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Evaluation of operative management of distal tibia fractures by plating

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Abstract
Introduction: Tibia is the most common long bone to get involved in injuries because of almost subcutaneous position, very less cover of soft tissue and surrounding muscle mass. Despite advancement in surgical methods distal tibia fractures remains a therapeutic challenge and associated with a high complication rate.
Aim: This study was aimed to evaluate the results of operative fixation of distal tibia fracture by plating in relation to union (clinical and radiological) and functional outcome.
Material and methods: This study was conducted on 20 patients who were treated with operative fixation with plating and followed up over a minimum period of 6 months for complication and functional outcomes. Final evaluation for the grading of result was done according to Johner and Wruhs criteria.
Results: The average time to attain radiological union was 19.78±2.39 weeks In our study 2 patients showed union at 16-17 weeks, 6 patients at 18-19 weeks, 5 patients at 20-21 weeks, 4 patients at 22-23 weeks, 2 patients at ≥24 weeks. In study 12 (60%) patients had no pain, 5 (25%) had occasional pain, 3 (15%) had moderate pain, no patients have severe pain. Incidence of Complications was 3 (15%) patients had ankle movement restriction; 1(5%) had non-union and 1(5%) had superficial skin infection. At final evaluation 11 (55%) patients showed excellent results, 6(30%) showed good, 2 (10%) showed fair, 1 (5%) had poor result.
Conclusion: As this technique provides effective stabilization, good union and early mobilization with adequate ankle mobility, is recommended for better outcomes.

Keywords: Johner and Wruhs criteria, distal tibia fractures, subcutaneous position, ankle mobility

Introduction
Tibia is the most common long bone to get involved in high velocity trauma because of almost subcutaneous position, very less cover of soft tissue and surrounding muscle mass [1]. The major blood supply is through nutrient artery and very less by periosteal vessels. This makes the fracture fragment susceptible to devascularisation and prone to go in non-union, delayed union and other disabilities.
The management depends on fracture type, soft tissue cover and articular cartilage involvement [2].
Nonsurgical management is possible for stable fractures with minimal shortening but malunion, shortening of affected leg, limitation of range of motion and early osteoarthritis of the ankle are possible complications [3].
Surgical methods includes external fixation, intramedullary nailing and plate fixation. External fixation can be done in open fractures with soft tissue injury, however inaccurate reduction, non-union, mal union and pin tract infection may occur [4]. Intramedullary nailing allows relatively atraumatic closed stabilization, preserves the vascularity of the fracture site but difficult to achieve stabilization of the fracture site because the hourglass shape of the intramedullary canal which prevents a tight endosteal fit and compromises torsional and angular stability [5]. Open reduction and internal fixation with plate require extensive soft tissue dissection and periosteal stripping with high rates of complication including infection, delayed union and non-union [6]. Despite all these advances distal tibial fractures remains a therapeutic challenge and associated with a high complication rate [6-8].

The Aim of our study was to evaluate the results of operative fixation of fracture of distal tibia by plating in relation to union (clinical and radiological) functional outcome.

Material and Methods

The prospective study was conducted on patients who were treated with operative fixation of fractures of distal tibial shaft by plating. Prospectively cases were followed up over a minimum period of 6 months for complication and functional outcomes. To achieve the precision within 5% i.e. (15%-35%), we needed the total sample size of 75. The significance level of the test was targeted at alpha 0.05. Since it was a time bound study, the sample size was limited to at least 20 cases.

Permission was obtained from the ethical committee in accordance with 1975, Helsinki Declaration before starting the research. Informed consent was obtained from all the patients.

Inclusion and exclusion criterion

All the patients with closed fractures and compound fractures of Gustilo and Anderson type I and type II fractures of tibia; all fractures types that is A1, A2, A3, B1, B2, B3, C1, C2, C3 of Orthopaedic Trauma Association classification; Age group of 18 year and above and of either sex; patient treated with external fixator and skin flaps were included in study while patients with age <18year; abnormal skin condition such as eczema; severe periosteal stripping or vascular compromise (Gustilo and Anderson type III b or III c) were excluded from study.

Patients were operated under general or spinal anaesthesia according to associated medical condition. The patient was placed in a supine position and tourniquet was applied as high as possible on thigh. A longitudinal incision on the anterior surface of leg parallel to anterior border of tibia and about one centimeter lateral to it was given, with the dissection essentially being sub-periosteal. Care was taken to avoid the posterior tibial tendon and the posterior medial neurovascular bundle. The fracture was reduced and held in position with a reduction clamp or provisional fixation. Once the fracture was adequately reduced, selection of appropriate length distal tibia plate was done and it was placed across the fracture and held with bone clamps. Screw hole close to fracture site was drilled with help of appropriate drill bit, depth was measured with help of depth gauge and tapping of the screw hole done after which screw of appropriate size was inserted. The second screw was inserted on the other end of the fracture in the compression mode to achieve compression at the fracture site. Subsequently locking screws were inserted in the distal locking holes. In oblique fractures, inter-fragmentary screws were used to increase the stability. Fluoroscopy was used to assess the position of screws with respect to plate, fracture site and it was assured that they are not in ankle joint. After assessment by fluroscopy tourniquet was deflated, all bleeders were secured and hemostasis was achieved. Wound was closed in layers over drain and aseptic dressing was done followed by assessment of neurovascular status and below knee slab was applied to take care of postoperative edema and provide soft tissue rest. All the operative details were noted down.

Antero-posterior and lateral radiographs were obtained next day. Knee mobilization and isometric quadriceps exercises were started from the very next day. Dressing was done on the second postoperative day and drain was taken out. Suture line was assessed for any gaping wound discharge or infection. Crutch or walker aided non weight bearing ambulation started patient were discharged on 4th or 5th day on oral antibiotics and analgesics.

Post-operative follow up:-Patient was called on 14th postoperative day for suture removal below knee slab was also removed. Postoperative complications like neurovascular damage, infection, delayed union, malunion, nonunion and any other complication were assessed on subsequent follow ups and dealt accordingly. Radiographs were obtained at regular intervals and assessment was done for the progress of union and tibial mal-alignment was measured. The degree of the tibial angulation (varus or valgus) was measured on the anteroposterior radiographs. The acceptable mal-alignment in tibia is less than 5º of angulation and shortening of less than 1cm. Partial weight bearing was started when radiograph showed callus at fracture site in one plane radiographic image and full weight bearing was started on observation of callus in two planes of radiographic images. At each follow up progress of the patient was noted and the range of movement of ankle (Dorsi-flexion/ Planter-flexion), pain on movement or rest, any deformity, limitation of activity and disturbance in gait was noted. Radiological progress of fracture and any sign of infection or other plate related problems like impingement or plate breakage was also assessed. Finally, we have taken the patients' clinical assessment at final follow up for the grading of result according to Johner and Wruhs criteria9 which is a very comprehensive criteria as it takes into account activity level, gait, mobility and deformity. Statistical analysis is performed using the SPSS statistical package (version 17.0). Continuous variables are presented as mean ± SD. Categorical variables are expressed as frequencies and percentages.

Results

In our study mean age of patients was 42.15±13.30 years; ranging from 18-65 years, male dominance present in fracture incidence as 15 were male (75%) and 5 (25%) were female. Most of fracture were on left side(55%).Out of 20, 11(55%) patients had sustained fracture due to road traffic accident, rest 9 (45%) had fracture due to fall. 18(90%) out of 20 patients had closed fracture, rest 2 (10%) had Type I Open fracture according to Gustilo & Anderson classification. None of the patients had Type II or III fracture. As per OTA classification fracture pattern of 8 (40%) were A1, 4 (20%) were A2, 1 (5%) were A3, 4(20%) B1 and 1 (5%) each of B2, C2 and C3 type S there was no fracture of B3 or C1 type. Average time of surgical intervention since injury was 3 days, most of the patients were operated on 3rd day [6 patients (30%)] and on 2ndday [5 patients (25%)] excluding the two extreme case, one being 20 days and other 10 months post injury. In our study average time for partial weight bearing was 10.55±2.41 weeks, minimum time was 8 weeks and maximum was 16 weeks with 6 patients (30%) started partial weight bearing at 8-9 weeks, 7 (35%) at 10-11 weeks, 5 (25%) at 12-13 weeks, and 2 (10%) at >14 weeks respectively. Average time for full weight bearing was 19±2.51 weeks, minimum time was 16 weeks and maximum was 24 weeks, in this 5 patients (25%) started full weight bearing at 16-17 weeks, 6 (30%) at 18-19 weeks, 3 (15%) at 20-21 weeks, 4 (20%) at 22-23 weeks and 1 (5%) at >22 weeks respectively. One patient (5%) couldn't bear full weight due to non-union.

In our study 2 patients (10%) showed union at 16-17 weeks, 6 (30%) at 18-19 weeks, 5 (25%) at 20-21 weeks, 4 (20%) at

22-23 weeks, two (10%) at ≥24 weeks. One patient (5%) couldn't bear full weight due to non-union. The average time to attain radiological union excluding the one case which went into non-union, was 19.78±2.39 weeks ranging from 16 weeks to 24 weeks. In our study 12 (60%) patients had no pain, 5 (25%) had occasional pain, 3 (15%) had moderate pain respectively. None of the patients had severe pain. Incidence of Complications was 3 (15%) patients had ankle movement restriction; 1(5%) had non-union and 1(5%) had superficial skin infection. In our study results were finally evaluated using Johner and Wruhs Criteria [9] according to which 11 (55%) out of twenty patients showed excellent results, 6(30%) showed good, 2 (10%) showed fair, 1 (5%) had poor result respectively

Table 1: Evaluation of final results by Johner and Wruhs Criteria

Result	Number	%
Excellent	11	55
Good	6	30
Fair	2	10
Poor	1	5

Fig 1: Showing Excellent Results

Fig 2: Showing Good Results

Fig 3: Showing Poor Results

Discussion

Distal tibial fractures are one of the most difficult fractures to treat and obtaining a good functional recovery. The status of soft tissue injury, degree of communition and other fractures sustained at the time of injury effect the long term clinical results. The main objective behind surgery and plating is to provide anatomic realignment of the bone and joint and to allow early mobilisation and recovery to normal daily activity. Keeping in view the outcomes and target of treatment approach is required to cause minimal osseous and soft tissue devascularization in lieu of reduced complications. The present study was undertaken to evaluate the results of operative fixation of fracture of distal tibia by plating in relation to union and functional outcome.

In our study the age of people sustaining distal tibial injury was ranging from 18-65 years with a mean of 42.15±13.30 years. It was comparable with other studies as range of patient's age was 23-59 (average age 39 years)and 16-77(average age 39.1 years) years in studies done by Yong Li *et al*., [10] and Heather A Vallier *et al*., [11] respectively. Sex distribution has showed male predominance in our study (M/F = 55%/45%) which is comparable with other studies possibly

due to the fact that there is male preponderance in travelling occupational activities. Yong Li *et al*., [10] had 78% male and 22% female while Heather A Vallier *et al*., [11] had 69% males and 31% males in their study. In our study 11 out of 20 patients (55%) had sustained fracture due to road traffic accident ie high energy trauma, Rest 9 (45%) patients had fracture due to low energy trauma. These results correlate with study done by Heather A Vallier *et al*., [11] in which High energy trauma and Low energy trauma cases was 51% and 49%, while 50% each in study by Abdulla S. Abu Senna [12]. In our study 18 out of 20 (90%) of patients had closed fracture, rest 2 (10%) had Type I Open fracture according to Gustilo & Anderson classification. On comparing the observation with other studies on distal tibial fractures similar distribution was obtained. T. W. Lau *et al*., [13] had 82% closed fractures, 7% type I, 6% type II and 5% type III in their study while N. Maffulli *et al*., [14] had 90% closed fractures and 10% type III fractures in their study. When classified according to OTA classification, 13 (65%) type A, 5 (25%) type B and 2 (10%) type C fractures were observed in our study. Correlation was seen with other studies like Hong Gao *et al*., [15] had 53% type A, 4% type B and 42% type C fractures while T. W. Lau *et al*., [13] had 51% type A, 35% type B and 14% type C fractures in their study.

Time to obtain radiological union in our study ranged from 16 weeks to 24 weeks (average time was 19.78±2.39 weeks), One case went into non-union has been excluded from the statistics. We found our results to be similar to other studies, T. W. Lau *et al*., [13] observed union time to be 18.7 weeks, Abdulla S. Abu Senna [12] found 17.5 weeks, Hazarika *et al*., 16 found 19.3 weeks and Im GI *et al*., [17] found 20 weeks respectively.

Various authors have reported results of distal tibial plating in terms of various different scales viz. subjective and objective scale, American orthopaedic foot and ankle score (AOFAS), Johner and Wruhs Criteria etc. In our study we used Johner and Wruhs Criteria to evaluate the bony and functional outcomes of distal tibial plating. We found that eleven (55%) out of twenty patients showed excellent results, six (30%) showed good, two (10%) showed fair and one (5%) had poor result. There were no cases of delayed union, plate breaking or implant impingement.

All fractures showed good radiological union except one who went into nonunion and hence showed Poor result. One patient had developed superficial skin infection which was treated well with antibiotics and wound care without affecting fracture union and the patient had Good result. One case present at 10 months after failed conservative treatment, but showed good results with plating and provided optimally functional limb.

12 out of 20 (60%) patient were pain free, 5 (25%) out of the rest had occasional pain not limiting limb function or gait. Rest 3 (15%) had moderate pain, 2 because of ankle stiffness and one was in nonunion.

3 patients developed postoperative ankle stiffness and were having moderate to occasional pain depending on the degree of stiffness. One case was having only 20% restriction in movement and pain was occasional and functionality was preserved with Good result. While two having restriction 40-50% and thus moderate pain was present limiting the limb functioning with Fair results.

Table 2: Functional Outcomes of distal tibia plating

Study	Acceptable	Not Acceptable
Abdulla S. Abu Senna [12]	90	10
Maffulli N. *et al*., [14]	65	15
Hazarika *et al*., [16]	85	15
Im GI *et al*., [17]	88	12
Mahajan N. [18]	90	10
Ahmad MA *et al*., [19]	73	27
Our Study	85	15

None of the patients had deep wound infection or shortening of limb more than one cm. all patients had full range of movement at the knee and strenuous activity although was limited, daily routine light work was easily accomplished by all the patients excluding the one who went into non-union. Excluding the same patient none of the patient required re-surgery or implant removal. The patient with non-union was advised re-surgery but it could not be performed due to lack of consent. There were no cases of delayed union, plate breaking or implant impingement.

Table 3: Average Union time

Study	Union time (weeks)
Im GI *et al*., [11]	20
Hazarika *et al*., [19]	19.3
T.W.Lau *et al*., [25]	18.7
Abdulla S. Abu Senna	17.5
Our Study	19.7

Conclusion

In our study we found that this technique provides effective stabilization of the fracture, good fracture union and an early mobilization with adequate ankle mobility. The open reduction allows fracture approximation even in difficult situations with communition without disturbing much the fracture hematoma and mostly preserves the blood supply to fragment. On the other side plating is a simple straightforward and single step approach to the fracture, with lesser surgical time and soft tissue handling in newer techniques, allowing a rapid fracture healing and return to daily activity with great patient satisfaction. Although for stronger results a larger study with more number of patients and longer follow up is required, as per the outcomes in this study, plating is affirmatively recommended for better outcomes in patients with distal tibial fractures.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients has/have given his/her consent for his/her images and other clinical information to be reported in the journal. The patients understand that their images and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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