

# The Efficacy of Single-stage Open Intramedullary Nailing of Neglected Femur Fractures

P. R. J. V. C. Boopalan MS, Azad Sait D Ortho,  
Thilak Samuel Jepeganam MS, Thomas Matthai MS,  
Viju Daniel Varghese MS

Received: 22 April 2013 / Accepted: 12 September 2013 / Published online: 21 September 2013  
© The Association of Bone and Joint Surgeons® 2013

## Abstract

**Background** Neglected femur fractures are not rare in the developing world. Treatment options include single-stage open reduction and intramedullary nailing, or open release, skeletal traction, and then second-stage open intramedullary nailing, with bone grafting. Single-stage procedures have the potential advantage of avoiding neurovascular complications secondary to acute lengthening, but they require a second operation, with potentially increased resource use and infection risk.

**Questions/purposes** We sought to determine the (1) likelihood of union, (2) complications and reoperations, and (3) functional results with single-stage open intramedullary nailing without bone grafting in patients with neglected femur fractures.

**Methods** Between January 2003 and December 2007, 17 consecutive patients presented to our practice with neglected

femoral shaft fractures. All were treated with single-stage nailing without bone grafting. There were 15 men and two women with a median age of 27 years. The average time from fracture to treatment was 13 weeks (range, 4–44 weeks). Eleven patients underwent open nailing with interlocked nails and six were treated with cloverleaf Kuntscher nails. Patients were followed for a minimum of 6 months (mean, 33 months; range, 6–72 months). The mean preoperative ROM of the knee was 28° (range, 10°–150°) and femoral length discrepancy was 3.1 cm (range, 1–5 cm).

**Results** All fractures united and the mean time to union was 16 weeks (range, 7–32 weeks). There were no neurologic complications secondary to acute lengthening. The mean postoperative ROM of the knee was 130° (range, 60°–150°). All patients were able to return to preinjury work. Sixteen patients regained their original femoral length.

**Conclusions** One-stage open intramedullary nailing of neglected femoral diaphyseal fractures without bone grafting was safe and effective, and obviated the need for a two-stage approach. Although the findings need to be replicated in larger numbers of patients, we believe this technique may be useful in treating patients with this injury, and may offer advantages in resource-constrained environments.

**Level of Evidence** Level IV, therapeutic study. See the Instructions for Authors for a complete description of levels of evidence.

---

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research* editors and board members are on file with the publication and can be viewed on request. Each author certifies that his institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained. This study was performed at the Department of Orthopaedics, Christian Medical College, Vellore, Tamilnadu, India.

---

P. R. J. V. C. Boopalan (✉), A. Sait, T. S. Jepeganam,  
T. Matthai, V. D. Varghese  
Department of Orthopaedics Unit III, Christian Medical College,  
Vellore 632004 Tamilnadu, India  
e-mail: jpboopy@me.com

## Introduction

Closed intramedullary nailing of acute femoral diaphyseal fractures has become the standard of care and some studies have documented good results using this approach [2, 7]. In developed countries, patients typically present early for

treatment and therefore neglected fractures seldom are seen. However, this is not always the case in underdeveloped countries, and neglected femoral fractures remain a problem in the developing world even in the new millennium. Some patients seek treatment from local bonesetters, and when treatment fails, these impoverished patients seek help after having lost their livelihoods [1, 10, 11].

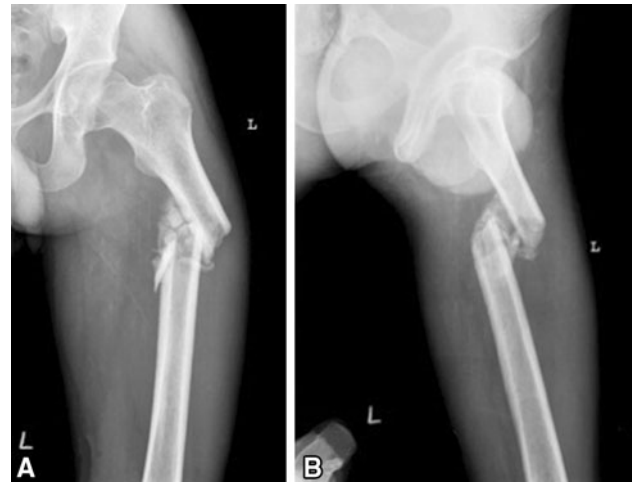
Limb massage and indigenous splinting by local bonesetters affect the fractured bone and the entire limb [4, 8, 11, 12]. The limb may become edematous with the loss of thigh contour. The femur shortens and the knee becomes stiff, with obliteration of the normal parapatellar fossae. Prolonged neglect results in equinus of the ankle as a result of contractures. In addition to the fracture, knee and ankle stiffness have to be treated when patients present late with this constellation of findings.

In one study [4], two-stage intramedullary nailing and bone grafting of neglected femoral fractures showed a favorable outcome. In two-stage approaches, patients experience the morbidity of two anesthetics and two procedures, including blood loss and prolonged hospitalization. In theory, a single-stage surgical reduction and fixation should reduce some of this morbidity. Acute lengthening of a neglected, shortened femur can be difficult and has associated complications such as neurovascular compromise from acute lengthening and the possible need for bone grafting. We sought to determine the (1) likelihood of union, (2) complications and reoperations, and (3) functional results with single-stage open intramedullary nailing without bone grafting in patients with neglected femur fractures.

## Patients and Methods

Between January 2003 and December 2007, 17 consecutive patients presented with neglected femoral shaft fractures. All were treated with single-stage nailing without bone grafting. The results of all patients were reviewed. The institutional review board approved the study and informed consent was obtained from each patient. The criteria for neglected femur fractures included fractures that were not treated by conventional methods or that were managed by nonmedical traditional bonesetters for a minimum of 1 month after injury (Fig. 1). Malunited fractures and nonunions after operative interventions were excluded from the study.

There were 15 men and two women with a median age of 27 years (range, 22–70 years). The mechanisms of injury were motor vehicle accidents in eight patients, fall from a height in eight, and fall of a heavy object onto the thigh at the workplace in one patient (Fig. 2). Nine patients had other system or skeletal injuries affecting the management and outcome of the femur fracture. The fractures were classified according to the AO/OTA classification [9].



**Fig. 1A–B** The preoperative (A) AP and (B) lateral radiographs show a 10-week-old neglected proximal third femur shaft fracture. Overriding and varus angulation are seen on the AP radiograph and callus formation can be seen at the fracture site on the lateral radiograph.



**Fig. 2** A preoperative AP radiograph shows a 20-week-old neglected midfemur shaft fracture sustained by Patient 8 in a fall from a height.

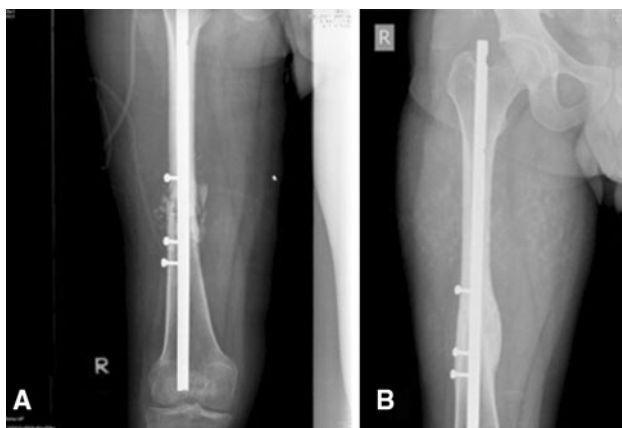
Ten patients previously were treated elsewhere with massage and indigenous splints by traditional bonesetters, six patients did not seek any medical help and were lying at home, and one patient initially was treated for a head injury and presented to us late. The median time from injury to the hospital visit was 10 weeks (range, 4–44 weeks).

## Operative Technique

The operations were performed with the patients in the lateral position using a standard posterolateral approach to

the femur. With the patient under anesthesia, before skin incision, the knee was manipulated gently with the thigh in its shortened position and the hip in neutral to avoid stretching of the sciatic and femoral nerves. The fracture site was exposed. The organized hematoma and the new bone formed around the fractured ends were removed for later use. The ends of the proximal and distal fragments were cleared of interposing fibrous tissue. Fibrous tissue and attachments to the linea aspera were released to mobilize the proximal and distal fragments. The medullary canals were opened with a drill and reamed with increasing diameter of reamers. The proximal and distal fragment ends were approximated with acute angulation and then levered to gradually straighten the femur, thus lengthening the limb progressively and allowing the soft tissues to adjust to the new tension. This position was maintained for some time to allow the soft tissues to stretch and a guidewire was inserted. After reduction, if the fracture pattern was rotationally and axially stable, a cloverleaf Kuntscher nail was used for stabilization, whereas if the reduction was unstable, a statically locked nail (simplified universal femur nail) was used. Proximal interlocking was done through the jig and distal interlocking was done using an image intensifier. In one patient, we used slot screws to achieve rotational stability with a Kuntscher nail (Fig. 3). The reamed material was placed in and around the fracture site before closure. The diameter of all the nails used was 11 mm.

The mean duration of hospital stay was 7 days (range, 4–20 days). Five patients required a blood transfusion either intraoperatively or postoperatively to a maximum of 2 pints. All patients were followed until union for a minimum of 6 months (mean, 33 months; range, 6–72 months). Plain AP and lateral radiographs of the femur



**Fig. 3A–B** (A) A postoperative AP radiograph after Kuntscher nailing shows the slot screws that were added for rotational stability. (B) On the final AP radiograph obtained at 37 months, union and remodeling are seen.

were taken to assess union. The patients received instructions in physiotherapy and their progress was monitored at each outpatient visit. Emphasis was placed on regaining active and passive knee movement and developing quadriceps strength. Weightbearing was dictated by the stability of the fracture and the associated injuries that the patients had sustained. With isolated femur fractures, patients were partial weightbearing for the first 2 months and full weightbearing by 3 months, although radiographic union was seen at approximately 4 months. Patients were provided with postoperative thromboembolic stockings as deep vein thrombosis prophylaxis and no chemical prophylaxis was followed. Two of the authors (PRJVCB, TJ) assessed all radiographs. The fracture was considered united if three of four cortices had bridging callus across the fracture site. At followup, another author (AZ) assessed fracture union, knee ROM using a goniometer, return to work, and clinical limb shortening was measured using a measuring tape.

Preoperatively, the mean ROM of the knee was 28° (range, 10°–150°). The mean preoperative femoral length discrepancy measured clinically from the anterosuperior iliac spine to the medial joint line of the knee was 3.1 cm (range, 1–5 cm) (Table 1). All patients were nonambulatory and were not working.

## Results

All fractures united at a mean of 16 weeks (range, 7–32 weeks) (Fig. 4), and all patients were able to return to their original occupation.

No patient experienced neurologic complications related to the single-stage nailing procedure. The total femoral length regained was 4.5 cm. Sixteen patients (94%) regained their original femoral length. The one patient with shortening of 3.5 cm opted to manage with height correction footwear.

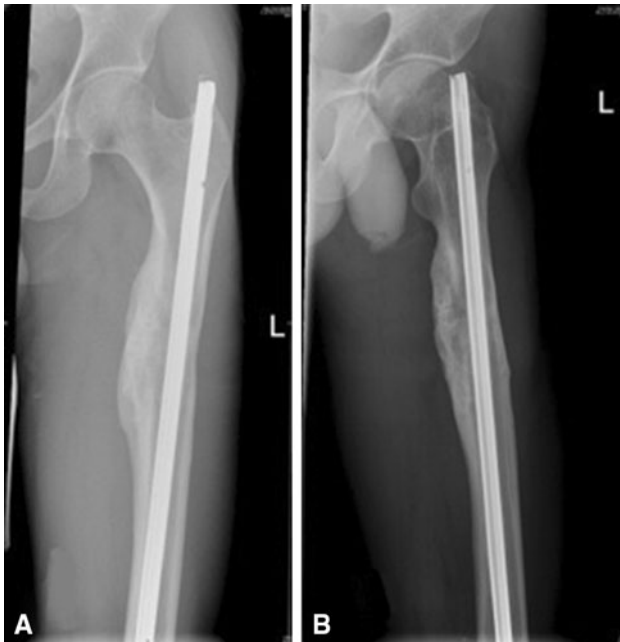
The mean postoperative knee flexion (Table 1) was 130° (range, 0°–60°, 0°–150°). Fourteen (82%) patients regained full ROM. Of the three patients with knee stiffness, one regained full flexion after quadricepsplasty. The second patient gained only 60° and the other gained 90° with manipulation under anesthesia. They were offered quadricepsplasty but refused because they were satisfied with their improvement in movement. No patient had any extensor lag.

Two patients had preoperative common peroneal nerve palsy, and their foot drop recovered in 3 months. Another patient had serous discharge from the incision site which resolved at 3 weeks with regular wound dressings.

Three patients underwent reoperation, including one for repositioning an interlocking screw and another for

**Table 1.** Summary of patients

Patient number	Age (years)	Preinjury occupation	Associated injuries	Fracture pattern (OTA type)	Interval from injury to presentation (weeks)	Preoperative femoral shortening (cm)	Femoral gained (cm)	Femoral length (cm)	Preoperative knee flexion (°)	Postoperative knee flexion (°)
1	64	Housewife	None	32B2	8	2.5	2.5	10	130	130
2	22	Mechanic	None	32A3	4	1.5	1.5	10	60	60
3	22	Agricultural laborer	None	32A2	12	3	3	10	130	130
4	27	Manual laborer	Closed fracture ipsilateral tibia	32B1	20	3	3	10	90	90
5	45	Manual laborer	Open fracture ipsilateral tibia	32B2	9	3.5	3.5	10	140	140
6	70	Housewife	None	32B1	8	2	2	90	130	130
7	29	Manual laborer	Malunited ipsilateral tibia, common peroneal nerve palsy	32B1	44	4.5	4.5	150	150	150
8	27	Agricultural laborer	None	32A2	20	3.5	0	15	125	125
9	24	Agricultural laborer	None	32B2	10	5	5	30	150	150
10	22	Agricultural laborer	Ipsilateral open clavicle fracture, open knee injury, mild head injury	32B2	7	2.5	2.5	10	130	130
11	22	Manual laborer	Open ipsilateral patella fracture	32A3	4	3.5	3.5	10	140	140
12	55	Manual laborer	None	32A1	4	1	1	10	135	135
13	22	Student	None	32A3	12	1.5	1.5	20	140	140
14	27	Manual laborer	Head injury, chest injury, common peroneal nerve palsy	32B1	12	3.5	3.5	40	140	140
15	31	Manual laborer	Olecranon fracture	32A2	24	4.5	4.5	20	140	140
16	28	Manual laborer	Straddle fracture pelvis, ipsilateral closed tibia, distal ulna fracture	32A2	8	5	5	10	130	130
17	38	Agricultural laborer	Ipsilateral open patella fracture	32A3	16	3	3	20	140	140



**Fig. 4A–B** Followup (A) AP and (B) lateral radiographs obtained at 48 months show union and restoration of alignment.

dynamization. The third patient had vascular compromise during the immediate postoperative period and underwent a thrombectomy. This patient presented 24 weeks after a midshaft fracture sustained in a motor vehicle accident, with preoperative shortening of 4.5 cm. Surgery was uneventful and the patient's pulses were palpable in the recovery room. However, his pulses were not palpable in the ward an hour later. Color Doppler confirmed a thrombus extending from the distal external iliac artery to the superficial femoral artery, which was identified and treated by thrombectomy. The vascularity was restored and his pulses were palpable. He has no residual ischemic changes and can walk 4 km.

## Discussion

Closed intramedullary nailing has become the standard of care for acute diaphyseal femur fractures [2, 7]. However, the literature is sparse for neglected femur fractures. Neglected fractures, as a problem in developing and underdeveloped countries, do not appear to be addressed sufficiently in the literature. We sought to determine the likelihood of union, complications, reoperations, and functional results with single-stage open intramedullary nailing without bone grafting in patients with neglected femur fractures.

This study has several limitations. It could be improved by comparing our patients with a cohort of patients who could be treated with staged intramedullary nailing; however,

because neglected femur fractures are not common enough to do a comparative study, it would be difficult to perform.

We found that open intramedullary nailing without iliac crest bone grafting for neglected femoral shaft fractures resulted in union in all patients thus treated, and 16 patients (94%) regained their original femoral length. In a previous study [8], single-stage open intramedullary nailing showed good results in patients with a similar presentation as described in our series, however, only five of 14 patients regained their original length. Mahaisavariya and Laupattarakasem shortened the bone to achieve reduction in nine patients [8]. Similarly, in another series of 11 patients with isolated femoral fractures, with a mean shortening of 3.8 cm [4], preoperative traction was used in selected cases and the nailing procedure was staged. Eight of 11 patients underwent iliac crest bone grafting along with open nailing [4].

We found that acute correction of femoral length can be performed safely up to 4 cm. Previous studies have shown that acute lengthening minimally affects knee ROM and the results have been gratifying [3, 13, 14]. Fourteen (82%) patients regained full ROM of the knee at latest followup. Neurovascular complications can be avoided by restricting lengthening to 4 cm to 4.5 cm in adults and 3 cm to 3.5 cm in children and maintaining knee flexion during nailing [6]. Akinyoola et al. [1] described the problems and outcome of neglected femur fractures in a large series of patients. The superficial and deep wound infection rate was 23.6%, and residual shortening was present in 10% of patients. We agree that these fractures can be difficult to treat with high complication rates compared with fresh fractures. In our series, all patients were treated with a single-stage open intramedullary nailing without bone grafting and traction. The mean preoperative shortening was 3.1 cm (range, 1–5 cm). The patients who regained their femur length had no neurologic complications.

All patients returned to work during the followup period and regained functional ROM. In the series of Mahaisavariya and Laupattarakasem, 42% of patients regained full ROM, and in the other 58%, the range regained was adequate for activities of daily living [8]. Iliac crest bone grafting is associated with potential complications and morbidity [5, 16]. Bone grafting has a role when performed for one-stage lengthening [3, 13, 15] and in cases of initial open injury with bone loss, however in our series, we think the local callus and reaming were sufficient to enhance fracture healing. A Kuntscher nail was used in this particular demographic, because it is inexpensive. When the fracture showed a stable geometry, the Kuntscher nail proved to be adequate. Interlocking nails were used only when the fracture was found to be rotationally unstable.

The strengths of this study are that it is among the larger studies of neglected femur fractures; other studies have ranged from 11 to 52 patients [1, 4, 8]. All patients in this

series were followed up until union and subsequently after union; none was lost to followup before union or before 6 months. Neglected femur fractures are uncommon, but they are important because of the morbidity they can cause, and because they disproportionately affect an already-disadvantaged, generally impoverished, patient population. Single-stage nailing without bone grafting showed timely union, low complication rate, and good restoration of function in our series. Although comparative controlled studies are required to prove its potential advantages, it is reasonable to hypothesize that single-stage open intramedullary nailing can be performed safely in most patients without shortening the bone and avoiding the addition of autogenous or allograft bone.

**Acknowledgments** We thank Isaac Jebaraj, MS (Ortho), Christian Medical College, Vellore, for contributing his case to this series.

## References

1. Akinyoola L, Orekha O, Odunsi A. Open intramedullary nailing of neglected femoral shaft fractures: indications and outcome. *Acta Orthop Belg.* 2011;77:73–77.
2. 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;70:1453–1462.
3. Cauchoix J, Morel G. One stage femoral lengthening. *Clin Orthop Relat Res.* 1978;136:66–73.
4. Gahukamble A, Nithyananth M, Venkatesh K, Amritanand R, Cherian VM. Open intramedullary nailing in neglected femoral diaphyseal fractures. *Injury.* 2009;40:209–212.
5. Goulet JA, Senunas LE, DeSilva GL, Greenfield ML. Autogenous iliac crest bone graft: complications and functional assessment. *Clin Orthop Relat Res.* 1997;339:76–81.
6. Herron LD, Amstutz HC, Sakai DN. One stage femoral lengthening in the adult. *Clin Orthop Relat Res.* 1978;136:74–82.
7. Kempf I, Grosse A, Beck G. Closed locked intramedullary nailing: its application to comminuted fractures of the femur. *J Bone Joint Surg Am.* 1985;67:709–720.
8. Mahaisavariya B, Laupattarakasem W. Late open nailing for neglected femoral shaft fractures. *Injury.* 1995;26:527–529.
9. Marsh J, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA, Prokuski L, Sirkin MS, Ziran B, Henley B, Audige L. Fracture and dislocation classification compendium-2007: Orthopaedic Trauma Association classification, database and outcomes committee. *J Orthop Trauma.* 2007;21(10 suppl):S1–S133.
10. Mukherjee SK, Jain V. Neglected femoral diaphyseal fracture. *Clin Orthop Relat Res.* 2005;431:72–79.
11. Onuminya JE. The role of the traditional bonesetter in primary fracture care in Nigeria. *S Afr Med J.* 2004;94:652–658.
12. Onuminya JE, Onabowale BO, Obekpa PO, Ihezue CH. Traditional bone setter's gangrene. *Int Orthop.* 1999;23:111–112.
13. Wu CC. Locked nailing for shortened subtrochanteric nonunions: a one-stage treatment. *Clin Orthop Relat Res.* 2009;467:254–259.
14. Wu CC, Lee ZL. One-stage lengthening using a locked nailing technique for distal femoral shaft nonunions associated with shortening. *J Orthop Trauma.* 2004;18:75–80.
15. Wu CC, Lee ZL. Treatment of femoral shaft aseptic nonunion associated with broken distal locked screws and shortening. *J Trauma.* 2005;58:837–840.
16. Younger EM, Chapman MW. Morbidity at bone graft donor sites. *J Orthop Trauma.* 1989;3:192–195.