Comparison of Plate VS. Nail Fixation for the Treatment of Distal Tibial Shaft Fractures in a Sample of Trauma Patients

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ABSTRACT:

BACKGROUND:

Fractures of the distal third of the tibia are the major cause of morbidity in patients with lower extremity injuries. Most fractures are sustained in young adults during high velocity injuries.

PATIENTS AND METHODS:

Forty patients with closed fractures of distal third of the tibia were treated in Al-Yarmouk Teaching hospital between May 2012 and April 2014. 20 patients had been treated with open reduction and internal fixation by heavy-duty plate and screws and were matched to 20 patients treated with closed reduction and intramedullary nailing fixation, with regard to gender, age, and the AO classification of the fracture.

RESULTS:

There were no significant differences in regard to: time of surgical procedures, non-union, hardware failure or deep infections between plate fixation and intramedullary nailing. Open reduction and plate fixation was associated with higher risk of: delayed union, osteopenia, ankle joint stiffness and algodystrophy. Closed reduction with intramedullary nailing was associated with higher rates of rotational malalignment and knee joint pain/stiffness. The limb length difference was of no clinical significance in all patients.

CONCLUSION:

Intramedullary nailing is the preferred method for treating closed distal tibial fractures but open reduction and plate fixation may provide superior results in terms of optimal alignment.

KEY WORDS: distal tibial shaft fracture, intramedullary nailing, open reduction and internal fixation.

INTRODUCTION:

Fractures of the shaft of the tibia are among the most common fractures encountered in orthopedic practice. The majorities of tibial fractures result from high energy injuries and may be associated with multiple system injuries. Because the tibia is one of the principal load-bearing bones in the lower extremity, fractures can cause prolonged morbidity and extensive disability unless the treatment is appropriate. (1) Several techniques are now available for their treatment, and the orthopedic surgeon must be aware of the advantages, disadvantages, and limitations of each to select the proper treatment for each patient. The type and location of the fracture, the degree of comminution, degree of soft tissue injury, the age of the patient, the patient's social and economic demands, and other factors may influence the method of treatment. (2)

Fractures in which conservative methods are inappropriate, can be treated with plate and screw fixation, intramedullary fixation (interlocking nails), and external fixation. Locked intramedullary nailing (IM) currently is the preferred treatment for most tibial shaft fractures requiring operative fixation. Intramedullary nailing of more distal shaft fractures is possible, but the ability to maintain a mechanically stable reduction becomes more difficult as the fracture extends distally. Plating is used primarily for fractures at or proximal to the metaphyseal-diaphyseal junction. (3)

The current study is designed to compare the clinical and radiographic results of patients with extra-articular unilateral closed or class 42 AO fractures of the distal third of the tibial shaft, treated with open reduction and internal fixation by plates and screws with those treated with closed reduction and intramedullary nailing.

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PATIENTS AND METHODS:

Forty patients with class 42 AO fractures of the distal third of the tibia were enrolled in the study and were divided into two groups, 20 patients each. Group A patients (7 females, 13 males) were treated with open reduction and internal fixation (ORIF) by plates and screws. Group B patients (6 females, 14 males) were treated with closed reduction and locking intramedullary nailing (CRIM). The patients were selected cases from the outpatient and ER departments of Al-Yarmouk teaching hospital in Baghdad and were treated and followed up during the period extending from May 2012 to April 2014. All patients were adults and their ages ranged from 32-61 years. All patients, except two in each group, had combined tibial and fibular fractures, in which fibular fractures were left unfixed. The fractures included in the study fell under one of four categories of the AO class 42 classification [4]:

- AO class 42-A1: spiral fracture.
- AO class 42-A2: oblique fracture (>30^{O}).
- AO class 42-A3: transverse fracture (< 30^{O}).
- AO class 42-B2: bending wedge.

The fracture class distribution for each group is shown in figure 1.

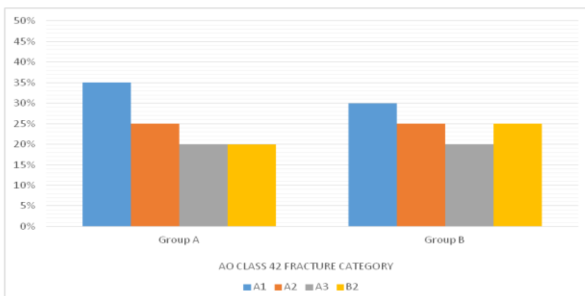

Figure 1: Frequency distribution of the distal tibial fracture class.

Surgical Procedure

In patients managed with ORIF, a dynamic compression plate and screws was used (figure 2).The size and shape of the plate depended on the comminution and classification of the fracture. In most patients,one or more lag screws were used to optimise reduction and fixation between the fracture parts. A longitudinal incision 1 cm lateral to the tibial crest, exposing the fracture, and retraction of the muscles laterally was done. Minimum stripping of the periosteum done only as necessary for accurate fracture reduction. Determination of the plate length with or without using bending instruments to contour the plate to the tibial surface was made. For tibial shaft fractures in which plate fixation has been determined, a 4.5-mm implants has been used with positioning the plate over the lateral surface of the fracture site, and temporarily holding it in place with a standard plate-holding forceps, using the 3.2-mm drill and guide for an eccentric (compression) or neutral (buttress) insertion of 4.5-mm cortical screws. The surgery was done with mid-thigh tourniquet application and no blood transfusion was given intra-operatively. A back-slab was applied extending from below the knee to the metatarso-phalangeal joints of the foot, with the foot in neutral position.

Figure 2: Pre-operative (above) and post-operative (below) AP & lateral radiographs of distal tibial fracture class A1 treated with ORIF using plate and screws.

In patients managed with closed reduction and IM nailing (CRIM), the nail was inserted after reaming (figure 3). In all patients the static locking type was used, with 2 proximal and 2 distal 5 mm locking screws. The fracture was reduced closely under fluoroscopic control. A 5-cm incision along the medial border of the patellar tendon, with curved awl was used to access the medullary canal through the standard entry point. A guide wire was introduced and followed with fluoroscopy to ensure passing the fracture site and centered in the distal segment, reaming of the canal and choosing the appropriate nail size with its insertion was done. Fixing the nail with proximal guided and distal free hand locking screws done without application of tourniquet or use of orthopedic table. The wound was dressed without application of back-slab.

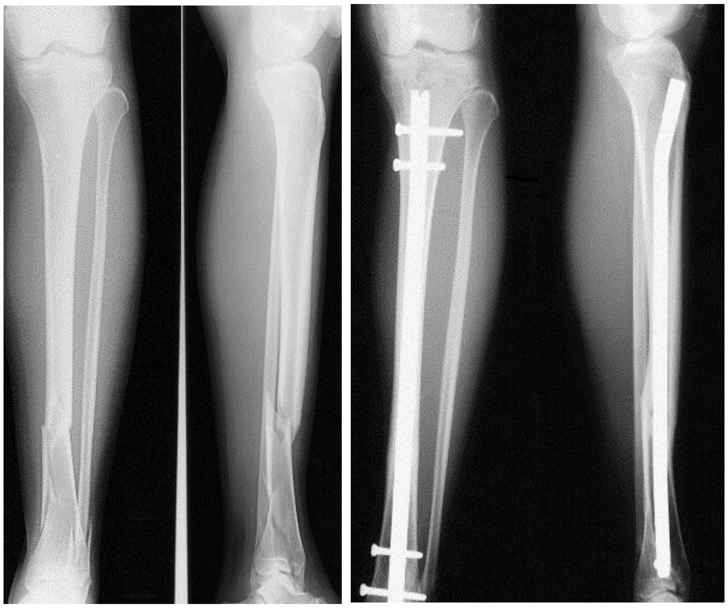

Figure3: Pre-operative (left) and post-operative AP & lateral radiographs of distal tibial fractures class A2 treated with closed reduction and IM nailing.

Follow-up

Patients were seen 2 weeks after the surgery for the removal of the sutures, and changing the back-slab into below knee POP for group A patients while allowing group B patients to walk with the aid of the crutches, all patients were seen after 4 weeks for assessment and allowing grpu A patinets to walk with crutches after the removal of POP, and every 6 weeks thereafter for a period of 12-18 months. In each visit, the patients were assessed clinically and by radiographs for: union, alignment (by recording the antero-posterior, lateral and rotational alignment of the operated side in relation to the other normal side, malalignment was defined as >10° procurvation/ recurvation, >10° varus/valgus deformity or >10° rotational difference) and active range of motion of the knee and the ankle, in addition to any other complicaiton that developed during the follow-up period.

RESULTS:

There was no statistically significant difference in the operative time and the time of postoperative hospital stay, while there was significant difference in the time of radiographic union between the two methods used for treatment, as shown in table 1.

Table1: Differences in time duration of operation, post-operative hospital stay and radiographic union in patients with distal tibial shaft fracture treated with ORIF or CRIM (values expressed as Mean±Standard deviation).

Patient group	Operative time (minutes)	Poste-operative hospital stay (days)	Time of radiographic union (weeks)
A (ORIF)	83±32	2±0.8	19±3.2
B (CRIM)	95±21	2±1.2	13±4.1

Postoperative complications differed between the two groups as shown in fiugure 4. The frequency of malunion, knee joint stiffness/pain was significantly higher in group B patients. On the other hand; delayed union, ankle joint stiffeness/pain, osteopenia and algodystrophy were more frequently seen in group A patients.

In patients with malunion; non of the patient in either group had >10° varus/valgus or procurvatum/recurvatum malalignment, while rotational malalignment was only seen in patients of group B, the shortening did not excede 1-1.5 cm and was of no clinical significance.

Anterior Knee Pain was significantly higher after IM nailing (group B) than after ORIF (group A). Five patients in group B had a knee movement limitation difference of >10°. Conversely, ankle stiffness was more frequent in group A patients.

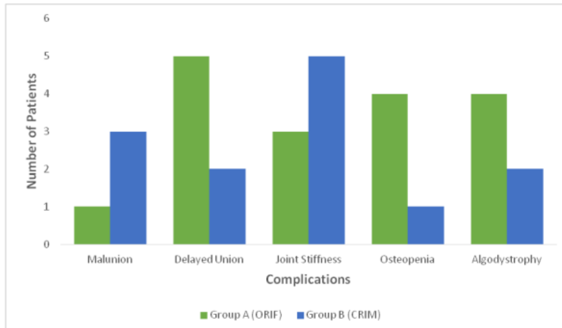

Figure 4: Difference in number of cases developing complications of distal tibial fracture treated with ORIF or CRIM.

- There were two additional complications in the group A patients: three patients developed a superficial wound infection which was successfully treated with antibiotics, another patient had atrophic nonunion without hardware failure and he was treated with bone grafting and protected weight bearing.
- In group B, there was one additional complication in one patient who developed an extra-fracture fragment during the introduction of the nail (iatrogenic comminution), but it was still possible to achieve acceptable alignment of the tibia.

DISCUSSION:

The treatment of distal tibial shaft fractures is still challenging because of the thin soft tissue cover and less stable osteosynthesis achieved by different methods. With the development of more advanced techniques and hardware of reduction and fixation, there is a controversy in comparison between closed reduction with intramedullary nailing and open reduction with plating for the treatment of distal tibial fractures[5]. With a satisfying alignment obtained, IM nailing may be preferential to plating with better function and lower risk of infection but a higher risk of malunion [6]. On the other hand open reduction carries the risk of infection and soft tissue damage with subsequent delayed union and nonunion.

IM nailing has the advantages of being minimally invasive, the parallel orientation of the rod with the biomechanical axis of the limb inside the bone. However, rotational malalignment remains a potential complication to the method. Moreover, degenerative knee changes secondary to the nail introduction may also occur. [7]

Reaming technique was used in IM nailing in the current study because different trials have shown that IM nailing with reaming provides shorter times for union, full weight bearing and early return to normal activities [8], especially with the use of new nails with proximal and distal interlocking in three different planes without disruption of bone vascularization [9]. Many authors have reported increasing bone healing complications with unreamed nails [10].

As in the current study, other studies have shown that despite higher rates of tibial malrotation following locked intramedullary nailing, the rotational/angulation malalignments are minimal and do not cause any significant intermediate-term functional impact [11].

The use of larger-diameter and tighter-fitting nails may offer better bending and rotational stability. Although bone vascularization may be affected by reaming with larger nails, it is possible that increased periosteal circulation after reaming compensates for any reduction in endosteal blood flow. Moreover, the products of reaming contain osteoblasts and multipotent stem cells which can act as an effective bone graft of high osteogenic potential [12], and this explain the better union rate in group B patients, in addition in being closed method with the preservation of the fracture hematoma.

Anterior knee pain is more commonly seen in group B patients and may be related to the surgical interference near the joint or possibly to injury of the infrapatellar branch of the saphenous nerve, as seen in other study done by Leliveld. et al [13].

On the other hand, ankle stiffness/pain is more commonly seen with group A patients and may be related to prolonged cast immobilization. This complication may be prevented by switching the cast to a functional brace at 2-4 weeks postoperatively [14].

In the current study, nonunion occurred in one patient treated with plating, and this complication may be related to untreated delayed union or early discontinuation of casting and it was successfully treated with bone graft. However, the high rate of delayed union in group A patients may be related to the evacuation of fracture hematoma in open method and delayed weight bearing in those patients.

Moreover, local anatomical blood supply of the tibia may play a role in the union rate, an anastomotic network of arteries from the anterior and posterior tibial arteries form a rich extraosseous blood supply of the medial distal aspect of the tibia. Theoretically, medial plating increases skin tension of the anteromedial aspect of the tibia and can result in poor extraosseous blood supply to the region and produce wound necrosis and nonunion, especially in patients with distal circulation insufficiency such as diabetes mellitus [15]. This may explain the low rate of nonunion in group A patients, since the plate was applied to the lateral surface of the fractured tibia.

The causes of osteopenia in the distal tibia after injury are uncertain, but are likely to be related to changes in bone remodeling secondary to changes in the local blood supply to the bone, to altered mechanics or to a stress-protection effect. After immobilization, disuse or injury, there is good evidence that bone turnover is increased, but the amount of new bone lay down in erosion cavities is less than normal [16] and this may explain the osteopenia encountered in this study.

The development of algodystrophy may be related to osteopenia and vice versa [17]. Persistent afferent input from damaged soft tissue nociceptive fibers is thought to be the initial insult in development of reflex sympathetic overflow output, leading to vascular and neuronal caused pain and swelling [18].

It is possible that the greater level of pain following ORIF is responsible for the higher incidence of algodystrophy in patients treated with this method.

CONCLUSION:

Although closed reduction and intramedullary nailing remains the treatment of choice for most significantly displaced distal tibial shaft fractures, the procedure is associated with higher incidence of rotational malalignment and knee joint stiffness/pain. The use of larger size reamed nails with careful rod introduction may minimize these complications.

When less invasive techniques are unsuccessful, open reduction with respectful handling of the soft tissue cover can be an effective treatment but carries a higher risk of: delayed union, ankle joint stiffness, osteopenia and algodystrophy. Such complications may be reduced by using smaller incisions and low contact plates.

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