Original Research Article

Operative Management of Fractures Shaft Tibia with Closed Intramedullary Interlocking Nail

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Abstract: Tibial diaphyseal fractures are one of the commonest long bone fractures encountered by most of the orthopaedic surgeons. There are many methods of treatment for tibial diaphyseal fractures. But now-a-days closed intramedullary interlocking nailing is emerging as treatment of choice for all closed tibial diaphyseal fractures, most of type Iand type II open fractures in adults. Closed IM IL nailing is a type of indirect fracture fixation, in which fracture unites by indirect healing. There are very less chances of complications like infection, non-union, delayed union, malunion, but more chances of union. We aim to study efficiency of closed intramedullary interlocking nailing in the treatment of tibial diaphyseal fractures. A total of 50 patients with tibial diaphyseal fractures (39 closed fractures, 8 type I open fractures and 3 type II open fractures) were operated with closed intramedullary interlocking nailing.The cases were followed up for an average period of 10-16 months. Excellent results were obtained in 70% of cases. Good results were obtained in 18%, fair results in 8% and poor in 4%. Complications include 10% superficial infection, 4% deep infection, 10% malunion, 12% restriction of ankle and knee movements. Intramedullary interlocking nailing is the reliable, versatile and effective treatment for closed tibial fractures, also in Type I, Type II open tibial fractures. It minimizes the hospital stay and reduces the economic burden and enhances early return to work.
Keywords: tibia, nail, interlocking, closed, fracture

INTRODUCTION

As industrialization and urbanization are progressing year by year with rapid increase in traffic, incidence of high energy trauma is increasing with the same speed. The tibia being the most commonly fractured long bone, because the exposed anatomical location of the tibia makes it vulnerable to the direct blow and high energy trauma as a result of vehicle accidents resulting in fractures. In contrast to the rest of appendicular skeleton, tibia has precarious blood supplies due to inadequate muscular envelope. The presence of hinge joints at knee and ankle, allows no adjustment for rotatory deformity after fracture. The optimum method of treatment remains a subject of controversy. "Every fracture is an individual problem and the decision to treat it by internal fixation or indeed, conservatively should be based on a realistic assessment of the advantages and the hazards of each method in the circumstances of that particular case. This calls for a high degree of clinical judgement which is harder to acquire, or to impart, than technical virtuosity in the operating theatre" [1]. Among the various modalities of treatment such as conservative gentle manipulation and use of short leg or long leg cast, open reduction internal fixation with P&S, intramedullary fixation and external fixation. Surgeon should be capable of using all these techniques and must weigh advantages and disadvantages of each one and adapt the best possible treatment. 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 [2].

Open reduction and internal fixation with P&S has yielded unacceptably high rates of infection [3-5] This method may be selected with more severe injuries associated with displaced intra-articular fractures of knee and ankle. External fixation considered the

treatment of choice by many traumatologists, has the disadvantage of bulky frames and frequent pin tract infections, non-unions and malunion [6]. The intramedullary nailing, locked or unlocked has became an attractive option since image intensifies has made closed intramedullary nailing possible. The present study was done to evaluate the functional results of fractures treated with closed nailing.

OBJECTIVES
1) Pre-operative assessment evaluating the age group affected, type of fracture, mechanism of injury and associated soft tissue status, and plan surgical procedure.
2) To analyze the efficacy of closed intramedullary IL nail in achieving anatomical reduction and stable fixation and early return to function.
3) To note the difficulties encountered in the operative procedures.
4) To study the intraoperative and postoperative complications.
5) To study the duration of period of union in different age, sex and types of fractures.

MATERIAL AND METHODS
This prospective study was performed at a teaching hospital in India. The study consisted of a total of 50 cases. Tibial diaphyseal fractures (39 closed fractures, 8 type I open fractures and 3 type II open fractures) were operated with closed intramedullary interlocking nailing. The cases were followed up for an average period of 10-16 months.

Method of data collection
Sample size: Fifty cases meeting criteria for the present study.

Sampling size: Simple random sampling

All cases presenting to the outpatient and fulfilling the below mentioned criteria were taken up for the study.

Inclusion Criteria
1. Closed tibial diaphyseal fractures.
2. Open daiphyseal fractures of tibia Type I, Type II as classified by Gustillo-Anderson grading.
3. Diaphyseal fractures in the age group of >18 years.

Exclusion Criteria
1. Open diaphyseal fractures of tibia Type III A, B, C.
2. Tibial fractures with intraarticular extensions.
3. Medically ill who are unfit for surgery

Technique of interlocking intramedullary nailing tibia: Adequate radiographs of the injured limb are needed to ensure that the injury is suitable for intramedullary nailing and to identify knee or ankle involvement. Measurement of opposite intact tibia from tibial tuberosity to medial malleolus is a good guide to nail length. This can be confirmed radiologically with a radiopaque ruler or provisionally selected implant. Diameter of nail is measured at the isthmus of tibia in a lateral view.If a fracture table is used, a calcaneal pin is placed before positioning. The patient is placed supine with the hip flexed 45° and the knee flexed 90°. A well padded crossbar is placed proximal to the popliteal fossa to support the thigh in the flexed position. Adequate padding should reduce the risk of compression neuropathy. A calcaneal pin is attached to the traction apparatus on the fracture table, apply traction, and reduce the fracture under fluoroscopic guidance. The limb is prepared and draped, allowing full exposure of the knee to above the patella and enough access to the distal tibia for locking screw placement. Then the traction is reapplied after the entry portal is made. The entry portal is made by making a 4 cm incision along the medial border of the patellar tendon, extending from the tibial tubercle in a proximal direction. It may be necessary to extend the incision farther proximally through skin and subcutaneous tissue only to protect the soft tissues around the knee during reaming and nail insertion. A curved bone awl and is inserted through the metaphysis anteriorly to gain access to the medullary canal. The tip of the awl is placed proximal to the tibia tubercle at the level of the tip of the fibular head (approximately 1.5 cm distal to the knee joint) and in line with the centre of the medullary canal on the AP view. Proper position is confirmed an anteroposterior and lateral fluoroscopic views before awl insertion. A true anteroposterior view of the tibia is obtained when assessing the placement of the awl. If the limb is externally rotated the portal may be placed too medially and violate the tibial plateau and injure the intermeniscal ligament. A portal placed to distally may damage the insertion of the patellar tendon or cause the nail to enter the tibia at too steep of an angle which may cause the tibia to split or cause the nail to penetrate the posterior cortex. Check the process of awl insertion on lateral fluoroscopic views. The safe zone for tibial nail placement is just medial to the lateral tibial spine on the AP view and immediately adjacent and anterior to the articular surface on the lateral view. The awl is directed nearly perpendicular to the shaft when it first penetrates the cortex, but gradually brings it down to a position more parallel to the shaft as it is

inserted more deeply to prevent violation of the posterior cortex. The entry portal also can be made by inserting a Kirschner wire into the anterior tibia and reaming over it with a rigid reamer. A ball-tipped guide wire is inserted through the entry portal into the tibial canal and passes it across the fracture site into the tibia under fluoroscopic guidance. The guide rod should be centered within the distal fragment on anteroposterior and lateral views and advance to within 1 cm to 0.5 cm of ankle joint. If a reamed technique is chosen, canal is reamed 0.5 mm increments, starting with a reamer smaller than the measured diameter of the tibial canal. Reaming done with knee in flexion to avoid excessive reaming of the anterior cortex. The fracture is held reduced during reaming to decrease the rise of iatrogenic comminution. Prevent the guide rod from being partially withdrawn during reaming. Minimal reaming preferred, with no more than 2 mm of reaming after cortical contact is first initiated. Other traumataulogists believe that 4 mm of cortical contact is acceptable. A nail of chosen diameter that is 1 to 1.5 mm smaller than the last reamer is used. Ream the entry sight large enough to accept for the proximal diameter of the chosen nail. It is important never to ream with the tourniquet inflated because this may lead to thermal necrosis of the bone and soft tissue, especially in individuals with small diameter-medullary canals. When reaming is completed, the ball-tipped guide rod is exchanged for one with a smooth tip for nail insertion. The insertion device is attached and proximal locking screw guide to the nail. The nail is inserted with the knee in flexion to avoid impingement on the patella. Rotational alignment is evaluated by aligning the iliac crest, patella and second ray of foot. Tremendous force should not be used to insert the nail. Moderate manual pressure with a gentle back-forth twisting motion usually is sufficient for nail insertion. If a mallet is used, the nail should advance with each blow. If the nail does not advance, withdraw the nail, and perform further reaming or insert a smaller diameter nail. It is important to keep the fracture well aligned during nail insertion to prevent introgenic comminution and malalignment. When the nail has passed well into the distal fragment, the guide wire is removed to avoid incarceration. During final seating of the nail, traction is released to allow impaction of the fracture. When the nail is fully inserted, the proximal end should lay approximately 0.5 cm to 1 cm below the cortical opening of the entry portal. This position is best seen on a lateral fluoroscopic view. If the nail protruder too far proximally, knee pain and difficulty in kneeling may result. Excessive counter sinking also should be avoided because it makes nail removal more difficult. The distal tip of the nail should lie approximately 0.5 to 2 cm from the subchondral bone of ankle joint. Proximal locking screws are inserted using the zig attached to the nail insertion device. The drill sleeve is placed through a small incision down to bone. Measure the length of the screw from calibrations on a drill bit. Use two proximal 43 locking screws in most fracture. All connections are tightened between the insertion device, drill guide and nail before screw insertion. Distal locking is performed by using a free hand technique after 'perfect circles' are obtained by fluoroscopy. In the lateral position, the fluoroscopic beam is adjusted until it is directed straight through the distal screw holes appear perfectly round. A drill bit is placed through a small incision overlying the hole and centre the tip of the hole. Taking care not move the location of the tip, bring the drill bit in line with the fluoroscopic beam, and drill through the near cortex, through and far cortex. The screw length is measured using drill sleeves and calibrated bits, or checked in the anteroposterior view on the fluoroscopy screen using the known diameter of the nail as a reference for length. After screw insertion, obtain a lateral image to ensure the screws have been inserted through the screw holes. After interlocking, the fracture site is inspected for possible distraction. Most nails are statistically locked. Minimally comminuted transverse diaphyseal fractures can be dynamically locked: however, comminuted or metaphyseal fractures should be statistically locked if there is any question about stability, perform static locking. Because the nail may not prevent malalignment of unstable fractures before it is locked, it is crucial to maintain accurate reduction until proximal and distal locking is complete.

The wound is stitched in layers and dressing changed after 2 days. The stiches are removed at 14 days. Patients advice for partial weight bearing between 7 days postoperatively to 30 days depending upon stability of fracture fixation. Patients advised for full weight bearing between 8 weeks to 16 weeks postoperatively after clinical and radiological examination for fracture union. Patients are advised for follow-up on 4th, 8th, 14th and 24th weeks after discharge.

RESULTS
The present study includes 50 fractures of tibial shaft surgically treated with closed intramedullary interlocking nailing. All the patients were available for follow-up. Period of follow-up was 8 to 10 months Majority of patients are from age group 20-39 years (54%). The youngest patient was 20 years old and oldest patient was 80 years old. Majority of patients

(66%) are males. The remaining 34% patients are females. Right tibial fractures in our study constitutes 52% and left are 48%. In our series, there were 39 simple fracture out of 50 (78%), 8 Type I compound fractures (16%) and 3 Type II compound fractures (6%). In our study, motor vehicle accident was the major cause for tibial fracture and it constituted 76% of cases. Second common mode of injury was fall from height and it was 14%. And third type was pedestrian hit by motor vehicle and it was 10%. Most of the cases are middle one-third fractures (54%). Next common level of fracture in tibia in our study is lower one-third (36%). Upper one-third is 10%. In our study, head injury was the common associated injury and it was 6%. One patient had same side shaft femur fracture that is floating knee. Nailing was done for both fractures. Another patient had bilateral fracture tibia. He was also treated with nailing. One patient had fracture clavicle, treated conservatively. Proper evaluation and treatment of head injury. Most of the patients in our study were operated within one week of trauma. For associated head injury patients (2 cases) operation was delayed for 2 to 3 weeks. In our study most of the cases are mobilized (non weight bearing crutch walking) on next day after operation. Majority of our patients, 36 out of 50 (72%) started partial weight bearing (PWB) between 10 and 20 days. Seven patients out of 50 (14%) patients started PWB between 20 and 30 days. In these patients PWB was delayed because stability of fixation was not good. Five patients in our study started PWB after 30 days. In these 5 patients, 2 patients had deep infection. So they were treated with IV antibiotics and above knee posterior slab application for 1 month, so PWB was delayed. In 1 case, patient had highly comminuted fracture configuration. So patient was not advised for PWB for one month. One patient had bilateral tibial fractures so PWB was delayed for 30 days. One patient had associated ipsilateral shaft femur fracture, so he was also delayed for PWB.

Most of the patients (46, 92%) in our study commenced protective FWB between 8 and 14 weeks. Four patients (8%) commenced FWB after 14 weeks. In these 4 patients, there were no signs of union radiologically and clinically. So FWB was delayed. Two patients had deep infection with infected non-union. The end results of all 50 cases are summarised here. All the cases had a follow-up between 8 and 10 months. Results were evaluated at every 4-6 weeks from the date of discharge.

Union is defined as the presence of bridging callus on two radiographic views and the ability of the patient to bear full weight on the injured extremity. 48 of 50 fractures united (96%). The time for union ranged from 3-9 months with an average of 4 months (figure 1). Forty-four fractures healed before 5 months (20 weeks), 4 fractures healed between 5 and 8 months (20 to 32 weeks). Two fractures with infection failed to unite after 9 months.

Fig-1: preoperative, postoperative and radiographic image at 12 weeks

One of the essential aspects of closed reduction and internal fixation with interlocking intramedullary nailing is the ability to mobilise the joints early.In 35 patients (70%) full range of knee motion gained at 12 weeks. In 9 patients (18%) <25° loss of knee motion was noted. In 4 patients (8%) 25° loss of knee motion was noted. In 2 patients (4%) >25° loss of knee motion was noted.In 32 patients (64%) full

range of ankle motion gained at 12 weeks. In 12 patients (24%) <25° loss of ankle motion was noted. In 4 patients (8%) 25° loss of ankle motion was noted. In 2 patients (4%) >25° loss of ankle motion was noted. Malunion was defined as angulation in a coronal plane (varus-valgus) of >5°, Sagittal plane (antero-posterior) angulation of >10° or >10 mm of shortening. Malrotation was evaluated by comparing the amounts of internal and external rotation of the injured extremity with those of the uninjured extremity. In five cases malunion was noted. In two cases 6-8° of valgus angulation was noted. In two cases anterior angulation of 10-12° was noted. In one case >1 cm (1.4 cm) of shortening was noted. Non-union US Food and Drug Administration Panel defined non-union as "established when a minimum of 9 months has elapsed since injury and the fracture shows no visible progressive signs of healing for 3 months". This criteria cannot be applied to every fracture. However, a fracture of the shaft of a long bone should not be considered as a non-union until at least 6 months after the injury because often union requires more time, especially after some local complications such as an infection. In the present study 2 cases went for non-union. Five patients developed superficial infection. This healed with oral antibiotics, fracture united. Two patients developed deep infection and treated for 6 weeks with antibiotics administered intravenously after pus culture sensitivity. In these two cases fractures not united after 9 months.In current study no failure of implant was observed. In our study, 12 patients (24%) developed anterior knee pain. Anterior knee pain is the most commonly reported complication after intramedullary nailing of tibia. 56% of patients have some degree of chronic knee pain and more have difficulty kneeling according to Campbell. Dogra, Ruiz and Marsh reviewed 83 patients with isolated fractures of the tibial diaphysis treated primarily with closed, reamed intramedullary nailing. 35% of patients had pain around the knee at rest and 71% had difficulty kneeling. The cause of this knee pain is still unclear. In our study, 12 out of 50 patients (24%) developed anterior knee pain. In our study also cause for knee pain was unclear. But the probable causes were nail prominence above the proximal tibial cortex, damage to the infrapatellar nerve, and meniscal tear.

Detailed analysis of function of the patient was done on the basis of following criteria by Kleman and Borner [7] I. Excellent: Full knee and ankle motion, No muscle atrophy, Normal radiographic alignment II. Good: Slight loss of knee and ankle motion (<25°), Less than 20 mm of muscle atrophy, Angular deformities (<5°). III. Fair: Moderate loss of knee or ankle motion (25°). More than 20 mm of muscle atrophy. Angular deformities (5-10°). IV. Poor: Marked loss of knee or ankle motion (>25°), Marked muscle atrophy, Angular deformities (>10°). In our study, 2 patients had poor results. These 2 patients were Type II open fractures treated with primary intramedullary nailing. Initially in the golden hours they were treated at periphery and then referred to our hospital. They were (wounds) handled badly. So it may be one of the causes for infection. Reamed intramedullary interlocking was done in these two cases. Reaming might be the cause for infection here. Because of infection patients were delayed for partial weight bearing and full weight bearing. Immobilized in splint for long period. So they developed quadriceps wasting. Their knee and ankle range of movements are also restricted. Radiologically also signs of union were delayed. In our study, 2 patients developed infected non-union. Their PWB and FWB was delayed. Their hospital stay was prolonged. They were advised for frequent follow-up to hospital. Overall the morbidity of the patients was more. So they were unhappy with the treatment.

DISCUSSION

Treatment of diaphyseal fractures of tibia evolved since many years. There are several methods of treatments and there are many modifications in each treatment method. Closed reduction and cast application which was practiced for many years based on Sermiento functional cast bracing. But its main disadvantage was development of fracture disease. Pins and cast application was another method. Its disadvantage was chances of loss of alignment, rotation, so more chances of malunion. Chances of fracture disease is also more.

External fixator application is another treatment option. It has the disadvantage of development of pin tract infection. Most of time it is used as temporary fixation. Plate and screws fixation for fracture tibia is another method used. It gives rigid fixation. But chances of infection are very high because periosteum stripping is more, soft tissue damage is more. Intramedullary nailing has many advantages. Closed reduction, reaming, interlocking all have advantages [10,11]. Close reduction is also called as indirect reduction, it preserves fracture site hematoma. Fracture unites by indirect healing. Chances of infection are very less in this method as soft tissue around fracture is undisturbed. Reaming prepares the canal into uniform diameter for proper fitting of nail. Interlocking with screws maintains axial length and rotation of fracture fragments. But they also have disadvantages,

closed reduction is technically demanding [12-16]. It needs C-arm guidance for reduction. Hazards of X-ray are another problem. Reaming destroys endosteal blood supply. Like another methods this method also has both advantages and disadvantages. So we conducted the study closed intramedullary nailing in our hospital to know the results and complications. In current series 50 cases of fracture of shaft of the tibia were treated by closed reamed interlocking intramedullary nailing. They were followed up for an average of 18 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 in this series was 31 years. The fracture is more common in the age group of 20 - 39 years. The average age in a study of 50 fractures of tibia conducted by Whittle *et al* [8] showed that the average age was 34 years. There were 33 male and 17 female patients showing male predominance in our series. In a study by Singer and Kellam [9], there were 30 males and 11 females. In present series, 48 out of 50 cases (96%) fractures united within 5 months of injury. Four cases (8%) went for delayed union. As these cases not shown signs of union with in normal time they were considered for secondary procedures. These cases required dynamization which was done at 8 weeks. 2 cases required bone grafting with which fractures united. In this study, 5 cases developed malunion. In two cases, 6-8° of valgus angulation was noted. In 2 cases, anterior angulation of 10-12was noted. In one case >1 cm (1.4 cm) shortening was noted.

CONCLUSION

The present series shows that closed fractures of the tibial shaft, managed with interlocking intramedullary nailing, it involves minimal surgical trauma and negligible blood loss. It provides the advantages of early ambulation, lower rates of infection, delayed union, non-union and malunion compared to other treatment modalities. To achieve these goals, we recommended early stabilization with reamed interlocked nail. Fracture should be dynamized at 8-10 weeks, if union does not progress to prevent the unwanted complication of non-union or delayed union. A significant advantage of interlocking in addition to early joint motion, early weight bearing allows earlier return to work. In our series we found that reamed interlocking nailing in fractures of tibial shaft is feasible as showed excellent and good results in 95% patients with minimal complications.

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