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A Study on The Analysis of Functional Outcome of Displaced Distal Third Tibio-Fibular Fractures Treated By Fibula Fixation And Tibial Interlocking Nailing

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Abstract
Background: *Diaphyseal fractures in the tibia are one of the commonest ones encountered in clinical practice and of which the distal third involvement accounts for about one-fourth. Various treatment modalities have been in practice from conservative management to operative modalities like plate fixation, Interlocking nailing, combined nail and plate fixation. The aim of this study was to identify the relevance and advantages of fibular fixation in lower one-third fractures of both bones of leg treated by tibial interlocking nailing.*
Materials and Methods*: 15 patients who presented with fracture in the distal third region of tibia and fibula underwent interlocking nailing for tibia and plate fixation for fibula were analysed prospectively. With an average follow up period of 11.3 months (6 to 18 months) patients were analysed radiologically and clinically, and the final outcome classified by Johner and Wruch's criteria.*
Results: *The mean time to union was around 5 months (4 to 7). 12 out of 15 patients had coronal plane mal-alignment, of which one (out of 15) patient had excess varus angulation of 8 degrees. All the other patients had an acceptable level of malalignment(less the 5 degrees). According to Johner and Wruch's criteria 12 out of 15 (80%) patients had good to excellent results, 3 out of 15 (20%) had fair results and no patient had a poor result. 2 out of 15 patients had a superficial wound infection at the fibula site, which was managed with intra-venous antibiotics.* ***Conclusion:*** *Fixation of fibula in cases of distal third fractures of both bones of leg where the tibial fracture is treated by intramedullary interlocking nail offers better outcomes by reducing the incidence of tibial malalignment (varus/valgus).*

Keywords: *Diaphyseal fracture, tibia, fibula, mal-alignment, Distal Third Tibio-Fibular Fractures*

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I. Introduction

Tibial Diaphyseal Fractures are the most common long bone fracture encountered.[1,2] Distal third region accounts to about 20-30%.[3,1,4,5] Intramedullary Interlocking Nailing is one of the good treatment options available because of various advantages like less wound complications, less malunion, early mobilization with less incidence of angular deformities or mal-alignment. Mal-aligned tibial fractures are still a major concern because of early onset post-traumatic arthritis at the knee and ankle joints. As the deformity approaches either of the joints, mal-alignment leads to mal-distribution of articular surface pressures that may predispose to premature osteoarthritis[6].

In cases of distal one-third fractures of both bones of leg, functional role of fibula in maintaining the fracture stability has not been defined.[7,8] Nicoll et al[2] in 1964 studied 705 cases and found a negative correlation between intactness of fibula and delay in union or nonunion of tibial site fracture. Kumar et al[9] in 2003 and various other authors conducted biomechanical as well as prospective studies to show the advantage of fixing fibular fracture in the setting of distal tibio-fibular fractures. They proposed that fibula plating[10] increased the initial rotational stability and adequate alignment after distal tibial fracture compared with intramedullary nailing alone thereby preventing varus and valgus mal-union at the fracture site. This study was conducted to find out the clinical relevance of fibular fixation in lower one third fractures of both bones of leg and in an effort to outline the advantage and benefits of fixation of the fibula.

II. Materials And Methods

Fifteen patients who presented with fracture of both bones of leg in distal third region underwent intramedullary interlocking nailing for Tibia and fixation of Fibula from July 2013 until September 2015 were

included in our study. Hospital review board and ethics committee approval was obtained before the commencement of the study.

2.1 Inclusion criteria

- Tibio-Fibular Fractures involving the Distal Third Region (upto 8cm from articular surface)– closed
- Compound Grade I Fractures,
- Compound Grade II Fractures
- Patients who have attained skeletal maturity when assessed radiographically
- Both sexes

2.2 Exclusion criteria

- Patients with upper one third and middle one third fractures of the both bones of the leg
- Compound Grade IIIa, IIIb, IIIc fractures
- Fractures involving distal tibial articular surface.
- Segmental fractures of the tibia.
- Co-morbid conditions not permitting major surgical procedures.
- Un-cooperative patients (mentally ill) and patients not willing for surgery.

Timing Of Surgery: 7 to 18 days from the time of injury.

2.3 Pre-Operative Assessment:

- X-ray of the affected leg including the ipsilateral Knee and Ankle Joints.
- Minimum two views are necessary: Antero-posterior and Lateral Views.
- Pre-Operative Nail length is measured clinically.
- Diameter of nail is measured using the Preoperative X-rays at the level of the Isthmus.

The Fracture pattern was classified according to Orthopaedic Trauma Association classification. Open fractures were classified according Criteria of Gustilo and Anderson.

2.4 Procedure:

Fibula Fracture was addressed first.

1.4.1 Technique of fibula fixation :

The fibula was fixed first in all the 15 cases. After painting and draping the leg, a straight incision that parallels the shaft of lower third of the fibula was made. The subcutaneous tissue was not undermined. The fracture site was opened and reduction held with appropriate reduction clamps. The fracture was fixed with one-third tubular plate or a DCP and 3.5mm cortical screws with a minimum of 6 cortical purchases on either side of the fracture site.

Fig 1: Technique of fibula fixation

1.4.2 Technique of Intramedullary Nailing of Tibia :

All cases were managed under spinal anaesthesia. An image intensifier with a C-arm was used in all the cases to provide fluoroscopic guidance. The patient was positioned supine on the fracture table. A triangular bolster was made using cotton rolls and was used to maintain the position of hip in a flexion of 70^{o} – 90^{o} and knee flexion of 60^{o} – 90^{o}.A pneumatic tourniquet was used in all cases with an average tourniquet time of one hour and fifteen minutes and average cuff pressure of 350 mm of Hg. Rotational alignment was achieved by

aligning the anterior superior iliac spine, patella and second ray of the foot. The affected leg was painted and draped. The image intensifier was draped with a sterile isolation drape. A patellar tendon splitting approach was undertaken. Using a curved awl, the medullary canal was opened proximal to the tibial tuberosity at the level corresponding to the proximal tip of the fibular head. For distal third fractures the entry point is taken when compared to the routine entry point which 1.5cm medial to the point in the tibial slope proximal to the tibial tuberosity. The bone awl was centered in the medullary canal. A curved ball tipped guide wire was inserted to the level of the fracture. The distal fragment was reduced to the proximal fragment. Under C-arm guidance, the guide wire was advanced in to the distal fragment, centering both in antero-posterior and lateral views. The guide wire was introduced 0.5 to 1 cm proximal to the ankle joint. The entire tibia was reamed using cannulated reamers over the guide wire in 1 mm increment until the desired diameter has been achieved. The ball tip guide wire is then replaced with a smooth guide wire before insertion of the nail. A nail with a diameter of 1 to 1.5 mm smaller than the final reamer was selected.

Fig 2: Technique of Intramedullary Nailing of Tibia

The selected nail was attached to the proximal drill guide with the hexagonal bolt. The nail was driven over the guide rod until the nail has entered the metaphysis of the distal fragment. The guide wire was then withdrawn. The nail was driven further until the proximal tip of the nail was countersunk into the tibial entry portal. The final hammer blows were given for seating the nail and counter pressure was applied through the foot to close any fracture gap. The distal locking in most cases was done in 2 planes i.e., one in medio-lateral plane and another in the antero-posterior plane and in rest of the patients, two medio-lateral screws were applied depending on the morphology and pattern of the fracture. The proximal locking is done with the help of drill guides. A single proximal lock is done in static mode in all cases.

2.5 Post-Operative Protocol:

- At the end of 48 hours - Static Quadriceps and Ankle Pump exercises started.
- When Pain reduces – Active Knee ROM exercises were started.
- Suture removal was done on 11th Post-operative day.
- Full ROM of Knee at discharge on 12th Post-op day.
- Non – Weight bearing for 6 weeks ; 1st visit after 6 weeks,
- Partial Weight bearing started when there is evidence of callus formation (6 weeks to 3 months) and,
- Full weight bearing started when there is radiological union of 3 cortices.

Patients were followed up clinically and radiologically at 6weeks, 3 months, and 6 months & yearly intervals. At the time of admission fractures were classified according to the Orthopaedic Trauma Association classification. Nature of the injury was also noted. In the post-operative radiographs tibial malalignment was measured. The degree of the tibial angulation (varus or valgus, Antero-posterior, rotational) and shortening were evaluated radiologically and clinically. The Varus/Valgus (medio-lateral) malalignment was measured on the antero-posterior radiographs by determining the angle formed by the intersection between the perpendicular lines drawn from the tibial plateau and tibial plafond.

At the end of six months, the range of movement [dorsiflexion and plantar flexion] at the ankle was determined. A clinical evaluation for the functional assessment of the ankle was obtained by using the "Ankle-Evaluation Rating System" by Merchant and Deitz.[5]
The final results were evaluated using the "Johner & Wruhs' Criteria[11]" as excellent, good, fair and poor outcomes.

2.6 Postoperative Scoring system:-
2.6.1 Clinical Assessment :-
Ankle Evaluation and Rating system by Merchant & Deitz: (100 POINT SCALE)

- 40 POINTS : Function
- 40 POINTS : Pain
- 10 POINTS : Gait
- 10 POINTS : Motion at Ankle

Range Of Motion Analysis of Ankle Joint:-

- Excellent: 100% motion
- Good: 75 to 99%
- Fair: 50 to 75%
- Poor: < 50 %

2.6.2 Radiological Assessment :

- Degree of Varus/Valgus angulation at the fracture site:

Excellent: 0 to 1 degree
Good: 2 to 5 degree
Fair: 6 to 10 degree
b 10 degree

- Evidence of union at the Fracture site

Final Analysis and Evaluation is based on **Johner and Wruchs Criteria** and classified as Excellent, Good, Fair and Poor Outcomes.

Table 1: Johner and Wruchs' criteria

	Excellent	**Good**	**Fair**	**Poor**
Nonunion	None	None	None	Yes
Deformity (varus/valgus)	None	2-5 °	6-10 °	>10 °
Mobility at Ankle (%)	Normal	>75 %	50 – 75%	< 50%
Gait	Normal	Normal	Insignificant limp	Significant limp

III. Results

The longest follow up was one year and six months; the shortest duration being six months. The mean duration was found to be 11.3 months. Age incidence ranged from 19 to 66 years with average age being 37.2 years The right side was more commonly involved [9 in number] than the left side [6 in number]. Most cases were due to road traffic accidents (73.3%). The other mechanism being accidental fall from height (26.6%). In this study, 73.3% of cases were closed fractures and 26.6% were open fractures of the tibia. Of the open fractures 3 were compound Grade I (20%) and 1 was Compound Grade II (6.6%) according to Gustilo and Anderson's Classification. The frequency distribution of the fractures according to AO/OTA classification is depicted in Table 2.

Table 2: Fracture distribution according to AO/OTA classification.

Classification	**Frequency**	**Percentage (%)**
A1	1	6.6
A2	5	33.3
B1	2	13.3
B2	6	40
B3	1	6.6
TOTAL	15	100

Among the 15 cases, 3 cases did not have any angulation. Among the cases having angular deformities 6 cases had valgus angulation (mean valgus of 2.8 ^{o}) and 6 cases had varus angulation (mean varus of 4.3^{o}). Only one Patient had an excess varus angulation of 8 degrees. 20% of patients had excellent results, 73.3% of patients with had good results, 6.6% of patients had fair and there were no poor results with respect to fracture mal-alignment (Table 3). There were 3 cases with antero-posterior angulation; 2 patients (13.3%) had anterior angulation with an average of 2 degrees and one patient (6.6%) had posterior angulation of 4 degrees. 12(80%) out of 15 patients did not have any antero-posterior malalignment. None of the patients had any amount of rotational malalignment or shortening.

Table 3: Frequency Distribution Of Patients According To Varus/Valgus Malalignment

Valgus/Varus	**Frequency**	**Percentage**
(in degrees)		
Excellent (0-1)	3	20
Good (2-5)	11	73.3
Fair (6-10)	1	6.6
Poor (>10)	-	-
Total	15	100

The mean range of movements in patients was 77.73%. Among the 15 patients, 2 patients (13.3%) had excellent results, 10 patients (66.6%) had good result, 3(20%) had fair result and no poor result. A clinical assessment of ankle function using Ankle Evaluation and Rating system by Merchant & Deitz was determined for each ankle at the end of six months follow-up. The mean clinical score was 73.26 points. (Table 4)

Table 4: Pattern of clinical Ankle Evaluation Rating System (AERS) Score

Ankle Evaluation Score	**Frequency**	**Percentage (%)**
(Total 100 Points)		
<60	2	13.3
60 – 80	9	60
>80	4	26.6
Total	15	100

Mean time of union in these patients was 5 months (minimum of 4 months and a maximum of 7 months). 2 out of 15 patient developed wound complications at the Fibular incision site. Both the patients had superficial infection which were managed with intravenous antibiotics. According to Johner and Wruh's criteria, among the 15 patients, 2(13.3%) had excellent result, 10(66.6%) had good results, 3(20%) had fair results. There was no poor result. (Figure 3)

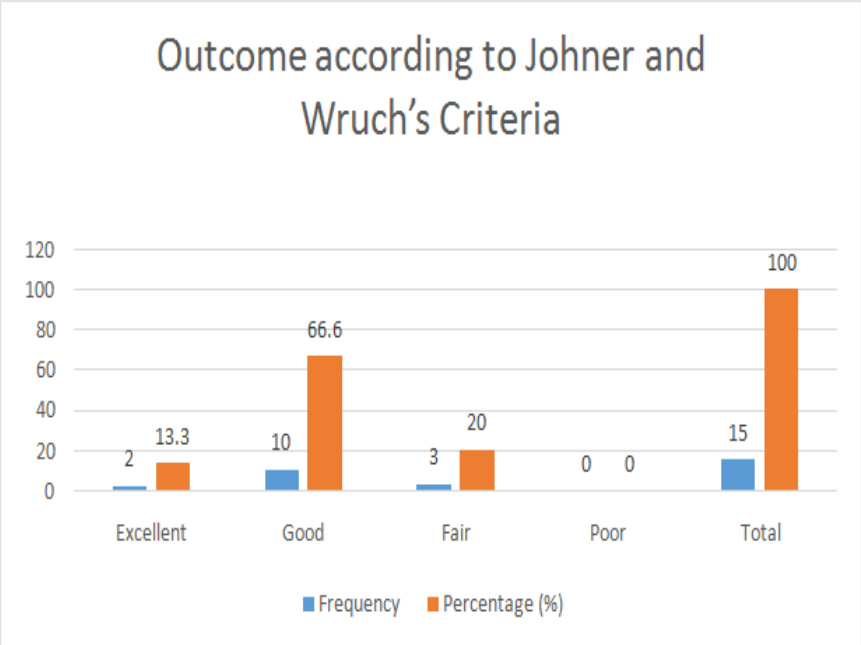

Figure 3: Final Results according to Johner and Wruch's Criteria

IV. Discussion

In the fractures of both bones of leg involving the distal third region, the importance of fixing of fibular fracture has not yet been clearly analyzed. Robinson et al[12] in 1995 observed various patients with fractures in the distal tibial metaphysis treated by closed nailing for tibia and proposed that closed intramedullary nailing is a safe option for fractures in the distal tibial metaphysis[13]. Sarmiento et al[14] (1995) reported on their extensive experience with functional bracing, which included 1000 consecutive closed tibia fractures that the presence of intact fibula had both positive and negative effects in their study. Intact fibula was associated with more rapid union but it was also associated with an increased risk of angular deformity. This study was conducted in 15 patients to analyze the results of fixing the fibula in fractures of the lower third of shaft of tibia and fibula. In all of the cases, the fracture tibia was treated with interlocking intramedullary nailing. In 12 out of 15 patients, there was mild amount of valgus / varus angulation at the fracture site within the acceptable range of 5 degrees. The average valgus angulation was 2.8 degrees and average varus angulation was 4.3 degrees. Only one patient had a varus angulation of 8 degrees. In comparison to the previous studies where fibula was treated conservatively in fractures of distal third of tibia and fibula, the valgus and varus angulations in our study was significantly less. Kenneth Egol et al.[15] proposed that, the proportion of fractures that lost alignment was very minimal among those receiving stabilization for fibula fracture in conjunction with IM nailing in comparison with those candidates receiving IM nailing alone. The authors insisted on fibular plating whenever IM nailing is contemplated in the unstable distal tibia-fibular fracture.

Buzzi et al.[16] concluded that fibula fixation and intramedullary nailing of distal Tibio-fibular fractures is a valid technique which prevents malalignment and respects soft tissue envelope. Henley et al.[17] , in laboratory simulation, found that fibular fixation initially increased stability by decreasing initial rotational displacement in nailed distal third tibial fractures. These data support our clinical observations that fibular fixation may decrease late valgus malalignment in distal third comminuted tibial fractures with a fibular fracture at the same level. Kumar et al.[9] found that fibular plate fixation increased the initial rotational stability after distal tibial fracture compared with that provided by tibial intramedullary nailing alone. Comparing the results of this study with the above mentioned literature, when the fixation of fibula[18] is done prior to nailing of tibia, it helps in alignment of the proximal and distal tibial fragments and maintains the length of lateral column, thereby reducing the incidence of varus/valgus mal-alignment at the fracture site. The average range of motion at the ankle in our study 77.7%. Merchant and Deitz[5] [1989] in their clinical study of 3717 patients followed up for 29 years, had a mean ankle evaluation score of 88.4 points for patients with distal third of the shaft of tibia. All of the patients in their series were treated non-operatively with a cast. In our study, the less mean score when compared to the study by Merchant and Deitz may be accounted to the shorter duration of the follow up [the longest duration of follow up being one year six months with a mean duration of 11.3 months]. Two out of 15 patients treated with fixation of fibula developed superficial wound infections over the fibular incision site. Both the infections were controlled by appropriate dressing and antibiotics.

The average union time was 5 months; minimum of 4 months and a maximum of 7 months. There were no non-unions. Comparing our results with previous studies conducted by Jeffrey and his colleagues[19] in 2004, the time of union was not influenced by fixation of fibula. All fractures united within the acceptable duration for union. Final analysis of results according to Johner & Wruh's criteria showed Excellent to good outcome in most of the patients (12 patients, 80%) and favorable in 3(20%) of the patients. When compared to previous studies by Kumar[9] and his colleagues the outcome assessment by this criteria showed a better results in our patients where fibula fixation is carried out.

Limitations of the Study:

1. Sample size is small when compared with other similar studies.
2. Duration of follow up when compared to other studies is less. Average duration in our study is 11.3 months.

V. Conclusion

Based on the results of the study the following conclusions were made:

1. Fixation of fibula in cases of distal third fractures of both bones of leg where the tibial fracture is treated by intramedullary interlocking nail offers better outcome by reducing the incidence of tibial malalignment (varus/valgus).
2. The fixation of the fibula establishes the length of the lateral column. When the fixation of the fibula is done prior to nailing of the tibia, it helps to restore the alignment of proximal and distal tibial fragments. This may be the reason for less valgus/varus angulation in cases where fibula was fixed.
3. There was no significance with respect to the time of union when comparing our results with the previous studies where fibular fracture was not fixed.

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