Management of closed tibial fractures with intramedullary interlocking nail

Dr. Maley Deepak Kumar*, Dr. Prateek Ahlawat**, Dr. Saurabh Chandrakar**, Dr. Ankit Mittal,*** Dr. Y. Hari Babu****

*Fellow in Trauma Care, Department of Orthopaedics, Pt. B.D. Sharma PGIMS, Rohtak
**Senior Resident, Department of Orthopaedics, Pt. B.D. Sharma PGIMS, Rohtak
***P.G. Student, Department of Orthopaedics, Pt. B.D. Sharma PGIMS, Rohtak
****Professor, Dept. of Orthopaedics, MNR Medical College, Sangareddy
Corresponding author: Dr. Prateek Ahlawat

ABSTRACT

Background and Objectives: Tibial fractures are one of the common injuries encountered in emergency department with majority being adult age group. Conservative management of tibial fractures are associated with high morbidity, henceforth surgical stabilization with intramedullary interlocking nail is effective treatment option to prevent morbidity and early return to his work.

Aims and Objectives: To evaluate the efficacy of intramedullary interlocking nail in the treatment of closed tibial fractures.

Methods: A total number of 40 patients with closed tibial fractures who underwent surgical stabilization of fracture fixation with intramedullary interlocking nail were included.

Results: Excellent results were obtained in 60% of cases, good results in 20%, fair in 15%, poor in 5%. Complications include 5% of the cases got infected, 10% had malunion, 5% of cases had restriction of ankle and knee movements.

Conclusion: Intramedullary interlocking nail is the reliable, versatile and effective treatment modality for closed tibial shaft fractures. It minimizes the hospital stay and reduces the economic burden and enhances early return to work.

Keywords: Tibial fractures, Intramedullary Interlocking nail

INTRODUCTION

One of the most common injuries encountered in an emergency department are the tibial fractures. Incidence of tibial fractures is increasing due to rapid growth of industrialization and urbanization progressing year to year with rapid increase in traffic, incidence of high energy trauma are increasing with the same speed. Fractures of the tibial shaft are important for the reason that they are common and controversial. The anatomical location of the tibia makes it vulnerable to the direct blow and high energy trauma as a result of motor vehicle accidents thus resulting in comminuted fractures, which are frequently open with significant loss of skin and soft tissues. Tibial fractures may be associated with compartment syndrome, vascular or neural injury. The presence of hinge joints at the Knee and the ankle, allows no adjustment for rotatory deformity after fracture. Because of the high prevalence of complications associated with these fractures, management often is difficult,
and the optimum method of treatment remains a subject of controversy. Management of the fractured tibia requires the widest experience, greatest wisdom and the best of clinical judgment in order to choose the most appropriate treatment for a particular pattern of injury. Among the various modalities of treatment such as conservative gentle manipulation and use of short leg or long leg cast, open reduction and internal fixation with plates and screws, intramedullary fixation (including Ender Pins, intramedullary nails, and interlocking intramedullary nails with remaining (or) without Reaming), and External fixation techniques, surgeon should be capable of using all these techniques and must weigh advantages and disadvantages of each one and adapt the best possible treatment. The best treatment should be determined by a thoughtful analysis of morphology of the fracture, the amount of energy imparted to the extremity, the mechanical characteristics of the bone, the age and general conditions of the patient, and most importantly the status of the soft tissues. Three goals must be met for the successful treatment of fractures of tibia: 1) prevention of infection, 2) achievement of bony union and 3) the restoration of function. These goals are interdependent and usually are achieved in the chronological order given. For example, failure to prevent infection promotes delayed union or non union, and delays functional recovery of the limb. Immobilization in a plaster cast has been used most commonly in the past, but it does not always maintain the length of the tibia and it leaves the wound relatively inaccessible. External fixation, considered the treatment of choice by many traumatologists, has the disadvantages of bulky frames and frequent pin track infections, non unions, and malunions. Charnley in his text closed treatment of common fractures; said that he believed the eventual solution to the tibial fracture would be a non reamed intramedullary nail. The intramedullary nailing, locked or unlocked has become an attractive option since image intensifier has made closed intramedullary nailing possible. Intramedullary nails, such as Lottes and Ender nails, used without reaming, have been employed successfully in the treatment of open tibial fractures and have been associated with low rates of post operative infection. The locking of intramedullary nails to the major proximal and distal fragments decreases the prevalence of malunion of comminuted fractures. Until recently, however, all interlocking intramedullary nailing involved reaming, which destroys the endosteal blood supply. This led us to design a trial, to study the results of closed interlocking intramedullary nails in the treatment of closed fractures of the tibial shaft.

MATERIAL AND METHODS

The present study was conducted in the Department of Orthopaedics and casualty in MNR Medical College and Hospital, Sangareddy over a period of 24 months with 40 cases of age between 20-60 years, irrespective of gender with all closed fractures. On admission general condition of the patient was assessed with regards to hypovolemia, associated orthopaedic
or other systemic injuries and resuscitative measures taken accordingly. All patients received analgesics in the form of I.M. injections, Tetanus toxoid intramuscularly and antibiotics intravenously. A thorough clinical examination was performed including detailed history relating to age, sex, occupation, mode of injury, past and associated medical illness and the limb was immobilized in the form of above knee plaster of paris posterior slab (or) Thomas splint. Limb elevation over a pillow was given in all the patients. Routine surgical profile investigations were done for all patients. All patients were evaluated clinically and radiographically to assess for any injuries. Radiographs were taken in two planes, anterio-posterior view and lateral view, and importance is given to other serious injuries like head injuries.

Preoperatively the length of the nail is calculated by subtracting 3 to 4 cm from measurement taken from the knee joint line to tip of the medial malleolus clinically and medullary canal is measured at the isthmus on conventional radiographs. Accordingly a stock of interlocking nails 2 cm above and below the measured length and 1 mm above and below the required diameter were always kept. AO hollow tibial nails was used. All patients underwent preanaesthetic check up prior to surgery. Patients were kept NBM for 6-8 hours before surgery. IV Fluids as per the need were given. Written and informed consent were taken.

**Surgical Technique:**

Patients were operated under spinal / general anaesthesia under supine position. The injured leg positioned freely, with knee flexed 90° over the edge of operating table to relax the gastrosoleus muscle and allow traction by gravity. The uninjured leg was placed in abduction, flexion and external rotation to ensure free movements of the image intensifier from A.P. to lateral plane. AO pneumatic tourniquet / Esmarch rubber tourniquet was used in all patients. The affected limb is thoroughly scrubbed from mid-thigh to foot with Betadine scrub and savlon. Then limb is painted with betadine solution from mid thigh to foot. Rest of the body and other limb is properly draped with sterile drapes.

**Determination of Nail Length:**

Hold the radiographic rule parallel to the tibial shaft in such a way that the proximal end comes to lie at the level of the insertion point. Mark the skin at the appropriate point. Position the image intensifier over the distal tibia. Align the measuring rule at the skin marking with correct reduction, so that can read off the required nail length on the image intensifier picture at the level of former epiphyseal cartilage. In another way to measure the length of nail is if using the Hollow and Tubular nails the exposed length of the guide wire and subtract this from its total length of 950 mm.

**Determination of Nail Diameter:**

The marking on the radiographic ruler was used to determine the diameter of the medullary canal. Position the square marking over the isthmus. If the transition to the cortex is still visible both to
the left and right of the markings, the corresponding nail diameter may be used. Make a vertical patellar tendon splitting incision over skin extending from central of the inferior pole of patella to the tibial tuberosity about 5 cm long. Split the patellar tendon vertically in its middle and retract it to reach the proximal part of tibial tuberosity. Next step is to determine the point of insertion, essential for the success of the procedure is the correct choice of the insertion point. As a general rule, the insertion point should be slightly distal to the tibial plateau, slightly medial and exactly in line with the medullary canal. If the insertion point is too distal, there is a danger of fracturing the distal cortex of the main proximal fragment. On the other hand, inserting too far proximally bears the risk of opening the knee joint, patella comes in the way of jig or removal of nail may be difficult. After selecting the point of insertion curved bone awl is used to breach the proximal tibial cortex in a curved manner, so that from perpendicular position its handle comes to be parallel to the tibial shaft. In the metaphyseal cancellous bone create a entry portal, making sure it is in line with the center of medullary canal. Point of entry is widened with curved tibial awl. After widened the medullary canal of proximal 1/3, the ball tip guide wire of 3 mm diameter x 950 mm length passed into the medullary canal of proximal fragment and reduce the fracture fragments under image intensifier by maintaining longitudinal traction in the line of tibia. After reduction, the tip of guide wire adjusted to pass in the distal fragment upto 0.5 - 1 cm above the ankle joint under image intensifier. Confirm its containment within the tibia by antero-posterior and lateral views. Next step is to ream the medullary canal. Remaining is done with the help of flexible reamers. Normally we start from 8.5 mm and increase by increments of 0.5 mm. The medullary canal is reamed 1 mm more than the diameter measured at isthmus on lateral view radiograph.

**Procedure for AO IMN:**

Insert the connecting screw through the insertion handle and coupling block then screw this assembly into the proximal end of the selected nail. Screw the inserter / extractor onto the proximal end of the connecting screw. Now introduce the (AO IMN) as far as possible manually into the medullary canal with the help of the mounted insertion instruments. Use the image intensifier to check passing of the fracture line. Insertion can be aided by gentle blows with the slotted hammer. Insert the nail until it is slightly counter sunk in the bone. Confirm the placement of nail in-situ under image intensifier in both AP and lateral planes. Routinely we prefer proximal locking carried out first, but if gap present at the fracture site we carried out distal locking first, it enables the use of the rebound technique to prevent diastasis. The insertion handle is used to locate the holes for proximal locking bolts. The insertion handle of the insertion instrument is in the medial position. The skin is incised, insert the trocar into the protection sleeve and push it down onto the insertion handle. Remove the trocar and insert the drill sleeve. To prevent the drill bit from
sliding off the tibial surface, ensure that the drill guide is sitting firmly on the bone and is not deflected by skin or soft tissue. Drill through both cortices using the drill bit. Determine the required length of the locking bolt by reading it directly by measuring with the depth gauge. We added 2 mm to the measurement found so that the bolt can find purchase in the opposite cortex. Insert the locking bolt with the hexagonal screw drive. Insert the second locking bolt in the same way. After screwing the insertion handle off ((AO IMN) insert the sealing screw into the proximal end. This prevents in growth of tissue and thus facilitates later implant removal. Incised wound washed with betadine and normal saline, patellar tendon sutured with delayed absorbable sutures and skin is sutured. Next step is distal locking, several distal locking options are available to the surgeon. Using free hand technique with an image intensifier provides a convenient method for targeting the distal locking holes. The leg is extended over the table from its flexed position. The AO IMN, three distal locking holes present two medio-lateral plane and middle antero-posterior plane. In our study all cases we locked medio-lateral hole. The image intensifier is placed in the medio-lateral position with the beam exactly at lateral aspect of the tibia with foot head in neutral position. Adjust the image intensifier until the most distal hole is clearly visible and appears completely round. Place a scalpel on the skin with the top of the blade over the center of the hole to determine the stab incision point. Make a stab incision in addition, it also ensures that the surgeon's hand remain outside the central radiation field of the image intensifier. Place the tip of the 2.5 mm K-wire centered in the locking hole image. Adjust it until the K-wire is in line with the X-ray beam and appears as radio opaque solid circle in the center of the outer ring, hit the K-wire into the bone. The DCP drill sleeve passed over the K wire holds sleeve firmly over the bone. The K wire removed and hole drilled through both cortices with drill bit. Measure the hole with depth gauge for locking bolts. Add 2 mm to this reading to ensure that the locking bolt will engage the far cortex. Insert the locking bolt and tighten with the hexagonal screwdriver. Position of the screw is again confirmed under image intensifier. The entire leg and the fracture site visualized finally in both views for the proper placement of nail. Incised wound is washed with betadine and normal saline skin is sutured. Sterile dressings applied over the wound. Compression bandage given. Tourniquet is deflated. Capillary filling and peripheral arterial pulsations checked.

**Post Operative Care:**
Immediate NBM started 4-6 hours postoperatively, intravenous fluids/blood transfusions, antibiotics, analgesics, tranquilizers HS. Limb elevation over pillows, active toe movements, TPR / BP chart every hourly, input / output chart, check X-ray of the operated tibia (full length) including knee and ankle joints in both AP and lateral view were started / monitored.
Postoperatively elastocrepe bandage applied and the limb elevation over pillows. I.V antibiotics
was given for 5 days postoperatively. Patient was allowed non-weight bearing crutch walking/walker on next postoperative day if associated injuries permits, general condition and tolerance of patient. Skin sutures were removed on 10th-12th postoperative day. Follow up was done at 6 weekly intervals i.e. at 12 and 28 weeks and each patient was individually assessed clinically and radiographically.

**Statistical analysis**

At the end of the study, the data was analysed statistically.

**RESULTS**

Majority of the patients were age group within 21-35 years (50%) and male were 75% and 25% were female. The major cause of fracture was motor vehicle accident (50%). Right tibial fracture constitute majority of 26 patients (65%). The predominant tibial fracture pattern was oblique (45%). Majority of fracture occurred at middle and distal third (80%) associated with fibula fracture. A total of 15% had associated injuries in which head injury was the most common. Majority of the cases operated under spinal anaesthesia (80%), spinal + epidural (15%) and general anaesthesia (5%). Most of the patients were operated 2-4 days after trauma. In all the cases midline patellar tendon splitting approach was used for nail insertion site. Mean operation time was 100 minutes. All patients were mobilized (NWB crutch walking/walker) on next day except 1 case which has ipsilateral acetabular fracture was delayed. Most of the patients Partial weight bearing was started on 21 to 30 days postoperatively 55%. 22 patients were commenced to protective full weight bearing at 8 to 12 weeks postoperatively. Dynamization of the nails was done in 15% of patients usually between 12-16 weeks. In two cases we did bone marrow injection and two cases of fibulectomy was done. All the cases had a follow up between 6 to 10 months. Results were evaluated at every 4-6 weeks from the date of discharge. Union was defined as the presence of bridging callus on two radiographic views and the ability of the patients to bear full weight on the injured extremity, if other injuries allowed. 38 of the 40 fractures were united. The time to union ranged from three to eight months. 28 fractures healed before 20 weeks, and 10 fractures healed between 21 weeks to 30 weeks. Two fractures with Infection were reoperated and fracture healed after 9 months of injury.

One of the essential aspects of closed reduction and internal fixation with interlocking intramedullary nailing is the ability to mobilize the patient early. 36 patients were mobilized by active knee bending and quadriceps exercises were initiated after over come from anaesthesia. Four patients associated with other injuries mobilization was delayed. In 26 patients (65%) full range of knee motion at 12 weeks, less than 25 degree loss of knee motion in 12 cases. In 2 cases more than 25 degree loss of knee motion. In 26 patients (65%) full range of ankle motion at 12 weeks, less than 25 degree loss of ankle motion in 12 cases (30%). In two cases more than 25 degree loss of ankle motion.

Malrotation was evaluated by comparing the amounts of internal and external rotation of the
injured extremity with those of the uninjured extremity. 4 varus angulations were noted less than 7.5 degree. In 2 patients anterior angulation less than 7.5 degree. Shortening noticed in 2 patients, less than 1 cm shortening. Two patients developed deep infection and treated for six weeks with antibiotics administered intravenously and debridement was done in two. In these cases fracture united at 9 months after trauma.

In current study no failure of implant was observed. Four patients (10%) noticed pain at the knee joint. Detailed analysis of function of the patient was done on the basis of the following criteria by KLEMM and BORNER. In our study, 24 cases (60%) had excellent results. 8 cases had good results (20%), 6 fair 76 (15%) and 2 cases (5%) poor result. A total of 28 patients (70%) were pleased, 10 patients (25%) were satisfied and 2 patients (5%) were unhappy.

**DISCUSSION**

The optimal management of tibial shaft fractures continues to be a problem with several unanswered questions. Those fractures, usually caused by high energy trauma, have numerous problems resulting from the poor soft tissue coverage and limited vascular supply of the tibia, cause malunion, non-union, infection and sometimes resulting in amputation. There are two major factors related to the lesion that alter the final outcome in tibial shaft fractures. The first is the severity of the fracture, characterized according to Nicoll\(^6\) by the degree of initial displacement, comminution and soft tissue injury. Accordingly, the more severe the fracture, the higher the rate of complications, and longer the periods of healing will be, whatever the method of fixation used.

In this study 40 cases of closed fracture of shaft of the tibia were treated by closed reamed interlocking intramedullary nailing over a period of two years. They were followed up for an average of 8 months. The purpose of this study was to evaluate the end results of treatment in these patients. These cases were of different age groups, occurred in both sexes, and the fracture were of different types and at different levels.

The average age of all cases was 30 years. The fracture was more common in the age group of 21 - 35 years. The average age in a study of 50 fractures of tibia conducted by Whittle et al\(^7\) showed that the average age was 34 years. In a study of 43 fractures of tibia conducted by Singer and Kellam\(^8\), the average age was 36 years. In another study of 72 fracture of tibia conducted by Borraatus et al,\(^9\) the average age was 30.3 years.

There were 30 males and 10 female patients showing male predominance. The sex distribution in a study by Borraatus et al\(^9\) showed that there were 52 men and 19 women. In a study by Singer and Kellam,\(^8\) there were 30 males and 11 females.

Majority of the cases sustained fractures from road traffic accidents. 12(30%) patients who sustained fracture after a fall, 4(10%) patients sustained fracture due to assault and 4(10%) due to pedestrian- automobile accidents. Among R.T.A. motor vehicle accidents 20 (50%) cases
was most common mode of injury in present series.

In this study 38 (95%) fractures united within 5 months of injury, is comparable with the other series as well. The delay in union was noticed in 2 patients which were infected. The physiological and stable fixation with reamed interlocking intramedullary nailing should lower the rates of infection and mal union and expand the use of intramedullary locked nails to the tibial fractures with any degree of comminution and soft tissue injury. A malunion was defined as angulation in a coronal plane (varus - valgus) > 5o, sagital plane (anterior - posterior) angulation of > 10o or 10 > mm of shortening. In this study, 6 cases of malunion occurred (15%). These results comparable with the early results of reamed interlocked intramedullary nailing of closed tibial fractures from other centers. In this study no implant failure was observed. On the basis of this study, we recommend dynamization of most statically locked nails at 8-12 weeks if callus is not evident to promote fracture union and to avoid fatigue fracture of the inter locking screws. In this study, 38 patients (95%) full range of knee motion, in 38 patients (95%) full range of ankle motion at 12 weeks of injury. In this study 4 (10%) patients noticed pain at the knee joint. Patzakis et al (1996) recommends removal of nail after fracture healed to avoid the risk for reactive infection. In our study, no patients developed fat embolism, compartment syndrome, peroneal nerve palsy and reflex sympathetic dystrophy.

At the end of the study each patient was individually asked regarding their opinion about the surgery and their return to premorbid status. 28 (70%) patients were pleased, 10 (25%) patients were satisfied and 2 (5%) patients were unhappy.

**CONCLUSION**

Hence, we concluded that closed reamed interlocking intramedullary nailing with the help of image intensifier seems feasible in diaphyseal fractures of the tibia. Early mobilization of the patient helps in healing of the fracture and prevents joint stiffness. Intramedullary interlocking nail is a reliable, versatile and effective treatment for closed tibial shaft fractures. It minimizes the hospital stay and reduces the economic burden and enhances early return to work.

**REFERENCES**


