

# Open interlocking nailing and bone grafting for neglected femoral shaft fractures

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## ABSTRACT

**Purpose.** To review the treatment outcome of patients with neglected femoral shaft fractures.

**Methods.** Records of 22 men and 3 women aged 20 to 55 (mean, 36) years who underwent open interlocking nailing and bone grafting for neglected ( $\geq 2$ -month-old) closed femoral shaft fractures were reviewed. 21 had nonunion and 4 had malunion. All patients had deformed, shortened, and wasted lower limbs, with knee stiffness. The mean delay in presentation was 3 (range, 2–7) months.

**Results.** Patients were followed up for a mean of 18 (range, 14–30) months. The mean time for radiological union was 5 (range, 4–7) months. Three patients had delayed union ( $\geq 6$  months) and underwent secondary procedures (dynamisation or bone marrow injection). None had non-union. All had some degree of shortening; in 3 it was  $>2$  cm. None had neurological injury following acute gain in length. None had deep infections; 2 had superficial wound infections and 6 had pin tract infections. Mean knee flexion improved  $50^\circ$  (from  $70^\circ$  to  $120^\circ$ ) and the mean extensor lag

decreased  $7^\circ$  (from  $15^\circ$  to  $8^\circ$ ). After a mean of 18 weeks, 23 of the patients were able to return to their work.

**Conclusion.** Open interlocking nailing and bone grafting coupled with aggressive rehabilitation can achieve acceptable results for patients with neglected femoral shaft fractures.

**Key words:** femoral fractures; fracture fixation, intramedullary; fractures, malunited

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## INTRODUCTION

In developed countries, femoral shaft fractures are commonly due to road traffic accidents.<sup>1</sup> In rural India, workplace injury such as a fall from a height is also common. Closed reduction and internal fixation with an interlocking nail is the gold standard for the management of such fractures in adults.<sup>2–4</sup> In rural India, most patients still consider surgery to be taboo and insist on conservative management or traditional bone setting methods. Many even neglect the fracture and become bed ridden for months. This often leads to malunion, nonunion, knee stiffness, compartment syndrome, and even gangrene,<sup>5–8</sup> all of which cause

an enormous burden on the family and society. The treatment outcome of these fractures is usually less than satisfactory and fraught with complications. We therefore reviewed the treatment outcome of patients who presented to us with neglected femoral shaft fractures.

## MATERIALS AND METHODS

Records of 27 patients who underwent open interlocking nailing and bone grafting for neglected ( $\geq 2$ -month-old) femoral shaft fractures between March 2005 and February 2007 were reviewed (Figs. 1 and 2). Pathological and open fractures and those already treated with surgery were excluded. Of the 27 patients, 4 had neglected the fracture completely, 22 had undergone traditional bone-setting treatment for 2 to 7 (mean, 3) months, and one had undergone conservative treatment using serial groin-to-toe casts. Two of the patients were excluded from the study because of deep infection following traditional treatment.

At presentation, the remaining 22 men and 3 women aged 20 to 55 (mean, 36) years had nonunion ( $n=21$ ) or malunion ( $n=4$ ) of the left ( $n=6$ ) or right ( $n=19$ ) femurs. The fracture sites involved the upper ( $n=4$ ), middle ( $n=19$ ), and distal ( $n=2$ ) thirds of the femur. Angular (coronal and sagittal) deformity of  $\geq 5^\circ$  and rotational deformity of  $\geq 15^\circ$  were considered unacceptable.<sup>9,10</sup> Malunion in the 4 patients was unacceptable; they had varus/valgus angulation of  $10^\circ$  to  $25^\circ$ , flexion/extension of  $5^\circ$  to  $15^\circ$ , and rotational deformities of  $5^\circ$  to  $25^\circ$ . All patients had deformed, shortened, and wasted lower limbs, with knee stiffness. The mean delay in presentation to us was 3 (range, 2–7) months.

Patients with non-union were put on skeletal traction through an upper trans-tibial pin for 2 weeks and had a mean gain in length of 0.7 (0.5–1.0) cm. All patients were operated on a standard radiolucent table through the lateral vastus-splitting approach under spinal anaesthesia. Three doses of second-generation cephalosporin were used as peri-operative prophylaxis.

In patients with mal-union, the fracture site was osteotomised. 16 of the patients underwent bone shortening of 0.5 to 2 cm for end-to-end apposition. Fracture ends were checked for punctate bleeding, and the medullary cavity was opened and reamed through the fracture site. A stainless steel interlocking nail (ATLAS nail; Sushrut Surgicals, India) was inserted in an antegrade manner. The distal end was locked using a free-hand technique with a C-arm.

The union was augmented with fresh autogenous cancellous bone grafts harvested from the ipsilateral iliac crest. Correct rotational alignment was achieved using the linea aspera as a guideline. All patients with a preoperative knee range of movement of  $<90^\circ$  underwent manipulation under anaesthesia.

Postoperatively, continuous passive motion was allowed from day 1 to gain range of motion. A femoral catheter was left in place and periodic anaesthetic infusions were given for pain relief. Static quadriceps exercises were started on the day of surgery. Patients with a transverse fracture with complete bony apposition were allowed weight bearing with crutches (for balance and support). Patients with an extensor lag of  $>10^\circ$  were allowed weight bearing after quadriceps strengthening exercises. Patients with comminuted fractures progressed gradually from non-weight bearing to weight bearing over 12 to 16 weeks, depending on bone union. Patients were discharged after suture removal and followed up with radiographs.

Pre- and post-operative functional status was assessed by a single trainee using the American Academy of Orthopaedic Surgeons (AAOS) lower limb core function score.<sup>11</sup> The treatment outcome represents the standardised score, and the degree of function with reference to the general population represents the normative score. Higher scores (on a scale of 100) indicate better outcomes. A non-parametric test for 2 dependent samples (Wilcoxon signed ranks test) was used.

## RESULTS

Patients were followed up for a mean of 18 (range, 14–30) months. The mean hospital stay was 21 (range, 18–25) days. The mean time for radiological union (complete bridging callus at the fracture site in 2 planes and lack of pain during full weight bearing<sup>12</sup>) was 5 (range, 4–7) months. Clinical evidence of union always preceded radiological union. Three patients had delayed union ( $\geq 6$  months) and underwent secondary procedures to augment union; one with a transverse fracture underwent dynamisation at 12 weeks, and 2 underwent 3 bone marrow injections at 2-week intervals after 12 weeks.<sup>13–15</sup> None had non-union. All had some degree of shortening; in 3 it was  $>2$  cm. None had neurological injury following acute gain in length. None had deep infections; 2 had superficial wound infections and 6 had pin tract infections. Infections were treated with wound care and parenteral antibiotics. 10 patients complained of occasional pain at the graft site.



**Figure 1** A 45-year-old man with a femoral shaft fracture neglected for 6 months showing a varus deformity of 25° and shortening of 5 cm. Early bone union is shown after open interlocking nailing and bone grafting.



**Figure 2** An ununited femoral shaft fracture neglected for 2 months showing solid bone union at the 18-month follow-up after open interlocking nailing and bone grafting.

The mean knee flexion improved 50° (from 70° to 120°) and the mean extensor lag decreased 7° (from 15° to 8°) [Table 1]. Three patients underwent implant removal after 18 months. All female patients were housewives and were unhampered in most activities of daily living. 20 of the 22 male patients were able to return to work after a mean of 18 weeks (one of them after additional surgery for multi-ligamentous injury of the ipsilateral knee); the remaining 2 changed their occupation owing to restricted knee flexion.

The mean pre- and post-operative standardised (40 vs. 93) and normative (13 vs. 52) AAOS lower limb core function scores were significantly different ( $p < 0.001$ , Table 2).

## DISCUSSION

Early closed interlocking nailing is the gold standard for treatment of all closed (and most open) femoral shaft fractures. The procedure reduces the risk of infections,<sup>16,17</sup> enhances the rate of union by preserving fracture haematomas, reduces hospital stay, and helps early functional recovery.<sup>18</sup>

Open reduction is often necessary in patients with fractures neglected for  $\geq 2$  months, because the resulting soft-tissue contractures may cause loss of length and even non-union/mal-union with unacceptable shortening. Nonetheless, open reduction increases the risk of infection owing to excessive soft-tissue stripping, prolonged operating times, and blood loss. The rate of union is relatively low and may necessitate secondary procedures. Excessive acute lengthening in a shortened limb can cause neurovascular injuries and restriction at the extreme range of motion. Preoperative skeletal traction can improve soft-tissue contractures and facilitate open reduction. It also increases hospital stay considerably, though this can be avoided. In our series only a minimal gain in length was achieved, which was not sufficient to attempt a closed reamed nailing.

Bone union is not the only goal for successful management of these fractures. Correction of limb-length discrepancy and knee stiffness can be challenging. 19 of 21 patients with femoral fractures neglected for more than 3 weeks achieved bone union, though 5 had rotational deformities; 75% of these subjects were treated by Kuntscher nails.<sup>19</sup> In another study, all 14 patients with 2 to 10 months old femoral shaft fractures achieved bone union after treatment with Kuntscher nails.<sup>20</sup>

In contrast to the benefits of early surgery and mobilisation, conservative management of femoral

**Table 1**  
Intra-operative data and range of knee movement

Parameter	Mean (range)
Surgical time (minutes)	92 (75–135)
Blood loss (ml)	600 (350–1050)
Fluoroscopy time (seconds)	15 (10–25)
Preoperative knee range of motion	
Extensor lag	15° (10°–20°)
Knee flexion	70° (40°–100°)
Shortening (cm)	3.5 (2–6)
Postoperative knee range of motion	
Extensor lag	8° (5°–10°)
Knee flexion	120° (100°–130°)
Shortening (cm)	1.2 (0.8–3)

**Table 2**  
Pre- and post-operative standardised and normative scores of lower limb core function scale

Patient no.	Standardised scores		Normative scores	
	Preop	Postop	Preop	Postop
1	41	97	14	55
2	23	97	1	55
3	53	91	23	50
4	41	97	14	55
5	43	96	15	54
6	29	93	5	52
7	38	96	12	54
8	35	87	10	48
9	38	88	12	48
10	29	94	5	52
11	51	91	21	51
12	45	93	17	52
13	45	96	17	54
14	37	89	11	49
15	42	100	15	57
16	48	79	19	41
17	45	96	17	54
18	40	96	14	54
19	35	94	10	53
20	38	100	12	57
21	43	94	15	52
22	37	91	11	50
23	48	94	19	53
24	35	89	10	49
25	36	96	10	54

shaft fractures in adults is less favourable, except in extraordinary circumstances. Traditional bone setting practices (e.g. egg bandages, bamboo casts, and massaging) are still prevalent in India and can affect outcomes adversely. Most of our patients underwent manipulation under anaesthesia to improve range of motion. We aimed to achieve a flexion range of at least 90°, so that toilet activities can be unhampered. Although a mean improvement of 50° was achieved, the results were still less satisfactory than in patients with fresh fractures. Early rehabilitation is paramount to facilitate good functional results.

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