the cessation of conservative treatment over the past 30 years.[4] Various intramedullary and extramedullary devices have been developed in an attempt to address potential complica-

Correspondence: Irfan Qadir, MD. Department of Orthopedic Surgery, Faculty offices opposite Community Health Centre, Aga Khan University Hospital, Karachi 74800, Pakistan.
Tel: +92 300 – 732 16007 e-mail: irfanqadir88@gmail.com

Submitted: November 24, 2012 **Accepted:** September 20, 2013

Available online at
www.aott.org.tr
doi: 10.3944/AOTT.2014.3084
QR (Quick Response) Code

tions of device failure, mal- or non-union and deformities. No single implant has been universally recommended for the internal fixation of these fractures and new fixation devices are periodically introduced.[1,5,6]

This study was conducted to evaluate the outcomes of spiral blade nailing for acute subtrochanteric fractures.

Patients and methods

This study included 33 patients (17 male and 16 female) with acute subtrochanteric fractures operated with intramedullary nail and spiral blade at our institution between March 2006 and February 2011. Medical charts were reviewed retrospectively for all patients. Mean age of the patients was 53 (range: 14 to 76) years. The most common mechanism of injury was ground-level fall (67%) with fall from a height common among younger population. Other mechanisms of injury included road traffic accidents and firearm injury. Indications for using intramedullary nail with spiral blade included acute subtrochanteric fractures and segmental fractures involving subtrochanteric area. Patients presenting more than 6 weeks following injury, with a pathological fracture and/or a non-union were excluded from the study.

All fractures were classified according to Seinsheimer's classification. Twenty patients (61%) were classified into Seinsheimer Type 3, eleven patients (33%) Type 2, one patient (3%) Type 1 and one patient (3%) Type 4 fracture.

Six different teams of consultants carried out the operations.

The patient was positioned in the true lateral position with the affected hip flexed. Under fluoroscopic guidance, a Steinmann pin was into the piriform fossa and its position verified in two planes at 90° before being advanced into the canal of the femur. The skin incision could be extended 2 to 3 cm to allow introduction of the starting drill and its tissue protector into the fossa for drilling of the cortical bone. This was then replaced with an olive guide pin placed all the way into the distal femur. One millimeter undersized nail of appropriate length was passed over the guide pin. A second guide wire was placed percutaneously within the femoral head and neck under fluoroscopic guidance. This incision was later extended 2 to 3 cm to allow drilling of the lateral cortex. The pin length was measured to obtain the correct length spiral blade plate prior to drilling. The spiral blade plate was inserted and subsequently locked into place with the proximal locking cap and distal interlocking screws placed in a standard fashion through the percutaneous incisions (Fig. 1).

Fig. 1. Minimally invasive approach for the insertion of the nail and spiral blade. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

Quadriceps exercises were encouraged on the 2nd postoperative day. Range of motion exercises were started within the limits of pain. Patients were discharged on the 6th postoperative day. Regular checkups were made at 4, 8, 12, and 24 weeks. Non-weight-bearing was begun from the 2nd postoperative week. Partial weight-bearing was commenced in Type A and B fractures from the 3rd week onwards as dictated by the patient's tolerance to pain and at 6 weeks in patients with Type C fractures. Full weight-bearing was begun when the fractures showed complete union clinically by absence of limb pain when standing upon the fractured limb alone and radiologically by the presence of the abundant callus at least in two views. On follow-up, special attention was given to mechanical complications, such as bending, migration, or breakage of the spiral blade and its relation to fracture type.

Results

Mean operative time was 2.4±0.5 hours. Cases were followed up by clinical and radiological examination for a mean of 23 (range: 12 to 60) months. Healing was evaluated in the coronal plane (varus or valgus), sagittal plane (anterior or posterior angulations) and transverse plane, and external and internal rotation deformities and shortening were noted. Mean radiological healing time was 16 weeks with acceptable alignment (less than 10° varus/valgus or anterior/posterior angulations and rotation). Good healing occurred in 31 (94%) patients within 6 months of index surgery. Twenty eight (85%) patient healed uneventfully.

Three (9%) patients suffered delayed union requiring additional minor surgical procedures for healing; two for dynamization and one for bone grafting. Two of these patients had fractures consequent to high-energy trauma resulting in Seinsheimer Type 3 and Type 4 fractures. Implant failure occurred in two (6%) patients within 2 months of index surgery due to early full weight-bear-

Fig. 2. **(a)** Views of a 54-year-old female with a subtrochanteric fracture, **(b)** fixed with a spiral blade and nail at one year of follow-up.

ing in one and secondary to a fall in the other. Revision surgery with repeat nailing was performed in one case and the patient healed successfully. The second patient underwent removal of the broken implant and fixation with a locked compression plate and healed 8 months following the revision surgery. There were no wound infections, DVT or any other postoperative complications (Figs. 2, and 3).

Discussion

Subtrochanteric fractures of the femur demand special consideration in orthopedic traumatology given the high rate of complications associated with their management. [7] The high incidence of delayed union, malunion and nonunion of fractures has left conservative treatment, as advocated by DeLee et al, abolished in modern trauma care.[8] Controversy regarding the use of extramedullary or intramedullary fixations for these complicated fractures continues.

Fig. 3. Fracture of the spiral blade despite good initial reduction in a 51-year-old female patient.

Intramedullary fixation is biomechanically superior to extramedullary fixation. Intramedullary devices have the advantage of reducing the moment arm over which bending forces act compared with a laterally placed plate. [9] Intramedullary devices require less surgical exposure, enable early weight-bearing, achieve better proximal fixation and exert less biomechanical stresses (as the lever arm is moved medially).[10] However, the use of conventional femoral interlocking nail creates an unstable biomechanical construct in cases in which the medial femoral cortex is comminuted or in subtrochanteric fractures with intertrochanteric extension.[11] Extramedullary fixation with a reverse dynamic condylar screw and plate, working as a tensile plate, allows for the indirect reduction of fracture fragments with buttressing of the comminuted lateral cortex. However, it carries the potential disadvantages of extensive surgical exposure, severe soft tissue damage and blood loss, leading to problems of fracture union and implant failure.[10] In addition, the plate is prone to fatigue breakage due to the mechanical load-sharing effect.[12]

In the early nineties, AO introduced the Modular Interlocking System of Unreamed Femoral Nail with Spiral Blade (UFN-SB) for subtrochanteric fractures and fractures of the femoral shaft associated with an ipsilateral fracture of the subtrochanteric region.[13] These nails allow for the use of locking bolts, shaft screws or a spiral blade module for proximal locking. A cannulated spiral blade has been designed to provide a wide weight-bearing surface to improve support of the proximal fragment, whilst maintaining maximum bending strength at the nail-blade interface.

Compared with other implants, the UFN-SB is a less invasive percutaneous procedure. The nail is manu-

Table 1. Implant failure rates of our series compared with other series.

Treatment modality	Author	No. of patients	Implant failure	
			n	%
Dynamic condylar screw	Warwick et al.[16]	36	6	16.6
	Halwai et al.[5]	30	1	3.3
Gamma nail	Jiang et al.[10]	49	0	0
	Saarenpää et al.[17]	58	5	8.6
UFN-SB	Broos et al.[14]	80	17	21.3
	Datir et al.[18]	55	5	9.1
FN-SB	Our series	33	2	6.1

UFN-SB: Unreamed femoral nail with spiral blade; FN-SB: Femoral nail with spiral blade.

ally introduced into the medullary canal by gentle twisting motions without previous reaming, resulting in less iatrogenic damage to bone vascularization. Faster bone healing may thus be expected, along with reduced risk for fat embolism, ARDS and adjacent pulmonary damage.[14] Vanderschot et al.[15] presented an overall re-intervention rate of 11% (18 patients) in 161 subtrochanteric fractures. Of these 18 patients, 8 (5%) were treated with a ninety-five degree condylar blade plate, 2 (1%) with a dynamic condylar screw and 8 (5%) with a gamma nail. Re-intervention rates of 6% due to implant failure were found in the current study (Table 1).

Brumback et al.[19] reported that UFN-SB fixation is a less time consuming procedure. It can be performed in 52 minutes on average, compared with 86 minutes when using a condylar blade plate, or 77 minutes when using a gamma nail. However, our mean operating time was 2.4 hours, which may be attributed to the initial learning curve and routine reaming of the medullary cavity before nail insertion. We opted for reaming in order to provide reamed bone autograft at the fracture site. Moreover, reaming also allowed for the use of a wider nail with better fatigue strength than a small diameter nail.

The spiral blade used in our study consisted of a titanium alloy (titanium, aluminum, niobium). Titanium alloy makes the modulus of elasticity of this implant much closer to human bone than the comparable implants made of stainless steel. This decreases the potential risk of implant failure. Theoretically, this characteristic is of benefit for stress distribution in the implant-bone complex.[14] Until now, only limited studies using this device in non-pathologic fractures have been published. When using the UFN-SB, Hoffmann et al.[13] observed no implant complications or loss of reduction in their first 9 patients. Fracture healing was uneventful in all cases. Stockenhuber et al. observed 3 perioperative and 2 postoperative complications in 12 patients.[20] Medial comminution, which results in a lack of stability after plate fixation, is not of major importance after a closed endomedullary procedure.

The spiral blade itself has theoretical limitations. The interface between the rod and the blade is not very strong and, moreover, it is cannulated.[14] This was confirmed by the findings of Wheeler et al.[2] In osteoporotic patients, the grip of the rather small blade is insufficient and carries risk of migration when early weight-bearing is permitted. This lateral migration of the blade may also be caused by its plastic deformity in the nail allowing for the end cap to lose its grip on the spiral blade.[14] In the current study, 2 patients had implant failure; one of which was due to breaking of spiral blade at the nail blade junction and the other due to a broken proximal nail. We attribute this to early weight-bearing in these 2 cases with a comminuted fracture. Both of these patients were under the age of 45 years. We now delay weight-bearing in all patients irrespective of their age and comminution until early radiological union is observed. One case of malunion occurred in the varus position a due to loosening of the end cap grip over the spiral blade, migrating laterally leading to fracture malunion. This patient tolerated malunion without any major clinical dysfunction and did not require re-intervention.

In cadaveric subtrochanterically osteotomized femora, Wheeler et al.[2] compared UFN-SB with other implants with respect to its fatigue characteristics, breaking strength and failure mode. They concluded that UFN-SB was the most flexible and least strong and failed by bending the spiral blade with a concomitant fracture of the femoral neck. Stover et al. also warned that the magnitude of bending forces in the subtrochanteric region of the femur can lead to hardware failure before union.[21] Despite these potential mechanical weaknesses, we had an overwhelming success rate of fracture healing (94%).

In conclusion, this study suggested promising initial results for femoral nail with spiral blade in the treatment of subtrochanteric femoral fractures. However, its use in

Seinsheimer Type 4 fractures is not recommended due to higher rates of complication.

Conflicts of Interest: No conflicts declared.

References

1. Lavelle DG. Campbell's operative orthopaedics. 10th ed. St. Louis: Mosby; 2003. p. 2897.
2. Wheeler DL, Croy TJ, Woll TS, Scott MD, Senft DC, Duwelius PJ. Comparison of reconstruction nails for high subtrochanteric femur fracture fixation. Clin Orthop Relat Res 1997;338:231-9. CrossRef
3. Sims SH. Subtrochanteric femur fractures. Orthop Clin North Am 2002;33:113-26. CrossRef
4. Craig NJ, Maffulli N. Subtrochanteric fractures: current management options. Disabil Rehabil 2005;27:1181-90.
5. Halwai MA, Dhar SA, Wani MI, Butt MF, Mir BA, Ali MF, et al. The dynamic condylar screw in the management of subtrochanteric fractures: does judicious use of biological fixation enhance overall results? Strategies Trauma Limb Reconstr 2007;2:77-81. CrossRef
6. Miclau T, Martin RE. The evolution of modern plate osteosynthesis. Injury 1997;28 Suppl 1:A3-6. CrossRef
7. Bedi A, Toan Le T. Subtrochanteric femur fractures. Orthop Clin North Am 2004;35:473-83. CrossRef
8. DeLee JC, Clanton TO, Rockwood CA Jr. Closed treatment of subtrochanteric fractures of the femur in a modified cast-brace. J Bone Joint Surg Am 1981;63:773-9.
9. Tencer AF, Johnson KD, Johnston DW, Gill K. A biomechanical comparison of various methods of stabilization of subtrochanteric fractures of the femur. J Orthop Res 1984;2:297-305. CrossRef
10. Jiang LS, Shen L, Dai LY. Intramedullary fixation of subtrochanteric fractures with long proximal femoral nail or long gamma nail: technical notes and preliminary results. Ann Acad Med Singapore 2007;36:821-6.
11. Vaidya SV, Dholakia DB, Chatterjee A. The use of a dynamic condylar screw and biological reduction techniques for subtrochanteric femur fracture. Injury 2003;34:123-8.
12. Siebenrock KA, Müller U, Ganz R. Indirect reduction with a condylar blade plate for osteosynthesis of subtrochanteric femoral fractures. Injury 1998;29 Suppl 3:C7-15. CrossRef
13. Hoffmann R, Südkamp NP, Müller CA, Schütz M, Haas NP. Osteosynthesis of proximal femoral fractures with the modular interlocking system of unreamed AO femoral intramedullary nail. Initial clinical results. [Article in German] Unfallchirurg 1994;97:568-74. [Abstract]
14. Broos PL, Reynders P. The use of the unreamed AO femoral intramedullary nail with spiral blade in nonpathologic fractures of the femur: experiences with eighty consecutive cases. J Orthop Trauma 2002;16:150-4. CrossRef
15. Vanderschot P, Vanderspeeten K, Verheyen L, Broos P. A review on 161 subtrochanteric fractures--risk factors influencing outcome: age, fracture pattern and fracture level. Unfallchirurg 1995;98:265-71.
16. Warwick DJ, Crichlow TP, Langkamer VG, Jackson M. The dynamic condylar screw in the management of subtrochanteric fractures of the femur. Injury 1995;26:241-4.
17. Saarenpää I, Heikkinen T, Jalovaara P. Treatment of subtrochanteric fractures. A comparison of the Gamma nail and the dynamic hip screw: short-term outcome in 58 patients. Int Orthop 2007;31:65-70. CrossRef
18. Datir SP, Bedi GS, Curwen CH. Unreamed femoral nail with spiral blade in subtrochanteric fractures: experience of 55 cases. Injury 2004;35:191-5. CrossRef
19. Brumback RJ, Uwagie-Ero S, Lakatos RP, Poka A, Bathon GH, Burgess AR. Intramedullary nailing of femoral shaft fractures. Part II: Fracture-healing with static interlocking fixation. J Bone Joint Surg Am 1988;70:1453-62.
20. Stockenhuber N, Schweighofer F, Bratschitsch G, Szyszkowitz R. UFN system. A method of minimal invasive surgical management of femoral shaft fractures. Langenbecks Arch Chir 1996;381:267-74.
21. Stover MD, Lin I, Bosse MJ. Removal of a broken Synthes proximal spiral blade. J Orthop Trauma 1998;12:190-1.