

## Original Research Article

# A prospective study of retrograde nailing for distal third femoral shaft fractures

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### ABSTRACT

**Background:** To evaluate the postoperative knee range of motion and results of unreamed retrograde nailing for distal third femoral shaft fractures.

**Methods:** Between June 2019 and June 2021 inclusive, a consecutive series of 20 patients who underwent retrograde nailing were prospectively evaluated. Outcome measures were union time, initiation of weight bearing, deformity and shortening, functional length of the nail, knee function assessed using a modified knee society knee score. Correlations between union time and other variables were also studied.

**Results:** In these patients 18 (90%) of the 20 fractures achieved union, of which 4 underwent dynamisation; the mean union time for the other 18 fractures was 3.1 months. Angular malalignment was present in 2 patients and shortening in 3 others. There was negligible correlation between union time and variables of nail-canal diameter mismatch, functional length of nail, fracture geometry, or initiation of partial weight bearing ambulation. Knee flexion of more than 100 degrees was achieved in 19 patients. 14 patients had anterior knee pain and 7 had instability in early phases of ambulation. By the end of one year, excellent or good scores for pain and function were recorded in 95% and 86% respectively of the 20 patients.

**Conclusions:** In view of such favourable union rates and no significant deterioration in overall knee joint function, at best retrograde nailing is a reliable alternative in the management of selected complicated fractures of the distal femoral shaft.

**Keywords:** Femoral distal third fractures, Fracture fixation, Intramedullary, Retrograde nailing

### INTRODUCTION

The management of femoral diaphysis fractures was revolutionised by the development of the interlocking intramedullary nail with antegrade insertion being the gold standard. Certain limitations of this technique have led to the development of retrograde nailing (RN) for femoral shaft fractures. RN has gained popularity over the past 10 years. The 2 main concerns in RN are: interference with knee function and fractures in the lower third of the femoral shaft (which take longer to unite), which was also our clinical experience.<sup>1</sup> However, reports dealing with this specific problem of such fractures managed by RN

and comprehensive evaluation of postoperative knee function are lacking. We therefore aimed to evaluate the postoperative knee function and results of unreamed retrograde intramedullary nailing for distal third femoral shaft fractures.

### METHODS

Between June 2019 to June 2021, a consecutive group of patients with fractures of the lower third of the femoral shaft who underwent unreamed RN were prospectively evaluated. The femoral shaft was divided into 3 equal segments and only fractures with the major fracture line

in the distal third were included. Fractures without involvement of the lower third of the femoral shaft, those with a supracondylar/intercondylar extension, grade-III open fractures, and those with an open physal plate were excluded. All relevant data were collected in a standardised proforma.

Outcome measures included; time taken for union fracture was considered united when the patient could walk painlessly without aid and when bridging callus was shown on at least 3 cortices on radiography, time to initiation of weight bearing, angular deformity (as measured on the anteroposterior and lateral radiographs after union), rotational deformity, and limb length discrepancy (as assessed by clinical examination), functional length of the nail in each fracture segment, nail-canal diameter mismatch, the status of the knee, according to Knee Society Knee Score. Malunion was defined as more than 5° of angular deformity or more than 1 cm of limb length discrepancy or more than 10° rotational deformity.

## RESULTS

Total 16 male and 4 female patients (20 fractures) aged from 20 to 75 (mean 41) years fulfilled the inclusion criteria. 12 fractures involved the right side, 8 the left side. The injury mechanisms were: motor vehicle accident (N=16), falls from a height (N=4), four patients sustained associated polytrauma to the chest, head, or pelvis and their injury severity score ranged from 13 to 27 (mean, 19.8). Four of these patients had associated fractures requiring surgical stabilisation: one had an ipsilateral tibial fracture floating knee, one had ipsilateral tibial and patellar fracture, one had associated fracture neck of femur. For the remaining 2, one had an ipsilateral tibial fracture and the other had a patella fracture. All these patients underwent simultaneous or sequential stabilisation of their associated injuries. 12 fractures were located at the distal third of the femoral shaft, another 7 at the junction of the distal and middle third. There was 1 open fracture (Gustilo grade II) and the rest were closed injuries. Comminution was graded according to the WH classification system: 5 were type 0, 4 type 1, 2 type 2, 1 type 3, 2 type 4, 6 were long oblique or spiral fractures. Over a mean patient follow-up period of 1.5 years, 18 (90%) of the 20 fractures achieved union: 16 united following the index procedure (Figure 1-2), 4 others underwent dynamisation of the implant (Figure 3). The mean time to union in the first group was 3.2 standard deviation (SD), 1.0 months, in whom there was no evidence of union at the third month, underwent dynamisation (removal of the proximal screw). One patient was lost to follow-up after 6 months and considered a treatment failure.

The mean operation set up time for the unreamed RN was 18 (SD, 3) minutes. The mean operation time in patients who underwent unreamed RN as an isolated procedure was 88 (SD, 16) minutes. Based on the stability of the

fracture and the technical difficulty during locking, all implants were statically locked with 3 screws distally or one or 2 screws proximally. Of the 20 knees available for evaluation, 19 achieved a flexion of >100° and one patient (with an associated fracture of the patella) only 90° of flexion. Mild anterior knee pain (not interfering with routine activities) recorded in 17 patients, was the most common complaint. Significant sagittal and coronal plane instability was noted in 6 of these knees. The overall status of the knee was assessed by the modified knee society knee score. At postoperative month 6, 63% had an excellent or good pain score, while only 37% had excellent or good functional scores. By the end of one year, excellent or good pain and functional scores were recorded in 95% and 87% of the patients respectively.



**Figure 1: Immediate post operative X-ray.**



**Figure 2: Six weeks post operative X-ray.**

Radiological angular malalignment (>5°) was present in 2 patients, 1 had valgus malunion and one had anterior angulation at the distal fracture. However, none were deemed to warrant a secondary procedure. Significant

limb length discrepancy (>1 cm) was noted in 2 patients (mean, 2.25 cm). Four patients complained of pain around the distal interlocking screw and were managed with analgesics or single screw removal (n=1). Superficial wound infection was evident in 4 patients (3 had a traumatic arthrotomy), which resolved after antibiotic treatment and antiseptic dressings. No patient experienced a deep infection, fat embolism, heterotopic ossification, or implant failure. Pearson's correlation test showed very negligible correlation between union time and nail-canal diameter mismatch or time to initiation of partial weight bearing. Chi squared test (with Yates correction) revealed a statistically significant association between the level of the fracture and the median time to union. Fractures at the junction of the lower and middle third united significantly earlier than those of the lower third. There was no significant association between union time and other parameters.



**Figure 3: 10 weeks post operative X-ray.**

## DISCUSSION

The gold standard in the management of femoral shaft fractures has been closed antegrade intramedullary nailing, with large series reporting union rates of more than 97%.<sup>2,3</sup> IMSC nailing has become the treatment of choice for fractures in the supracondylar region.

In patients with polytrauma, RN is an alternative to antegrade nailing for the treatment of femoral shaft fractures, because it is technically easier, allows easier access to other fractures and obviates the need for traction on a fracture table. Several authors have advocated the technique to treat bilateral femoral shaft fractures and floating knee injuries and it also enables ipsilateral femoral neck and shaft fractures to be stabilised.<sup>1,4-9</sup> Others have expanded its use to patients with ipsilateral pelvic or acetabular fractures.<sup>8,10,11</sup> By taking the advantages of intramedullary nailing, it spares the abductor muscles, thus avoiding incisions in the region of future

acetabular surgical approaches and the need for traction on a fracture table (which may stress an unstable pelvis).

Obese patients and those with skin lesions in the region of greater trochanter are also suitable for RN.<sup>1,4,8</sup> As femoral RN entails no direct radiation to the pelvic region, it is particularly suitable for pregnant patients.<sup>1,12,13</sup> Patients with femoral head injuries may also benefit, because the antegrade approach can lead to significant heterotopic ossification of the hip joint and importantly RN shortens the corresponding operation time.<sup>11,14,15</sup>

Over the past 2 decades, RN of the femur has evolved to address some of these limitations of antegrade nailing. For femoral shaft fractures, it achieves union rates varying from 88 to 98%, which are comparable to those of antegrade nailing.<sup>1,16,17</sup>

Fractures of the distal third of the femoral shaft remain a surgical challenge. Because of its expanding trumpet shape, when stressed the nail may move within the bone. This leads to a loss of reduction on weight bearing, even though the fracture has been well reduced with an antegrade or supracondylar nail. RN provides more stable fixation because of its longer functional length in the fracture fragments and better purchase/adherence at both ends. The present study addresses the particular problem of distal third femoral shaft fractures managed with an unreamed RN. We achieved a union rate of 93%, which is comparable to other studies with antegrade nailing as well as RN.<sup>1,3,16,17</sup>

In the present study, the mean union time of 3.2 months is more than that for antegrade nailing performed in our institution. Comparative studies have revealed that fractures treated by RN take longer to unite, particularly when an unreamed nail is used.<sup>1,16</sup> However, others found no difference in the union time between reamed antegrade nailing and RN, which depended on multiple variables (mechanical factors, fracture morphology, and most important of all reaming of the medullary canal).<sup>15</sup> Ostrumetal.<sup>1</sup> It was observed that the longer time required for union in retrogradely nailed femurs may be related more to fracture morphology and the surrounding soft tissue injury than to the insertion technique. They localised this problem to fractures at the junction of the middle and distal third, noting that though there were no large nail-canal diameter mismatches at this level, these sites tended to resorb and take longer to unite. Although we expected a correlation between nail-canal diameter mismatch and the time to union, statistical analysis revealed no relationship. Contrary to Ostrum et al,<sup>1</sup> in our series fractures at the junction of the lower and middle third united significantly earlier than those of the distal third. Moed and Watson also observed that the time to union was also long (15 weeks) in their patients and suggested that static locking might be delaying union.<sup>5</sup> Like us, many others have observed the increased need for dynamisation of the implant to achieve union by RN, and 20% of our cases needed dynamisation to achieve

fracture union. The most common technical difficulty encountered during the RN procedure was free hand proximal locking.<sup>1,5,13</sup> As the implant used was the standard antegrade femoral nail, the proximal locking was in the lateral to medial direction. Although this eliminated the risk of neurovascular injury during placement of the interlocking screw, visualisation of its hole was difficult. In addition, the bulk of soft tissue in the proximal thigh increases the risk of the screw getting lost.<sup>11,12</sup> Suggested remedial measures include: the use of a sandbag under the ipsilateral hip, making a generous incision and tying an absorbable suture around the screw. Due to these technical difficulties, in a few patients we restricted proximal locking to a single screw. The number of screws used did not have any correlation with fracture union time or alignment. We also observed that when the nail length fell short of the lesser trochanter, the locking process became easier. Whether this compromises the stability of the fixation or increases stress at the subtrochanteric region needs further study.

Knee pain, knee stiffness, quadriceps atrophy, articular cartilage damage, and synovial metallosis are the potential problems of the RN procedure, which prevent its wide acceptance. Although knee stiffness following RN has been a major concern, several studies have shown that the range of movement is not adversely affected.<sup>1,4,15</sup> In our series, 93% of the operated knees achieved >100° of flexion (mean, 123°). The only patient whose range of knee flexion was more limited, had an associated ipsilateral patellar fracture.

Comparative studies have shown no difference in the incidence of knee pain between antegrade nailing and RN. Anterior knee pain has multiple causes (e.g. cartilage injury from initial trauma or quadriceps atrophy) and may not be due to the retrograde nail per se.<sup>1,15</sup> In our study, it was the most common complaint (70%), noted even as late as one year postoperatively. In most patients it was not so severe as to interfere with activities of daily living, and only 3 (11%) required medication for pain relief. 53% of the patients with anterior knee pain had ligamentous instability of the knee, but there was no record of preoperative assessment for comparison. As RN does not interfere with the anterior cruciate or collateral ligaments, the likely cause of such instability is the initial trauma itself. Indeed, the incidence of ligamentous injury following fractures of the femoral shaft range from 5 to 48%, but to what extent this ligamentous instability contributes to knee pain is unknown.<sup>7</sup>

Postoperative function of the knee has always been evaluated in terms of knee pain and/or range of movement, rather than as a comprehensive function. Though the knee society knee score was developed in relation to total knee replacement surgery, the first 2 components of the scoring system (knee score and knee function score) provided a suitable instrument for overall assessment in our study; the categorical score was

omitted as it was not relevant.<sup>18</sup> RN appeared to have a detrimental effect on the knee, as seen by the reduced knee score even one year post operatively. The high incidence of knee instability compromises the knee score, though as mentioned already its aetiology is probably unrelated to the nailing. Hence, to attribute the low overall knee scores entirely to the RN procedure may be inappropriate. Irrespective of aetiology, the fact remains that the knee function is compromised in at least 27% of the patients, which is contrary to the claims of many authors reporting that knee function is not significantly compromised.<sup>1,4,15</sup> This contradiction could also be related to different parameters used to assess the knee joint, variations in surgical technique or the joint mobilisation protocol. The status of the operated knees improved over time; the mean pain score improved from 70 (SD, 16) at 6 months to 82 (SD, 16.) at one year and the mean functional score from 60 (SD, 21) to 80 (SD, 22). However, further studies with longer follow-up should give a clearer picture. Other complications associated with RN of the femur include malalignment, knee joint sepsis, neurovascular injury during proximal screw placement, symptomatic distal interlocking screws, and hetero-topic ossification. The reported incidence of malunion varies from 2.2 to 42%, which is probably due to variations in the definition of malunion. Using the criteria mentioned earlier, 4 of our patients had angular malunion and 4 had limb length discrepancy; none of them received additional surgical procedures to correct these deformities. The reported incidence of symptomatic distal interlocking screws varies from 9% to 33%.<sup>1,5</sup> Our 4 patients were managed either with analgesics or single screw removal (N=1). There is a potential risk for injury to the femoral artery and nerve during placement of the proximal anterior-to-posterior interlocking screw.<sup>13</sup> However, as the direction of its placement was lateral-to-medial in our series, we did not encounter this problem. Nor did our patients develop, knee sepsis or heterotopic ossification around the joint, both of which are recognised risks.<sup>17</sup>

## CONCLUSION

Though the results of unreamed RN for distal third femoral shaft fractures are encouraging in terms of union, we recommend its use with caution, due to significant deterioration in overall knee joint function. There is no significant correlation between the time taken for union and variables such as the type of fracture, nail-canal diameter mismatch, and functional length of the nail in each fracture segment. More detailed studies with longer follow-up are required before accepting RN as routine. Nonetheless, RN is a reliable alternative in the management of selected complicated fractures of the distal femoral shaft.

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