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Distal Metaphyseal Fractures of Tibia Treated by Multiaxial Locked Intramedullary Nail: A Study of 43 Cases

Medical Science

KEYWORDS : Tibial fractures, Multi-axial locked nail, Expert tibia nail®, Metaphyseal fractures, Intra-medullary nail

Gawatre PR	Resident Doctor, Department of Orthopaedics, Medical College & SSG Hospital, Baroda.
*** Chavali VH**	Associate Professor, Department of Orthopaedics, Medical College & SSG Hospital, Baroda , * Corresponding author
Shah HD	Assistant Professor, Department of Orthopaedics, Medical College & SSG Hospital, Baroda
Daveshwar RN	Professor of Orthopaedics, Medical Superintendent, SSG Hospital,Baroda.

ABSTRACT

Objective: To study and analyze the early results of metaphyseal fractures of the distal tibia fixed with multi-axial locked intra-medullary nail.

Introduction: Intra-medullary nailing is considered gold standard for fixation of fractures of the shaft of tibia. However, fixation of distal tibial fractures with uniplanar locking intra-medullary nails pose problems of primary and/or secondary malalignment. The intra-medullary nail with multiple locking options in different planes is biomechanically a better option retaining the advantages of intra-medullary nailing and its minimally invasive technique for use in fractures of metaphysis of distal tibia.

Methodology: Data for a cohort of 43 distal tibial metaphyseal fractures, treated with the multiaxial locked intra-medullary nail between July 2014 and November 2015 was collected. Closed and minimally open extra articular metaphyseal fractures of distal tibia were included. Union time, complications, ankle movements and radiographic alignment were analysed. At final follow-up (minimum 6 months), all patients were evaluated as per the Modified Karlstrom-Olerud scoring system.

Results: The mean age of patients was 38 (Range 18-65) years with maximum (54%) of them being in the range of 18-35 years. Average time to union was 15.4 weeks. Although the patients showed equivocal results on grading against outcome score, 95.4% of the fractures united without any major significant complications. Only 7% patients showed implant related complications. The change observed in primary and secondary alignment was not statistically significant. Ankle movements were either not affected or, at the most, mildly affected in nearly 80% of the cases.

INTRODUCTION

The pathomechanics and principles of fixation of fractures of metaphyseal ends of long bones differ from those of the diaphyseal region. Even though intra-medullary nailing is considered gold standard for fractures of the shaft of tibia[1,2,3], its applicability in distal metaphyseal fractures is cut down because of two reasons. First, its uniplanar locking options and second, the diameter of distal tibial metaphysis is wider than the nail that fits the diaphysis[4,5]. Both the factors pose a danger of primary (at the time of fixation), and/or secondary angulations[6] (at or after initiation of mobilization or weight bearing). Several methods have been in use to overcome these problems including casting[7]after intra-medullary nailing, cutting of distal tip of nail to lock as close to the joint as possible[8], use of poller screws[9] and use of angle-stable locked (multiaxial) intra-medullary nails.

The intra-medullary nail with multiple locking options in different planes is biomechanically a better option retaining the advantages of intra-medullary nailing and its minimally invasive technique for use in fractures of metaphysis of distal tibia.

The purpose of this study was to evaluate the results of multiaxial locked intra-medullary nail in management of metaphyseal fractures of the distal tibia.

METHODOLOGY

Study design & Sample: We present here a prospective study of metaphyseal fractures of distal tibia (within 9-4cm from distal tibial articular surface) treated by multiaxial locked intra-medullary nail between July 2014 and November 2015 at a tertiary level care hospital. Forty-three patients were identified and studied based on the selection criteria.

Inclusion Criteria: Recent (<4weeks) extra articular metaphyseal fractures of distal tibia defined by AO as 43A pattern.

Exclusion Criteria: Intra articular metaphyseal fractures of distal tibia defined by AO as 43B/C and any fracture as defined in inclusion criteria with: patient age <18 years, OGIII injuries, pathologic fractures, neuromuscular conditions that could affect functional assessment and preexisting deformities of Tibia.

Surgical Method: All fractures were operated on a radiolucent table under control of an image intensifier. Closed reduction with manipulation and/or joystick assistance was performed. Entry point had to be strictly in the axis of the medullary canal in all views; perfectly at the ventral edge of tibial plateau in line with the lateral inter- condylar tubercle.

Approximate nail length was measured from tibial tuberosity to the tip of medial malleolus minus 2 cm. Similarly, nail diameter was measured at the level of isthmus on x-ray subtracting adequately for magnification. These measurements were confirmed radiologically with measuring device intra-operatively. Canals that appeared tight to fit at least a 9 mm nail were reamed, else unreamed nailing was done. However, all nails were cannulated and passed over guide wire. Axial alignment, length and rotation of bone were controlled with clamps, towels or k-wires. Trafton's criteria was used to label 'acceptable reduction'. Distal inter-locking in three different directions was done with free hand technique. Unidirectional proximal locking was done with the help of a targeting device. Concomitant fibular fractures were left alone.

Post-operative protocol: After initial non-weight-bearing for

six weeks, all patients were allowed toe-touch weight-bearing irrespective of radiological progress of union if otherwise not contraindicated due to any other reason. Between 8-12 weeks, decision regarding dynamization was taken depending on status of bone healing.

Follow-up & evaluation: All the patients were followed-up (clinical and radiological) fortnightly for first 3 months and later at monthly intervals for next 3 months. A complete set of AP and lateral radiographs since trauma to final follow-up were available with each patient. At final follow-up at six months, fractures showing signs of union in both AP and lateral views were labelled as united; those in process were labelled as delayed union and the rest showing no signs of union were grouped under non-union. Alignment was measured from radiographs taken immediately after surgery and again at final follow-up. Modified Karlstrom-Olerud scoring system was used for assessment at final 24 weeks follow-up. General demographics of patients, fracture characteristics, and clinico-radiological findings were documented during admission and follow-up. Descriptive statistical methods and expression of results in terms of mean, chi-square test and others using Microsoft excel software with significant p value <0.05 were used for computation of data.

OBSERVATIONS

Demographics: A sample size of 43 (33 male, 10 female) was available to us from initial presentation until final follow-up of at least six months. The mean age of patients was 38 (Range 18-65) years with maximum (54%) of them in the range of 18-35 years. The main cause of injury was road traffic accident (65%). The fractures were confined to the metaphyseal segment of distal tibia with the average length of intact distal tibial segment measuring 6.9 cms (Range 4.3-8.6cm). Table.1 shows the distribution of patients according to the fracture types.

OTA→ Gustilo-Anderson↓	43A1	43A2	43A3	TOTAL
Closed	13	10	1	24
OG I	2	6	4	12
OGII	0	3	4	7
TOTAL	15	19	9	43

Table 1. Distribution of patients according to fracture types.

Fracture union: At six months follow-up, 38(88%) fractures were labeled as united, 3(7%) as delayed uniting and 2(4.64%) as non-union. The average union time was 15.41 weeks. (Range: 12-24 weeks). As the patients were evaluated every monthly, the mid-point of the month of the most recent follow-up preceding union was considered as union time. Table 2. shows the correlation between time to union and fracture type in our study. For obvious reasons open fractures took longer time to heal with two of them going in to non-union.

Fracture type→ Duration (weeks)↓	Closed	Open	Total	Percentage
8-12	6	3	9	20.93%
12-16	14	4	18	41.86%
16-20	2	8	10	23.25%
20-24	0	1	1	2.32%
>24	2	1	3	6.97%
Non union	0	2	2	4.64
Mean union time(weeks)	15.0	17.18		
Gross Avg union time	15.41weeks			

Table 2. Union time versus fracture type.

Complications & secondary procedures: The list below (Table 3.)shows the complications and their frequency of occurrence in this study. It requires to be highlighted that none of the patients required implant removal/exchange.

Complication	Frequency	Secondary procedure
Anterior knee pain	4(9.3%)	Nil
Superficial Infection at nail entry/ locking site	5(11.6%)	Daily dressing
Deep infection/ Osteomyelitis	1(2.3%)	Debridement
Screw breakage	3(7%)	Removal of screw
Doubtful initiation of union at 8-12weeks	5(11.6%)	Dynamization
Grossly appreciable deformity of leg	3(7%)	Advised corrective osteotomy
Nonunion	2(4.6)	Bone grafting

Table 3. Complications & secondary procedures

Because the fracture under study was distal tibia, we felt it justified to evaluate compromised ankle movements separately.

Ankle movements	Number of patients	Percentage
Not restricted	24	55.8%
Restricted movements (combined df & pf) $<10^0$ 10^0-20^0 $>20^0$	 10 6 2 18	 23.25% 13.95% 4.65% 41.85
Fixed deformity	1	2.3%
Total	43	100%

Table 4. Evaluation of ankle movements

It is obvious from the above table (Table 4.) that ankle movements were either not affected or at the most mildly affected in nearly 80% cases.

Radiographic alignment: The average primary malalignment in any plane on radiologic long leg view was 8.85 degrees. At six months follow-up the average secondary malalignment(Figure 1.) was 12 degrees. Table 5. shows the breakdown of patients with different degrees of malalignemnt primarily and at six months follow-up. Statistically this change did not prove to be significant.

Direction of deformity→	Varus/Valgus (No. of Pts)		Antecurvatum/ Recurvatum (No. of Pts)	
Measured Angle↓	Immediate Post-op	6 months Post-op	Immediate Post-op	6 months Post-op
0^0-5^0	37	29	34	33
5^0-10^0	4	6	2	0
10^0-15^0	3	6	4	4
$>15^0$	0	1	3	6
X^2	3.325		3.01	
P Value	0.3442		0.3893	

Table 5. Frequency change of radiographic alignment immediate post-operatively & at 6 months.

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Figure 1. Immediate post-operative (above) x ray and x ray at 4 months of follow-up showing secondary malalignment.

Functional scores: At final follow-up (minimum 6 months) all patients were evaluated as per the Modified Karlstrom-Olerud scoring system. Table. 6 shows the result distribution of our study. Majority of our patients returned back to their previous level of ativities of daily living. (Figure 2.).

	No. of patients		Total	Percentage
Outcome (Score)	Closed Fr	Open Fr		
Excellent (33)	6	1	7	16.28%
Good (30-32)	7	5	12	27.9%
Fair (27-29)	6	5	11	25.58%
Moderate (24-26)	3	3	6	13.95%
Poor (21-23)	2	5	7	16.28%
Total	24	19	43	100%
Mean score	28.79	26.63		
Standard Deviation	4.17	4.98		
P value	0.32331			

Table.6 Distribution of patients in relation to Modified Karlstrom-Olerud score & type of fracture. P value obtained after Fischer Exact test for 2x5 table shows no significance.

Figure 2. X ray and clinical photographs of excellent result.

DISCUSSION

Intra-medullary nailing, in the surgical treatment of distal tibial fractures is an atraumatic method that avoids soft tissue injury, spares vascular structures and is performed without opening of fracture site. However, the chances of angular deformity are high when fixed by conventional intra-medullary nails because of uni-directional locking and the continuously changing shape and broadening of distal tibail metaphysis. The multiaxial locked intra-medullary nail not only gives three-dimensional locked stability but also locks closer to the tibial articular surface, which makes fixation more stable and decreases the incidence of implant breakage by maintaining force line after reduction, when used in distal tibial metaphyseal fractures[3,10,11,12].

A significant proportion of the patients included in this study were of open fractures. Yet all except two open fractures united. The average union time calculated for all patients was 15.41 weeks. Union time calculated separately showed longer time (17.2 weeks) for open as compared to closed (15.0 weeks) fractures, reasons thereof not related to fixation. However this pattern of union time is in range of that available in literature for such fractures[3,4,13,14,15].

We had significantly low volume of implant related complications: only three cases (7%). All cases progressed to union without any further major surgical intervention. Previous studies have shown similarly low incidence of implant related complications with intra-medullary nails[3,16,17,18]. It has been our experience that lower leg fractures that face major complications usually end up with restricted ankle movements. Intra-medullary nails have shown to less compromise the ankle movements and our results stand true with this evidence[6,14]. Ankle movements were either not affected or at the most mildly affected in nearly 80% cases. Vascular complications reported[19,20] with locked nails were not encountered in our study.

Fixation of fibula in combined fractures of tibia-fibula has been controversial[3,21,22,23]. Whereas anatomical restoration of fibula helps in getting tibial rotation correct and increased resistance to torsion forces[24], delayed union has been reported with fibular plating done along with intra-med-

ullary nailing and the risk increasing fourteen fold when fractures of tibia and fibula were at the same level[3]. All fibular fractures in our series were above the syndesmosis. None of the patients in our series had any complaints related to fibula during follow-up even as we opted not to fix it primarily. We reserve discussion on this entity for future studies

We used the Trafton's criteria[25] for labeling as acceptable reduction during surgery. We do realize the applicability issues of these criteria in metaphyseal fractures. However, with the aim of preventing primary malalignment these criteria proved good. Primary malalignemnt is considerably prevented by guiding the guide wire in to the designated portion of the distal fragment[3]. The average primary malalignment in any plane on radiologic long leg view was 8.85 degrees. At six months follow-up the average secondary malalignment was 12 degrees. Although statistically insignificant, this higher absolute value of secondary malalignment in our study might have been due to not fixing concomitant fibula fractures. Although literature[3,11,26,27,28,29] shows lower incidence of secondary malalignment with multiaxial locked nails, some authors[13,30,31] showed distal two-fifths of the tibia to be at the highest risk of secondary malalignment.

Although the patients showed equivocal results on grading against outcome score, 95.4% of the fractures united without any major significant complications. The better outcome results seen in our study can be attributed to biological fixation[32], less handling of soft tissue and the debatable factor of avoiding fixation of fibular fractures. Guo et al.[33] compared closed intra-medullary technique with minimally invasive plate osteosynthesis and found no differences in terms of time to union. However, surgical time and exposure to radiation were significantly higher in the plating group. Alignment and functional outcome were better with intra-medullary nailing.

From this study, it is our interpretation that multiaxial locked intra-medullary nail is a good option in treatment of both closed and minimally open fractures of distal tibial metaphysis. Fibular plating can sparingly be used[26,34] in cases where follow-up shows progress towards unacceptable secondary malalignment.

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