



INFRA ISTHMAL FEMUR SHAFT FRACTURE TREATMENT WITH RETROGRADE INTRAMEDULLARY NAILING - TECHNICAL CONSIDERATION AND FUNCTIONAL OUTCOME.

Orthopaedics

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ABSTRACT

Introduction- Infra-isthmal femur shaft fracture term has not attained status as special entity in general orthopedic practice. It has been associated with non-union, malalignment and implant breakage. Open reduction and internal fixation with plating for these fractures is also problematic. Retrograde nailing of these fractures appears to be biological solution. But literature shows divided opinion. While retrograde nailing had few technical issues reported, few authors consider retrograde nailing as Biological Osteosynthesis for distal femur fractures. Hence this prospective study is done to find out technical efficacy and functional outcome after retrograde nailing in infraisthmal femur shaft fractures. **Methods-** This is a prospective study conducted from January 2022 to May 2024 in tertiary care teaching hospital in India. Twelve consecutive patients full filling criteria with 13 closed infraisthmal femur shaft fractures were treated with retrograde femur nailing. Patients followed up for 2 years. Time to radiological union and Modified HSS knee score recorded. **Results-** In this study, average time to union was 15 weeks and no patient had deformity more than 10° in any plane at 6 months follow up. Average Modified HSS knee score was 86. There was excellent score in 7 patients while 3 patients had Good result and 1 poor result. **Conclusion-** Retrograde nailing if done with proper technique, is truly a Biological osteosynthesis for infraisthmal femur fracture. This retrograde technique with use of thigh support for traction can mitigate difficulties in retrograde nailing for infraisthmal fracture. Knee pain and knee issues after retrograde nailing lack strong evidence and efficacy of retrograde technique should not be neglected.

KEYWORDS

INTRODUCTION

Infra isthmal femur shaft is part of femur shaft from lower edge of isthmus to line between epicondyles of femur. Fractures of this distal third of the femoral shaft are relatively rare (0.4% of all fractures and 3% of femoral fractures). Though reported in early literature in 70's and 80's, infra-isthmal femur shaft fracture term has not attained status as special entity in general orthopedic practice. Femur shaft fractures are major bone fractures and are traditionally treated with antegrade femur nailing, other options being open reduction and internal fixation with distal femur plate or dynamic condylar screw but these need extensive exposure and associated with complications compared to antegrade nailing. Retrograde femur nailing with Distal Femur Nail (DFN) is another treatment option.

Indications described in literature for the use of retrograde nailing include polytrauma, floating knee injuries, ipsilateral pelvic or acetabular fractures, ipsilateral total knee arthroplasty, ipsilateral hip arthroplasty or osteosynthesis, obese patients, and AO type-A and type-C distal femur fractures. Treatment of Distal third shaft fracture including infra-isthmal or junctional fracture with retrograde nailing have been reported. While outcomes have been favorable, retrograde femoral nailing is not without its own shortcomings. Reported adverse associations include postoperative knee pain, knee arthrosis, and knee septic arthritis. Also retrograde nailing had few technical issues reported such as inability to use traction table, need of blocking screws. On the other hand, few authors consider retrograde nailing as Biological Osteosynthesis for distal femur fractures. Because of more fear of these shortcomings and being comparatively newer procedure, retrograde nailing is not favored procedure in general orthopedic practice.

Several authors have documented that infra isthmal femur shaft fracture treated with antegrade nailing have been associated with non-union, malalignment and implant breakage. Treatment of nonunion is difficult task after antegrade nailing. Hence this prospective study is done to find out technical efficacy and functional outcome after retrograde nailing in infraisthmal femur shaft fractures.

REVIEW OF LITERATURE-

Literature particularly considering infraisthmal distal femur fracture is sparse. Most of the studies of retrograde nailing have treated distal femur fracture and many of them are retrospective studies, though these studies have large sample size.

N. Reis et al in 1977 (Reis & Hirschberg, 1977), described infraisthmal femur shaft fracture special entity and considered intramedullary nailing (antegrade) is mechanically unsound and advised plating is choice for these fractures.

Contrary to above study, R. Richards (Richards, 1984) in 1984 in his review of 82 patients, stated that intramedullary nailing should be used whenever possible of infraisthmal fractures H. Janzing (Janzing et al., 1998) in 1998, stated that retrograde intramedullary nailing makes a biological osteosynthesis of distal femoral fractures possible. Even in aged patients good functional results could be obtained. Poor hold of the distal inter- locking screws and difficult proximal locking are the two major technical problems encountered.

Tornetta (Tornetta & Tiburzi, 2000) in 2000 study stated that though all fractures healed and knee pain resolved over time, there were more problems of length and rotation using a retrograde technique on a radiolucent table than with an antegrade approach on a fracture table.

G. Papadokostakis et al (Papadokostakis et al., 2005) in a systematic review concluded that retrograde femoral nailing is an effective method in the treatment of distal femoral fractures and an alternative option in the treatment of femoral diaphyseal fractures, but only after careful selection of patients to avoid problems.

Watanabe in 2013 (Watanabe et al., 2013) in retrospective study concluded that infraisthmal femur fracture as one of the risk factor for non-union, where most of the procedures were done with antegrade approach in his study and stressed that the need for additional surgical fixation for the distal fragment when performing femoral nailing of infra-isthmal femoral fractures.

Kim et al in 2018 (Kim, Oh, et al., 2018), in an excellent retrospective study concluded that retrograde nailing show higher rate and shorter time of union, but there was no significant difference with antegrade nailing for the treatment of infra-isthmal femoral shaft fracture. The retrospective study design was a shortcoming of that study and they recommended additional larger scale, prospective study.

Bryan van dyke et al (Van Dyke et al., 2018) did not find any significant advantages when blocking screws were added to a retrograde intramedullary nail construct for distal femur fractures with respect to union time, union rate, or improvements in alignment Wei-Chang Hung (Hung et al., 2022) advised to avoid non-union with longer and larger nails and apply more distal locking screws, especially for unstable, wider IM canal, and shorter distal fragment fractures.

Garrett Breyer (Breyer et al., 2023) concluded that retrograde femoral nailing is often associated with anterior knee pain. With an incidence rate of 64% and most patients reporting mild to moderate pain severity, his study supports this relationship. While the generation of this pain is somewhat unpredictable and could be confounded by arthritis or concomitant undiagnosed knee injury. Studies documenting knee pain

after retrograde nailing often state that knee pain resolved over time and there is no strong correlation.

MATERIALS AND METHODS-

This is a prospective study conducted from January 2022 to May 2024 in tertiary care teaching hospital in India. Considering 0.4 % prevalence of infraisthmal fracture and confidence interval of 95%, sample size was 10. Ethical approval taken from institutional ethics committee and informed written consent taken from all patients before surgery included in study. Twelve consecutive patients with 13 closed infraisthmal femur shaft fractures were treated with retrograde femur nailing. One patient lost follow up after surgery, hence 11 patients with 12 fractures were followed up monthly till minimum of 6 months and afterwards telephonically till 2 years for any relevant fresh complaints. Seven fractures were left and 6 were right sided injury. The mean age was 45 years. There were 9 males and 3 females. There were 6 left sided injury, 5 right sided and 1 patient had bilateral fractures. Road traffic accident was mechanism of injury in 7, fall from height in 3 patients while 2 patients had slip and fall. Co-morbid conditions were noted. One patient had fractured his limb with post-polio residual paralysis, 2 patients were chronic smoker and one 52 year lady was morbidly obese.

Inclusion Criteria-

1. Skeletally mature patients (>18 years old)
2. Closed infra isthmic extra articular distal femur fracture in hemodynamically stable patient without neurovascular injury.

Exclusion Criteria-

1. OTA Type 33 fracture (based on the rule of squares)
2. Pathologic fracture
3. Prior surgery of affected femur
4. Ipsilateral hip or other fractures around ipsilateral knee.
5. Clinical signs of infection at operative site prior to or during surgery.

Retrograde nailing technique- Patient positions on fracture table with central post at groin held firmly and thigh resting on thigh support. Thigh support attached to table with the help of attachment so that moving thigh support distal can exert traction if needed (Figure 1). After painting and draping, patella tendon split longitudinally with incision over midline (Figure 1 inset). Fat pad removed if excess. Entry made with at anterior end of Blumensaat's line with awl. Guide wire passed and attempt made to pass the wire parallel to lateral and anterior cortex as these cortices are more in line with isthmus. While wire is in distal fragment, if reduction not there, slight traction can be given with the help of thigh support movement distally or cannulated straight reamer can be used to manipulate distal fragment and once reduction achieved guide wire advanced. Sequential reaming carried out and nail passed half size smaller diameter than reamer and confirmed that it's around half centimeter deep to cartilage. Nail fixed distally with 3 screws first and then fracture can be compressed with direct blow over nail attachment. Short DFN can be fixed proximally through jig only. If long DFN is needed then, once nail is passed, hip is abducted after loosening the attachment and proximal locking done with 1 or 2 screws free hand under C arm guidance. After hip abducted, proximal locking is same as free hand distal locking in antegrade nailing. Patients discharged on post op day 5 if wound dressing are clean and dry.



Figure 1 Fracture table with thigh attachment, position of patient (inset) during the technique

All patients' baseline characteristics are recorded as age, sex, mechanism of injury, side of injury and AO/OTA fracture type. Patients followed up monthly till minimum of 6 months and afterwards telephonically till 2 years for any relevant fresh complaints. Bony trabeculae crossing fracture gap on 3 cortices is considered as radiological union and < 10° deformity in any plane as acceptable alignment. Time to radiological union and alignment recorded, full weight bearing started after confirmation of radiological union. Modified HSS knee evaluation score recorded at 6 months follow up. In this scoring system, pain (30 points), function (22 points), knee range of motion (15 points), muscle strength (15 points), flexion deformity (10 points), and instability (5 points) were evaluated. According to the presence of using a brace, extension loss in knee and deformity, 1-3 points was deducted from the HSS score to give a final result. According to this scheme, > 85 was evaluated as excellent, 70-84 as good, 60-69 as moderate, and < 60 poor.

Parametric variables described as means and non-parametric variables described with median and compared results of other studies with one way ANOVA and Kruskal Willis test respectively.

RESULTS-

Out of 12 patients, one only patient with multifragmentary type infraisthmal fracture did not followed up after surgery as he was resident of other state.

Many studies state regarding inability to use of traction on fracture table for these fractures. In all 13 fractures, patients positioned on fracture table. In one bilateral case, one limb operated after the other in same setting. Traction was adequate with distal movement of thigh support and was not issue in any case.

Reduction was satisfactory in all cases as distal fragment was manipulated with the help of cannulated straight reamer and did not encounter any problem. But in fractures with displaced large wedge fragment or flipped fragments as shown in radiograph- Figure 3, fracture site is opened and fragment repositioned and held circumferentially with no. 1 vicryl suture. Blocking screw was not necessary in any case. Proximal screw was placed through jig in short DFN case and in long DFN cases, abducting hip made screw placement as easy as free hand distal screw placement of antegrade technique.

Table 1 Baseline Characteristics And Study Results.

Characteristics	Findings
Age, mean	45 yrs
Gender	9 males ,3 females
Side of injury	6 left, 5 right, 1 bilateral.
Mechanism of injury	RTA 7, fall from height 3, slip and fall 2
AO/OTA fracture type	Transverse 2, wedge-10 , multifragmentary 1
Nail type	2 short, 11 long
Time to union in weeks mean	15 weeks (44 wks. - 7wks)
HSS Knee evaluation score avg.	86



Figure 2: AO 32A- fracture with post op Xray



Figure 3: AO 32B-fracture and post op x ray



Figure 4: AO 32C-fracture with post op x ray-

Most of the fracture type was AO 32B with 10 out of 13 cases. Most of the patients were treated with long distal femur nail with 1 dynamic proximal screw while short DFN had 2 proximal screws. Distally all nails fixed with 3 screws. Distal 2 holes are for cancellous screw but experience of this study is that cortical screws in distal 2 holes improve strength of the construct so that blow on nail attachment for compression at fracture site can be done effectively. In this study, average time to union was 15 weeks and no patient had deformity more than 10° in any plane at 6 months follow up. Average Modified HSS knee score was 86. There was excellent score in 7 patients while 3 patients had Good result and 1 poor result. Poor result patient did not showed healing at 4 months hence additional plating was done and fracture healed after 44 weeks of index surgery. Retrospectively realized that this poor result is because of tight fitting nail which prevented compression at fracture site. But there was no patient with knee pain complaint nor any patient developed knee sepsis at 6 month of follow up. There were no fresh relevant complaints in any of 11 patients on telephonic follow-up.

DISCUSSION-

Infraisthmal femur fracture is terminology though found in western literature, use of this terminology in practice and in Indian literature is sparse. Retrograde nailing of distal femur though called biological osteosynthesis by Janzing in 1998, has not received wide spread

interest and studies report contradictory findings such as technical problems, malalignment, screw breakage/ loosening and knee issues. There are studies with large sample size in literature but firstly, most of them are retrospective studies and rest are systematic reviews and most studies focused on retrograde nailing of distal femur fracture and not particularly the infraisthmal fracture. So this prospective study was needed to contribute in literature regarding issues of infraisthmal fractures.

Tornetta et al (Tornetta & Tiburzi, 2000) , found that in retrograde technique, nailing without a traction table made length and control of rotation more difficult while G. Papadokostakis et al (Papadokostakis et al., 2005) opinioned that retrograde technique does not require traction. In this study, there was no need of traction in most of the cases while use of thigh support facilitate certain amount of traction needed for reduction. Particular technique of thigh support for support and traction used in this study is efficacious, considering the results of the study.

Gavaskar (Gavaskar & Chowder, 2013) concluded that Blocking screws increase the stability of the construct and thereby minimize macro-motion at the fracture site while B. Van Dyke et al (Van Dyke et al., 2018) concluded that did not find any significant advantages when blocking screws were added to a retrograde intramedullary nail construct for distal femur fractures with respect to union time, union rate, or improvements in alignment. Results of this study indicate that without use of blocking screws this procedure can be carried out safely. This can be correlated to technique for guide wire and reaming used in this study and that made retrograde nailing of distal femur, a technically easy procedure.

This study has 63% excellent and 27% good result at 6 months with average Modified HSS Knee score of 86. This is comparable to other studies. Knee pain and knee related issue are not seen in this study. Even one patient with poor result never complaint of any knee related issue though he had difficulty in stair climbing which improved with fracture healing after resurgery with additional plating.

This study did not found implant breakage, distal screw loosening, nail migration into the joint, thromboembolism or knee sepsis in any patient.

Nonunion of femur shaft after antegrade nailing reported in 2 studies was treated with exchange nailing and additional plating. (Kim, Yoon, et al., 2018; Sancheti et al., 2017) And one study on non-union after plating of distal femur treated with retrograde nailing vs plating. (Ziranu et al., 2022) Though retrograde nailing not considered option in literature, this retrograde technique has potential for treatment of nonunion of infraisthmal femur fracture.

This study had limitations. Firstly sample size is limited because of rarity of the fracture occurrence. Long term follow up is required to know more regarding peri-implant fracture or stress shielding. Implant removal is recommended after fracture healing and long term follow up required to document implant removal related issues. Antegrade nailing technique is in common use for femur shaft fracture. Hence study design involving randomization with comparison group will yield more interesting results. As an author, I had prior experience of non-union with antegrade nailing, hence bias in results cannot be ruled out. Only one case of multifragmentary fracture reported, that patient also lost to follow-up. Hence result is not all inclusive.

CONCLUSION-

Retrograde nailing if done with proper technique, is truly a Biological osteosynthesis for infraisthmal femur fracture which is risk factor for non-union after antegrade nailing.

This retrograde technique with use of thigh support for traction can mitigate difficulties in retrograde nailing for infraisthmal fracture.

Knee pain and knee issues after retrograde nailing lack strong evidence and efficacy of retrograde technique should not be neglected.

Retrograde nailing has potential for treatment of nonunion after antegrade nailing of infraisthmal fracture.

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