Indian Journal of Orthopaedics Surgery 2022;8(3):183–189

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Orthopaedics Surgery

Journal homepage: https://www.ijos.co.in/

Original Research Article

Role of fibula in healing of closed diaphyseal tibial fractures treated with intramedullary interlocking nail

Aswin Deepak Rajan[1,*], Munin Borgohain[2], Kiran Sonowal[1], Daniel Abraham[2], Madhujya Sharma[2], Mandar Deb[2]

[1] *Jorhat Medical College & Hospital, Jorhat, Assam, India*
[2] *Assam Medical College and Hospital, Barbari, Assam, India*

ARTICLE INFO

Article history:
Received 04-07-2022
Accepted 30-08-2022
Available online 20-09-2022

Keywords:
Tibial fractures
Intact fibula
Nonunion
Deformity

ABSTRACT

Background: Isolated tibial shaft fractures with intact fibula are a fairly common injury. Hospital records often fail to mention the intact fibula in such injuries. Many studies blame that with an intact fibula, tibiofibular length discrepancy develops resulting complications associated with the management of tibia fractures like delayed union, non-union, and malunion.

Materials and Methods: A prospective study in 59 patients of tibial shaft fractures with 33 having fibula fracture (FF) and 26 patients with an intact fibula(IF) were treated by closed intramedullary interlocking nail between June 2019 to July 2020. Radiological follow up were at 6 weeks, 3 months, 6 months. The final functional evaluation was done with Johner and Wruh's criteria at the end of 6 months.

Results: The mean duration of surgery in group IF was 106.62 minutes wherein group FF was 97.91 minutes The radiological union was early with a mean union rate of 19.09 weeks in group FF compared to group IF where the mean was 22.23 weeks. The percentage of nonunion was 3.85% in group IF. 4 patients had a deformity where the level of tibia fracture was lower 1/3 diaphyseal with fibula fracture at the same level. At the final follow up the functional score had no significance.

Conclusion: The union of a tibial shaft fracture was slower in patients with an intact fibula compared to those with a fractured fibula. Although the intact fibula was more proven for the delayed union, non-union, it prevents malalignment.

1. Introduction

Diaphysis is the most common site of fracture in the tibia and about 80% of these injuries have associated fibular fractures at the same or different level. However, it is possible that fibula fracture may not occur with tibia fracture in low energy injury.[1] Around 26 tibial diaphyseal fractures per 100,000 of the population per year seen in the average population. The average age seen in the tibial shaft fracture population was about 37 years.[2] Isolated tibial shaft fractures with intact fibula are a fairly common injury. Hospital records often fail to mention the intact fibula in such injuries. Compared to fractures elsewhere in the body, tibial fractures have relatively high rates of nonunion and malunion.[3] Many studies blame the intact fibula for the cause of complications associated with the management of tibia fractures like delayed union, non-union, and malunion.[4] With an intact fibula, tibio-fibular length discrepancy develops and causes altered strain patterns in both tibia and fibula leading to delayed union, nonunion, or malunion of tibia leading to a sequel of joint disturbance.[5] Historical descriptions of the treatment of tibial fractures are included in the Edwin Smith Papyrus, an

* *Corresponding author*.
E-mail address: aswinderajan@gmail.com (A. D. Rajan).

https://doi.org/10.18231/j.ijos.2022.032

ancient Egyptian medical text dating back to at least 1500 to 1600 BC.[6] Intramedullary interlocking nailing has become a gold standard choice.

2. Materials and Methods

To compare outcomes in terms of duration surgery, rate of union, malunion, delayed union, non-union when closed tibial shaft fracture managed with reamed intramedullary nailing in a patient with intact fibula versus fractured fibula.

The study was conducted at the Department of Orthopaedics, in our institute for duration of 1 year. All patients underwent closed reduction and intramedullary interlocking nail for tibial shaft fracture with or without fibula fracture. Ethical clearance was obtained from the institutional ethics committee (human) of the institute before starting the research.

2.1. Inclusion criteria

1. Closed tibial fracture with or without fibula fracture.
2. Tibial diaphyseal fracture in the age group above 18 years below 65 years.
3. Tscherne grade C0 and C1.
4. Patient giving informed consent.

2.2. Exclusion criteria

1. Age less than 18 years and more than 65 years.
2. Fracture with intraarticular extensions & Pathological fracture.
3. Tscherne grade C2 and C3.

2.3. Nail length measurement

We followed the method of tubercle medial malleolar distance by measuring the length between the most prominent points on the medial malleolus and the tibial tubercle. The diameter of the nail was assessed by measuring the tibia at its narrowest point, which was best appreciated on lateral radiographs.

2.4. Procedure

Nailing was done using a standard radiolucent operating table. The patient was placed supine under spinal anaesthesia with the injured leg was positioned freely, with the knee flexed at 90° with padded support over the edge of the operating table. Surgical Draping was done with 10% betadine from the distal part of the femur covering the knee joint up to all toes of the fractured limb and the foot part was covered with sterile gloves /sterile cloth. In our cases, we commonly used the medial parapatellar approach. After selecting the ideal point of insertion at just medial to the lateral tibial spine which we had determined from a true AP radiograph using C-arm as the amount of tibial rotation had been shown to affect the appearance of the guide wire location by as much as 15 mm, Therefore, it was important that a "true" AP of the knee was used to determine the starting point. This view was obtained by ensuring that the fibula was bisected by the lateral aspect of the tibia at the joint. Once the starting point was correctly placed, curved bone awl was used to breach the proximal tibial cortex and then ball tip guide wire of length 3 mm diameter x 950 mm was advanced in the appropriate direction. The guide wire was passed into the medullary canal anterogradely across the fracture site after closed reduction with image intensifier guidance. Serial reaming will be done in increments of 1 mm. A nail of the measured length and diameter which was 1 mm less than the last reamer was mounted in the jig and negotiated down the medullary canal and across the fracture. The distal locking was done by freehand technique with the help of an image intensifier. Proximal locking with one or two screws was done using the jig.

2.5. Postoperative

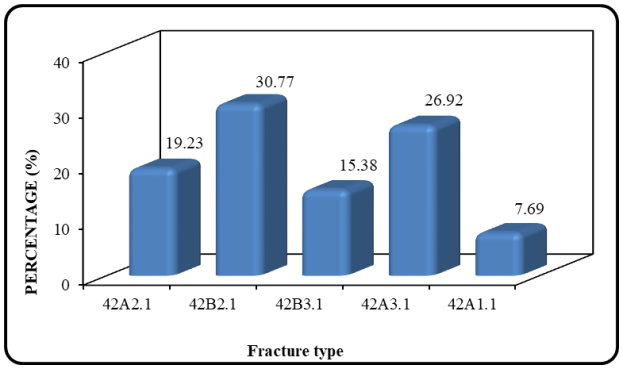
The patients were given intravenous antibiotics for five days and oral antibiotics up to the day of stitch removal. A check x-ray was taken immediately after the surgery. Sutures were removed on the 14th day. Physiotherapy was started with active quadriceps strengthening, range of motion, and non-weight-bearing ambulation with the support of axillary crutches, and patients were followed up at 6,12, and 24 weeks and assessed for subjective, clinical, radiological signs of union and ability to do strenuous activity. Fracture union was considered when the patient bears full weight without pain; the fracture site not tender on palpation and the radiograph shows osseous union. Finally, the functional assessment was done at 6 months using Johner and Wruh's criteria (Table 1) and radiological assessment at 6 weeks, 12 weeks, 24 weeks using RUST score[7] (Table 2). RUST scoring was a radiographic evaluation method with high repeatability and reliability, which was used for tibial shaft fractures applied with intramedullary nailing. A RUST score $\geq$9 was accepted as union.[7]

2.6. Statistical analysis

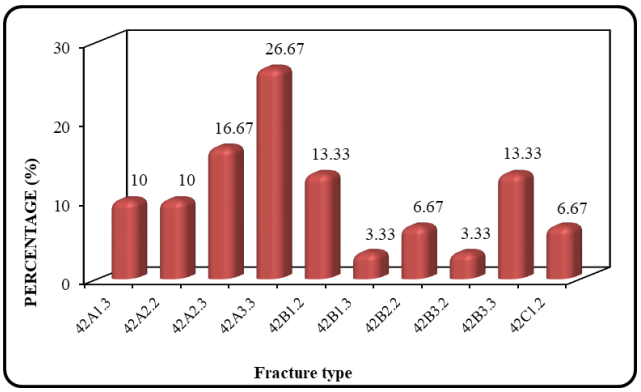
The statistical analysis of data was performed using the computer program, Statistical Package for Social sciences (SPSS for Windows, version 20.0. Chicago, SPSS Inc.) And Microsoft Excel 2010. Results on continuous measurements are presented as mean + standard deviation are compared using the student's t-test. Discrete data are expressed as numbers (%) and are analyzed using the Chi-square test and Fischer's exact test (where the cell counts < or 0). Pearson's correlation coefficient (r) was used to measure the associations among continuous variables. For all analyses, the statistical significance was fixed at a 5% level (p-value <0.05).

3. Results and Observation

A total of 59 patients were divided into two groups, Group (IF) (n =26) isolated tibial shaft fracture and Group (FF) (n = 33) tibial shaft and fibula fractures. The mean age was 29.38 years in group IF and 30.09 years in group FF. 69.49% of the total study population were male patients. RTA was the most common mode of injury in group FF whereas in group IF, 46.15% of patients sustained falls. The right side was commonly involved in both the group. In both groups, middle 1/3rd diaphyseal tibial fracture was commonly observed. Among the group IF according to AO classification 42B2.1 was common with 8 patients among 26 (30.77%) (Graph 1). Among the group FF according to AO classification 42A3.3 (transverse fracture of tibia with a fibular fracture at the same level) was common with 8 patients (26.67%) and tibia fracture with a fibular fracture at the same level (42A1.3+42A2.3+42A3.3+42B1.3+42B3.3)=3+5+8+1+4=21 (63.63%) which was commonly noted in our study (Graph 2).



Graph 1: Fracture type according to AO classification in group IF



Graph 2: Fracture type according to AO classification in fibular fracture group

Secondly lower 1/3rd tibial diaphyseal fracture was observed in 3 patients (11.54%) in group IF and 6 patients (18.18%) in group FF. The time interval between the day of trauma to the day of surgery in group IF was an average of 3.31 days and in group FF average was 3.55 days. The mean duration of surgery in group IF was 106.62 minutes wherein group FF was 97.91 minutes The radiological union was early with a mean union rate of 19.09 weeks in group FF compared to group IF where the union rate mean was 22.23 weeks. (Table 4) The final functional outcomes in both the groups were derived by using Johner and Wruh's criteria (Table 3) Radiological Union was evaluated according to the RUST criteria (Table 4). In our study, none of the cases went into malunion and deformity in group IF. The percentage of nonunion was 3.85% in group IF and there was no case of nonunion in group FF. Percentage of the delayed union in group IF was 19.23% whereas in group FF was 6.06%. At 6 months due to delayed union in 5 cases of group IF dynamization was done in 3 cases and bone marrow injection in 2 cases. In the 9th month, a case of nonunion was treated with fibular osteotomy, and the union was obtained (Figure 5). The percentage of infection was 7.69% in group IF whereas in group FF it was 3.03 percentage. In group IF the percentage of a screw breakage was 7.69% but in group FF it was 9.09%. In group IF there was 19.23% with anterior knee pain as a complication compared to group FF which had 9.09%. In group FF four patients had malunion and deformity, in all four cases, the level of tibia fracture was lower 1/3 diaphyseal with fibula fracture at the same level (Figure 4) compared to group IF where there was no deformity. (Table 4)

Fig. 1: Group IF – preoperative image & followup at 6 weeks

4. Discussion

Intramedullary nailing is accepted as the gold standard method of treatment in closed tibial shaft fractures. Still, there is a debate on how a tibial fracture with concomitant fibula fracture or intact fibula should be treated. An intact

Table 1: J&W criteria

Criteria	Excellent	Good	Fair	Poor
Non union, osteomyelitis, amputation	None	None	None	Yes
Neurovascular Disturbances	None	Minimal	Moderate	Severe
Varus/valgus (degree)	None	2 – 5	6 - 10	>10
Anterversion/recurvatum Degree	0-5	6 – 10	11- 20	>20
Rotation (degree)	0-5	6-10	11-20	>20
Shortening	0-5mm	6-10mm	11-20mm	>20mm
Knee%	Normal	>80%	>75%	<55%
Ankle %	Normal	>75%	>50%	<50%
Subtalar %	>75%	>50%	<50%	-
Pain	None	Occasional	Moderate	Severe
Gait	Normal	Normal	Insignificant	Significant
Strenuous activity	Possible	Limited	Severely limited	Impossible

Table 2: RUST criteria

Score	Lateral cortex	Anterior cortex	Posterior Cortex	Medial cortex
1	Absence of callus Visible fracture line	Absence of callus Visible fracture line	Absence of callus Visible fracture line	Absence of callus Visible fracture line
2	Absence of callus Visible fracture line	Presence of callus Visible fracture line	Presence of callus Visible fracture line	Absence of callus Visible fracture line
3	Presence of callus Absence of fracture line	Presence of callus Absence of fracture line	Presence of callus Absence of fracture line	Presence of callus Absence of fracture line

Table 3: Clinical evaluation

J&W Criteria	Group–IF		Group–FF		p-value
	Number (n)	Percentage (%)	Number (n)	Percentage (%)	
Excellent	16	61.54	24	72.73	0.286
Good	4	15.38	7	21.21	
Fair	2	7.69	1	3.03	
Poor	4	15.38	1	3.03	
Total	26	100.00	33	100.00	

Table 4: Results

		Group IF	Group FF	P value
Duration of surgery(in min)		106.62	97.91	<0.001
Union in weeks		22.23 weeks	19.09 weeks	<0.001
RUST score	6 weeks	5.23	6.21	0.004
	12 weeks	7.35	8.27	0.022
	24 weeks	9.35	10.27	0.021
Malunion(n)		0	4	0.065
Deformity(n)		0	4	0.065
Delayed union(n)		5	2	0.120
Non union(n)		1	0	0.255

Fig. 2: Group IF – Follow up at 3 month (up) and 6 months (down)

Fig. 3: Group FF – preoperative & 6 weeks, 3 months (lower left corner) and 6 months (lower right corner)

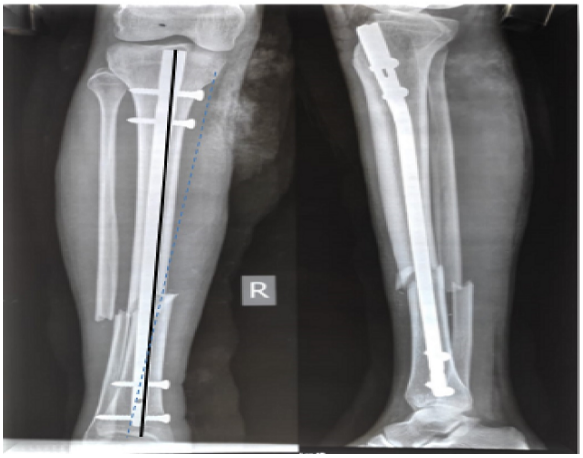


Fig. 4: Group FF – case of malunion (complication)

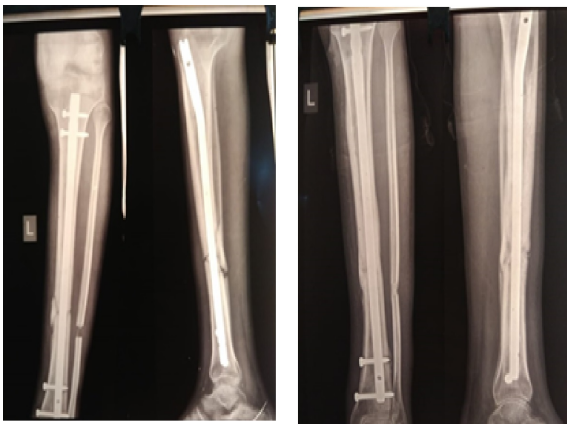


Fig. 5: Group IF – case of nonunion managed with fibulectomy

fibula seems to interfere with the healing of ITS fracture by preventing effective compression at the fracture site as one of the essential features in the healing process is a physiological cyclical application of weight-bearing forces across the fracture.[8] Duration of surgery was measured from the time of incision to suture. Madhukar K.T et al in their study observed that intraoperative reduction of tibia fracture was difficult when the fibula was intact, especially tibia was grossly displaced.[9] In our study, we also experienced similar difficulty in tibial fracture reduction intraoperatively when the fibula was intact hence the duration of the surgery in group IF was more with an average of 106.62 minutes when compared to group FF where it was only 97.91 minutes. The most significant finding of the current study was that when there is an intact fibula, the union of the tibia fracture is delayed while malalignment is prevented. An intact fibula can cause distraction in the fracture line during intramedullary nailing of tibial fractures. It has been reported that 5 mm distraction of the fracture line in tibial fractures can prolong union to 8-12 months.[10] Isolated tibial fractures have been examined in literature and it has been

reported that union problems have been experienced.[11] In a study by Court-Brown et al isolated tibial fractures were compared with cases of both bone fractures and a significant difference was determined in the time to union (16.7 weeks vs.15.6 weeks).[12] Balaji et al. found the time to union to be mean 19.7 weeks in 56 cases of isolated tibial fracture with an intact fibula.[13] In the current study, the meantime to union was determined as 22.23 weeks in Group IF and 19.09 weeks in Group FF ($p< 0.001$). The intact fibula was observed to have prolonged the time to union. Although there is no time limit for non-union in tibial fractures, a delayed union is said to be a union occurring at 3-4 months, and non-union is accepted as no union within 6-8 months. In the current study, the non-union rates according to the 6-month RUST scores were determined to be average score of 9.35 in Group IF and 10.27 in Group FF. The difference between the groups was statistically significant ($p = 0.021$). The anatomic fibula was observed to have delayed union of the tibial fracture. At 12 months postoperatively, non-union was observed in 1 patient in group IF. Malalignment is often seen in distal tibial shaft fractures with a concomitant fibular fracture at the same level. In the current study, malalignment was observed in 4 patients in Group FF and none of the cases went to malunion in the intact fibula group. The anatomic fibula was found to have reduced malalignment. In a study by De Giacomo et al of 122 patients with distal tibial fracture applied with intramedullary nailing, malalignment was observed mostly in patients with a fibula fracture at the same level as the tibial fracture.[14]

5. Conclusion

Tibia fracture with concomitant fibular fracture was a far more common injury compared to isolated tibia fracture. Although these two types of injury were common at any age group the mode of injury still differs. High energy trauma was the common cause of both tibia and concomitant fibula fracture whereas isolated tibia fractures were caused by low energy trauma. The displaced isolated tibial fracture was difficult to reduce intraoperatively leading to prolonged operative time compared to both bone fractures of the leg. A longer duration of the radiological union was observed in isolated tibial fracture compared to the other. Nonunion and delayed union were significantly noted in the isolated tibial fracture. The functional outcome remains the same between the two. Among the various complications, there were cases of deformity in the distal one-third of diaphyseal tibial fractures with a fibular fracture at the same level.

6. Limitations

Limitations of the current study can be said to be the low number of patients and that the groups were not equal in number. In addition, other factors affecting unions were not compared (smoking, socioeconomic status). With such methodological limitations, the interpretation of this study remained limited. Therefore, further multicentered, randomized controlled studies on a larger sample size with long-term follow-up should be implemented to conclusively ascertain the outcomes.

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Sanders RW, Dipasquale TG, Jordan CJ, Arrington JA, Sagi HC. Semiextended Intramedullary Nailing of the Tibia Using a Suprapatellar Approach. *J Orthop Trauma*. 2014;28(5):245–55.
2. Sheth N, Lonner J. Intramedullary Nail Fixation of Tibial Shaft Fractures. In: Gee AO, Israelite CL, editors. Gowned and Gloved Orthopaedics: Introduction to Common Procedures. Philadelphia PA: Elsevier/Saunders; 2009. p. 314–23.
3. Dujardyn J, Lammens J. Treatment of delayed union or non-union of the tibial shaft with partial fibulectomy and an Ilizarov frame. *Acta Orthop Belg*. 2007;73(5):630–4.
4. Ranganath KV, Arun HS, Hariprasad S. Surgical Management of Isolated Tibial Shaft Fractures with Closed Intramedullary Interlocking Nail. *Int J Sci Study*. 2016;3(12):110–4.
5. Weber TG, Harrington RM, Henley MB, Tencer AF. The Role of Fibular Fixation in Combined Fractures of the Tibia and Fibula: A Biomechanical Investigation. *J Orthop Trauma*. 1997;11(3):206–11.
6. Smith E, Ware EW. Hieroglyphic Transliteration, Translation, and Commentary. In: James BH, Ware EW, editors. Edwin Smith Surgical Papyrus. vol. Volume 1. Chicago: Oriental Institute of the University of Chicago; 1991.
7. Leow JM, Clement ND, Tawonsawatruk T, Simpson CJ, Simpson A. The radiographic union scale in tibial (RUST) fractures: Reliability of the outcome measure at an independent centre. *Bone Joint Res*. 2016;5(4):116–21.
8. Teitz CC, Carter DR, Frankel VH. Problems associated with tibial fractures with intact fibulae. *J Bone Jt Surg*. 1980;62(5):770–6.
9. Madhukar K, Basha M. To compare outcomes in patients with diaphyseal fracture of tibia managed by intramedullary nailing with intact fibula vs fracture tibia with fibula. *Indian J Orthop Surg*. 2017;3(4):382–5.
10. Evren AT, Yaradilmis YU, Okkaoglu MC, Ates A, Demirkale İ, Altay M, et al. Effect of anatomic fibula on tibia union and alignment after intramedullary nailing of tibia shaft fractures. *Eur Res J*. 2020;6(4):337–42.
11. Jørgensen TE. The Influence of the Intact Fibula on the Compression of a Tibial Fracture or Pseudoarthrosis. *Acta Orthop Scand*. 1974;45(1-4):119–29.
12. Court-Brown CM, Christie J, Mcqueen MM. Closed intramedullary tibial nailing. Its use in closed and type I open fractures. *J Bone Joint Surg Br*. 1990;72(4):605–11.
13. Balaji SM, Chandra PM, Devadoss S, Devadoss A. The effect of intact fibula on functional outcome of reamed intramedullary interlocking nail in open and closed isolated tibial shaft fractures: A prospective study. *Indian J Orthop*. 2016;50(2):201.
14. DeGiacomo AF, Tornetta P. Alignment After Intramedullary Nailing of Distal Tibia Fractures Without Fibula Fixation. *J Orthop Trauma*. 2016;30(10):561–7.

Author biography

Aswin Deepak Rajan, Senior Resident

Munin Borgohain, Professor

Kiran Sonowal, Assistant Professor

Daniel Abraham, Post Graduate Trainee

Madhujya Sharma, Post Graduate Trainee

Mandar Deb, Post Graduate Trainee

Cite this article: Rajan AD, Borgohain M, Sonowal K, Abraham D, Sharma M, Deb M. Role of fibula in healing of closed diaphyseal tibial fractures treated with intramedullary interlocking nail. *Indian J Orthop Surg* 2022;8(3):183-189.