Role of Dynamization in Interlocking Nailing of Fractures of Tibia and Femur

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Abstract

Background: Intramedullary interlocked nailing has been the most widely accepted and practiced strategy of the management of diaphyseal fractures of tibia and femur, however, associated with delayed and/or non-union in many cases. Dynamization forms one of the various methods proposed to overcome the problem of non-union. This study aims at assessing the need and effectiveness of dynamization in tibial and femoral diaphyseal fractures.

Materials and Methods: A total of 218 diaphyseal fractures of femur (77) and tibia (141) were selected for the prospective study in the time frame of 01-06-2015 to 31-08-2016. All patients underwent closed or open interlocking nailing, and clinical and radiological follow-up was done for 1 year with the results being obtained on radiological assessment.

Results: In femur interlocking nailing, the average union time was 22.4 weeks for non-dynamized and 21.6 weeks for dynamized nails. For tibial interlocking nailing, it was observed to be 22.5 weeks for non-dynamized and 20.1 weeks for dynamized cases.

Conclusion: Delayed and non-union continue to be a major problem associated with intramedullary interlocking nailing of diaphyseal fractures of tibia and femur, for which dynamization has been advised. In our study, the progress of union and the average time to union were observed in dynamized versus non-dynamized cases, and it was observed that dynamization had a definite role in enhancing tibial diaphyseal fracture union while having an equivocal effect on femoral diaphyseal fractures, as compared to non-dynamized cases.

Keywords: Dynamization, Interlocking, Tibia, Femur.

Introduction

Diaphyseal fractures of tibia and femur have been known since the medieval times. Their management protocols evolved starting from wooden and ivory sticks in the 16th century onto metallic rods used as internal splints in World War 1 [13]. Later in the 20th century, newer metallic implants with greater strength and pliability came forth. These metallic rods inserted into the medullary cavity provided satisfactory axial stability. However, lack of rotatory stability continued to be a cause of a high rate of delayed and non-union. With the advent of the Kuntscher nail [13] in 1940, the concept of three-point fixation of a fracture was brought into light that received immediate and widespread recognition across the orthopedic community. Although the K-nail provided axial stability as well as three-point fixation and thus improved stability of the fracture, it could not provide rotatory stability except in transverse or short oblique fractures in the isthmic region of femur. To improve rotatory stability, surgeons came up with the idea of putting screws just anterior or posterior to the nail to obliterate the space [16] and later to put screws into the slot of the nail to restrict the rotatory mobility at the fracture [12]. This technique, however, imparted too rigid fixation and continued to yield a high rate of non-union. To overcome this problem, the concept of interlocking nails was proposed, where the screw was passed from the cortex of the bone into the hole of the nail and into the opposite cortex at both ends of the nail. However, again a high rate of non-union was seen, and hence, surgeons recommended dynamization in each and every case of interlocking after 6–12 weeks of surgery. Dynamization could be achieved by the provision of oblong slots in the intramedullary nails [41] called as dynamic holes, along with the circular slots. Thereafter, the process of dynamization was done that
included removal of the screw in the circular slot (static hole) after 6–12 weeks of surgery when the soft callus had already formed [45] that allowed the interlocking screw in the dynamic hole to move about in the axial direction, thus conferring a dynamic compression at the fracture site during weight bearing. There are, however, advantages and disadvantages of both methods of fixation. Static nailing provides rigid fixation and thus helps in maintaining length and alignment, especially in comminuted and segmental fractures, where dynamic nailing from the beginning may lead to the loss of reduction and shortening, especially in comminuted fractures. Today, the debate for nailing in static mode and dynamization later on or nailing in a dynamic mode since beginning is going on. This study has been undertaken to study the role and timing of dynamization after interlocking nailing in diaphyseal fractures of femur and tibia.

Materials and Methods

A total of 209 patients with 218 diaphyseal fractures of femur and tibia attending the emergency and outpatient department of Maharani Laxmi Bai Medical College Hospital, Jhansi, were selected for the study in the time frame of 01-06-2015 to 31-08-2016. Patients were examined, hemodynamically stabilized, and first aid administered in the form of splintage/traction/Plaster of Paris slab along with analgesics followed by radiological evaluation. Relevant data were recorded in pre-prepared pro forma. Patients were evaluated clinically for the fitness for anesthesia and surgery. Relevant investigations were done. Only diaphyseal fractures of femur and tibia including Gustilo’s type 1 and 2 compound fractures were included in the study. Patients with Gustilo’s Grade 3 compound fractures, already infected fractures, sclerotic disease of bone with inadequate marrow cavity, periarticular fractures, patients below 8 years of age, patients with pre-existing non-functional limbs due to pre-existing pathology, polytrauma patients, and patients medically unfit for surgery/anesthesia were not included in the study. Having attained surgical and anesthetic fitness, all patients underwent open or closed interlocking nailing procedure. During follow-up visits at 4 weeks and 6–8 weeks post-operative, assessments regarding condition of suture line, pain, fracture fixity, mobility of knee, hip, and ankle, and evidence of callus on X-rays was made. When X-rays at these two consecutive visits did not show progress of union, the patients were subjected to dynamization that theoretically involves removal of the static locked screw from the longer fragment of the shaft of the bone. However, in certain implants, when a dynamic hole was not available in the distal part, both the distal static screws were removed. This, though, was only done once the fracture had consolidated and macromovements were no longer possible at the fracture site. Patients were then followed up at monthly intervals, and the radiological progress of union along with the final time to union was recorded and studied.

Results

Our study encompassed a total of 218 fractures of femoral and/or tibial diaphyses (77 femoral and 141 tibial) indicating the higher incidence of tibial diaphyseal fractures as compared to femoral diaphyseal fractures. The mean age of patients was 34.08 years. There were 161 males and 57 females. The side of involvement was right in 109 and left in 99 cases. The number of open fractures was 69 among tibial and 18 among the femoral diaphyseal fractures. The compounding status of the injuries was classified using the Gustilo-Anderson system of classification, according to which, 47 tibial and 13 femoral fractures were compound Grade 1 while the remaining 22 tibial and 5 femoral fractures were compound Grade 2. The X-ray grading of the tibial diaphyseal fractures under the study revealed 67 transverse and short oblique, 40 spiral, 30 comminuted, and remaining 4 to be segmental fractures. The femoral fractures, on the other hand, were classified as 42 transverse and short oblique, 4 spiral, 29 comminuted, and 2 segmental fractures. Closed reduction could be achieved in 61 femoral interlocking and 118 tibial interlocking procedures. The mean operative time was 47.19 min for tibia interlocking and 56.7 min for femur interlocking nailing. The mode of locking employed during the interlocking procedures was static locking in 71 femoral and all 141 tibial interlocking nailings. Weight bearing was started at 6 weeks’ post-operation, in case of femoral fractures in the form of toe-tip touching in 35 and partial
Finally, the average union time observed in our study was 22.5 weeks for non-dynamized and 21.6 weeks for dynamized femoral interlocking nails, with a difference of 0.8 weeks between the two. For tibial interlocking nails, it was observed to be 22.5 weeks for non-dynamized and 20.2 weeks for dynamized cases, yielding a greater difference of 2.3 weeks between the two, as compared to femoral fractures. There have been past studies that yield observations identical to ours, as well as with equivocal and even conflicting findings. Data in support of dynamization were recorded in the study by Basumallick and Bandopadhay in 2011 [2], who reported a union time of 19.2 weeks in dynamized cases and 23.5 weeks in non-dynamized cases of femoral fractures, highlighting a beneficial role of dynamization on union time. On the other hand, works that arrived at equivocal results included Sharma and Gopalan’s [39] study on dynamization and fracture healing in 2011 and Salooki and Misbah’s study in 2011 [8], and both of which reported identical times to union in dynamized and non-dynamized groups. At the same time, there were surgeons who came up with results against dynamization. These included works by Carlton et al. in 2005 [11], who observed a faster healing rate in the static group, Brumback et al., 1988 [5], who achieved satisfactory union in 99% of cases without the need for dynamization, and Brumback et al., 1988 [5], who also came up with data going against dynamization. The timing of dynamization was also studied. While we observed an average union time of 21.6 weeks for dynamized femoral interlocking nails and 19.2 weeks in dynamized tibial interlocking nails, having performed all dynamization procedures between 6 and 12 weeks post-operation, similar study by Subhramaniam in 1988 [14], who performed dynamization after 24 weeks post operation, observed an average union time of 22.8 weeks and 21.4 weeks for femoral and tibial interlocking nails respectively, denoting a greater efficacy of an early versus a delayed dynamization.

**Conclusions**

Intramedullary interlocking nailing has stood the test of time to be the most widely accepted protocol for the management of tibial and femoral diaphyseal fractures worldwide. Along with this, dynamization has been a very important tool to overcome the pitfalls of delayed union and non-union, resulting from too rigid fixation imparted by interlocking nails. Its overall effectiveness and appropriate timings, however, have always been topics of great debate. We studied the effects and timings of dynamization and came up with observations favoring its beneficial effect on accelerating the time to union in tibial diaphyseal fractures but an equivocal effect on the healing rate of femoral diaphyseal fractures. Furthermore, early dynamization...
between 6 and 12 weeks post-operative proved to yield faster healing times in tibial and femoral diaphyseal fractures when compared with earlier studies.

References


Conflict of Interest: Nil. Source of Support: None