e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(1); 1409-1414

Original Research Article

Role of Fixation of Fibula Fractures in Proximal and Distal One-Third to Prevent Hind Foot Valgus Deformity following Interlocking Nailing of Tibial Diaphyseal Fractures

Sunil Kumar Kar

Assistant Professor, Department of Orthopedics, Hi-Tech Medical College, Rourkela, 769004 Odisha, India

Received: 20-12-2022 / Revised: 10-01-2023 / Accepted: 20-01-2023
Corresponding Author: Dr. Sunil Kumar Kar
Conflict of interest: Nil

Abstract:

Aim and Background: Intramedullary interlocking nailing is the gold standard treatment for tibial shaft fractures, which continues to be the most common type of fractures in the current era. In the event of interlocking tibial fractures, the proximal and middle third fractures are typically treated conservatively. The current study examines the possibility of ankle deformity and the radiological outcomes in the lower extremities if intramedullary interlocking nailing is used to treat tibial shaft fractures with concurrent fractures of the fibula (apart from at the distal one-third level) without surgical fixation of the concomitant fractures of the fibula.

Materials Method: The current study included forty patients with concomitant fibular fractures and mid-shaft tibia fractures, excluding those at the distal one-third level. The study was conducted from Nov 2017 to May 2019 at IMS and SUM Hospital, Bhubaneswar. The anatomic reduction was used to fix all tibia shaft fractures using interlocking nails. Conservative treatment was used for the proximal and middle third fibula fractures. In forty fractures, 100% of them had anatomic union. Goniometer-based clinical evaluation was carried out in accordance with Astrom and Arvidson methodology. A long axial view was taken to perform a radiological evaluation.

Results: Compared to the normal limb, the radiographic examination of the long axial view revealed an increase in the hindfoot angle, with a mean value of 16 degrees (9-20 degrees). In 28 patients (70%) fractures the mean value of fibular shortening was found to be 13 mm (range, 5-19 mm).

Conclusion: To prevent the development of hindfoot valgus deformity due to fibular shortening, fibula should be fixed in such patients, which can help to achieve better functional outcomes. Moreover, it can be believed that the fractures of the fibula in the middle or proximal one-third level should be anatomically fixed in conjunction with the intramedullary fixation of the tibial shaft fractures.

Keywords: Fibula fractures, hindfoot valgus, tibial shaft, intramedullary fixation (IMN).

Introduction

The most common type of long bone fractures are closed tibial shaft fractures. [1] The interlocking nailing of tibia is the gold standard treatment for displaced fractures of shaft of tibia in the current era. [2-3]. Displaced Tibial shaft fractures are generally treated surgically and are frequently associated with fibular fractures [4–5]. Usually, a concomitant fibular fracture in the distal one-third is usually fixed surgically;

however, in the middle or proximal one-third, it is usually treated conservatively [4–7].

The current study evaluates the possibility of ankle deformity if intramedullary nail fixation was done in the fractures of the tibial shaft with concomitant fibula fractures (except at the distal one-third level) without internal fixation of an associated fibula fractures.

Materials and Methods

In the current study a total of fifty-one patients were enrolled, out of which six patients were lost to follow-up, two cases had surgical site infection, two patients had implant failure and one patient died during follow up.

Finally, forty patients were evaluated in this study. The study was conducted from Nov 2017 to May 2019, and ethical clearance was obtained from the Institutional Review Board, IMS and SUM Hospital. The unilateral mid-shaft closed tibial fractures were treated with anatomic reduction and fixation by interlocking intramedullary nails in whom fibular fractures in the proximal to middle one-third level were treated conservatively. The patients with compound or complex fractures, tibial nonunion, surgical site infections, implant failure, and those who had undergone a second surgery were exclud- ed from the study. The mean follow-up period was 14 months (10–20 months). The clinical evaluation of hindfoot alignment was done using a goniometer and drawing lines on the skin as described by Astrom and Arvid- son [8] (Figure 1] in the follow-up.

Figure 1: Figure (A) in left side shows clinical image of both ankles in weight bearing phase showing increased hind foot angle (g) in left ankle as compared to normal right ankle. Figure (B) indicate long axial radiograph of left affected ankle and right normal ankle

The radiological assessment was done by taking a long axial view radiograph to determine the hindfoot angle [9-10]. The mid-diaphyseal axis of the tibia is defined as the line bisecting the tibia into two mid-diaphyseal points (lines A and B) 30 mm apart and extending the line towards the calcaneum (line E). Next, two points were determined in the calcaneus. The first point was determined by drawing a horizontal line at a distance of 7 mm from the most distal part of the calcaneus (Line D) and is divided into a 40%: 60% ratio, where the length of the 40% line is measured from the lateral aspect. The second point was determined by drawing a line (Line C) horizontally, 30 mm from the most distal part of the calcaneus and the middle point of bisecting this line. The calcaneus axis (line F) is drawn by connecting those two points at lines D and C.

The hind foot angle (G) was the angle between lines E and F [11]. Anteroposterior and lateral radiographs of the tibia and

fibula in full length was taken for both lower limbs at the same distance and exposure time. It was used to compare the length of the tibia and fibula for the injured and contralateral limbs [8]. The long axial views were taken from the computerized x-ray digital system

Figure 2: Long axial radiograph showing the determination of hindfoot angle (G)

Results

A fraction of 70% of patients were male, and the rest 30% were female out of 40 participants. In the current study, the overall average age of patients with tibial fractures was 38 years. In males, the average age was found to be 32 years, whereas in females, the average age was 56 years.

The age range of participants was highest among the ages of 31-40 years with a fraction of 43%, and the lowest group of age was ranging > 60 years with a fraction of 10% (Table 1).

Tables 1: Age range of study participants

Sl. No	Age range	Frequency (n)	%
1	31-40	17	43
2	41-50	13	32
3	51-60	6	15
4	>60	4	10

There was a shortening of fibula in 28 cases (70%) with a mean value of 13 mm (range, 5–19mm) (Table 2). There was an increase in hindfoot angle (G) with a mean value of 16° (range of 9-20°) as compared to that of the other extremity during radiological evaluation [Fig 1]

Table 2: Fibula shortening length in mm

Sl. No	Ranges in mm	Frequency	Percentage (%)	average
1	7-9	8	29	13mm
2	10-15	11	39	
3	16-19	9	32	

The patients were examined individually, and their external and internal overviews were observed through radiological examination (Fig 2). Apart from the routine test of the individual participants, their physical and biochemical parameters were studied during the study.

Discussion

The closed fracture of the tibia shaft is the most common type of fractures among the other fractures [12]. The fractures occurring

5 mm distal to the tibial plateau and 5 mm proximal to the tibial plafond are defined as tibial shaft fractures. These fractures are predominant in males, with an approximate 4:1 male-to-female ratio. The average age of a patient with a tibial fracture was 38 years, with the males with an approximate age of 32 years; in females, it was about 56 years. In 30% of cases, there was a concomitant injury elsewhere on the body. The current study corroborated the previous studies. Ipsilateral fibular fractures were associated with as many as 80% of tibial shaft fractures [13]. In a study where the tibial shaft fractures with concomitant fibula at the proximal or middle third levels were treated conservatively, whereas the fibula fractures in the distal one-third were surgically fixed, it was observed that interlocking nailing of closed tibial shaft fractures were successful in achieving high union and low complication rates [14].

It has been observed that both conservative and surgical treatment of tibial shaft fractures have been associated with complications such as rota- tional deformity, angulation, and ankle malalign- ment [15]. Anatomically, the fibula bears the shear- ing force of 3% and 16% of the axial loads of the leg and has a tension band effect along with the medial bending forces on a fractured tibia [16]. In 1971, Lambert et al. demonstrated the weight- bearing function of the fibula, which endures ap- proximately 1/6 of the load applied to the knee, and this load increases if associated with syndesmosis disruption [17,18].

The fractures of the tibia and fibula should be considered as a single biomechanical and pathological entity and the value of double surgical fixation as a complement to stability and tibial reduction was confirmed by a study by Stoffel et al. 2022 and Filipov et al. 2019 [19, 20]. In a cadaveric study conducted by Kumar et al. [21], in the patients with distal tibial fractures and concurrent fibular fractures, it was found that plate osteosynthesis of the fibular fractures improved rotational stability and may lower the risk of malunion with valgus deformity. However, a previous study revealed that fibula fixation may impede the tibial reduction and results in rigid fixation, raising the incidence of non-union and delayed union [22]. Kruppa et al. [23] also reported an increased incidence of non-unions associated with fibular fixation in distal tibia fractures treated with IMN. In a multicentric study conducted by Attal et al. [24], it was found that in the plate osteosynthesis of the fibula in tibial fractures treated with an IMN, there was an eight-fold increase in the risk of delayed union of the tibia. Moreover, it has been observed that there is more risk of soft tissue injury and malunion owing to improper reduction and fixation during surgical fixation of the fibula.

The fibular fractures may lead to fibular shortening, but in a study performed by Hooper et al. [25], successful results were reported after conservative management of isolated diaphyseal fibular fractures and no information was provided about bone shortening. However, in the current study, the shortening of the fibula was encountered. Some studies have reported that fixing the fibula in patients with distal tibial or fibular fractures increases fracture stability up to week 12 after surgery [26-28]. Biomechanical results have shown that fixing the fibula may help prevent loss of alignment in distal tibial fractures treated with either intramedullary nailing or plate osteosynthesis [29,30].

In the current observation, fibular shortening was expected and a valgus calcaneal deformity was significantly noted after bone healing from the fracture of the tibial shaft. The author meticulously observed the fibular length of the affected limb and compared it with the healthy fibula using the same exposure time, position and distance by full-length radiography. To assess hindfoot deformity clinically, the assessment was done in a standing, weight-bearing position, and a goniometer was used in a method as described by Astrom and Arvidson [6]. A long axial radiographic view on weight-bearing stance determined the radiological assessment of the hindfoot angle.

As the hind foot alignment disorder is dynamic, the patients were evaluated clinically and radiologically in the weight-bearing position.

Conclusion

This study has several limitations. Firstly, this study involved a few number of patients and randomization was not done. Secondly, there may be inter-observer variations. Thirdly, the radiological and functional outcomes were dependent upon the skills of the surgeons and the technical team involved in the study. In this study, by not doing surgical fixation of fibular fractures in the supra syndesmotic region and only fixing the tibial fractures by interlocking nailing, it was observed that there was a significant incidence of fibular shortening and hind foot valgus deformity leading to adverse functional outcomes. The current study suggests that the fibula may be surgically fixed to prevent the fibular shortening, which may prevent hindfoot valgus deformity and attain the optimal functional outcomes. This subject requires more extensive studies to assess the long-term functional outcomes and to formulate a more genuine approach towards this ailment.

Acknowledgment: The study investigator obliged the medical management and other staff who helped to undertake the study smoothly

Reference

1. Praemer A, Furner S, Rice DP. Musculoskeletal conditions in the United States. Park Ridge, IL: American Academy of Orthopaedic Surgeons; 1992.
2. Bone LB, Sucato D, Stegemann PM, et al. Displaced isolated fractures of the tibial shaft treated with either a cast or intramedullary nailing. An outcome analysis of matched pairs of patients. J Bone Joint Surg Am. 1997; 79:1336-1341.
3. Karladani AH, Granhed H, Edshage B, Jerre R, Styf J. Displaced tibial shaft fractures: a prospective randomized study of closed intramedullary nailing versus cast treatment in 53 patients. Acta Orthopaedica Scandinavica. 2000 Jan 1; 71(2):160-7.
4. J. G. Garrick, R. S. Riggins, R. K. Requa, and P. R. Lipscomb, "Fracture of the mid-shaft of the tibia and fibula. A survey of treatment, Clinical Orthopaedics and Related Research, 1972; 88: 131–137.
5. J. F. Keating, R. S. Kuo, and C. M. Court-Brown, "Bifocal fractures of the tibia and fibula. Incidence, classification and treatment, Journal of Bone and Joint Surgery, 1994; 76(3): 395–400, 1994.
6. Weise K, Hermichen H, Weller S. Significance of the fibula in tibial fractures and pseudarthroses. Aktuelle Traumatologie. 1985 Oct 1; 15(5):195-204.
7. Merchant TC, Dietz FR. Long-term follow-up after fractures of the tibial and fibular shafts. JBJS. 1989 Apr 1; 71(4):599-606.
8. Åström M, Arvidson T. Alignment and joint motion in the normal foot. Journal of Orthopaedic & Sports Physical Therapy. 1995 Nov; 22(5):216-22.
9. Lamm BM, Mendicino RW, Catanzariti AR, Hillstrom HJ. Static rearfoot alignment: a comparison of clinical and radiographic measures. Journal of the American Podiatric Medical Association. 2005 Jan 1; 95(1):26-33.
10. Mendicino RW, Catanzariti AR, Reeves CL, King GL. A systematic approach to evaluation of the rearfoot, ankle, and leg in reconstructive surgery. J Am Podiatr Med Assoc. 2005; 95:2–12.
11. Reilingh ML, Beimers L, Tuijthof GJ, Stufkens SA, Maas M, van Dijk CN. Measuring hindfoot alignment radiographically: the long axial view is more reliable than the hindfoot alignment view. Skeletal radiology. 2010 Nov; 39:1103-8.
12. Taki H, Memarzadeh A, Trompeter A, Hull P. Closed fractures of the tibial shaft in adults. Orthopaedics and Trauma. 2017 Apr 1; 31(2):116-24.
13. Jeffrey Anglen MD, FACS. Fractures

in Core Knowledge in Orthopaedics: Trauma, 2008.
14. Yao X, Lv B, Hu M, Yuan J, Fan X, Zhou K, Tang J, Wang L. Classification and treatment strategies of concomitant fibular column injuries in tibial plateau fractures. BioMed Research International. 2021 Sep 7; 2021.
15. Milner SA, Moran CG. (v) The long term complications of tibial shaft fractures. Current Orthopaedics. 2003 Jun 1; 17(3):200-5.
16. Francesco P, Paolo S, Filippo C, Francesco C, Enrico V. When is indicated fibular fixation in extra-articular fractures of the distal tibia? Acta Bio Medica: Atenei Parmensis. 2018; 89(4):558.
17. Lambert KL. The weight-bearing function of the fibula. A strain gauge study. J Bone Joint Surg Am. 1971; 53(3):507–13.
18. Maly MR. Abnormal and cumulative loading in knee osteoarthritis. Current opinion in rheumatology. 2008 Sep 1; 20(5):547-52.
19. Stoffel K, Sommer C, Lee M, Zhu TY, Schwieger K, Finkemeier C. Double fixation for complex distal femoral fractures. EFORT Open Reviews. 2022 Apr 1;7(4):274-86.
20. Filipov OB. Biplane double-supported screw fixation of femoral neck fractures: Surgical technique and surgical notes. The Journal of the American Academy of Orthopaedic Surgeons. 2019 Jun 6; 27(11):e507.
21. Kumar A, Charlebois SJ, Cain EL, et al. Effect of fibular plate fixation on rotational stability of simulated distal tibial fractures treated with intramedullary nailing. J Bone Joint Surg Am 2003; 85: 604-8.
22. Zelle BA, Bhandari M, Espiritu M, et al. Treatment of distaltibia fractures without articular involvement: a systematic review of 1125 fractures. J Orthop Trauma 2006; 20: 76-9.
23. Kruppa CG, Hoffmann MF, Sietsema DL, et al. Outcomes after intramedullary nailing of distal tibial fractures. J OrthopTrauma 2015; 29: e309-e315.
24. Attal R, Hansen M, Kirjavainen M, et al. A multicentre caseseries of tibia fractures treated with the Expert Tibia Nail (ETN). Arch Orthop Trauma Surg 2012; 132: 975-84.
25. G. Hooper, R. A. Buxton, andW. J. Gillespie, “Isolated fracturesof the shaft of the tibia,” Injury, 1981; 12(4):283–287.
26. E. J. Strauss, D. Alfonso, F. J. Kummer, K. A. Egol, and N. C. Tejwani, “The effect of concurrent fibular fracture on the fixationof distal tibia fractures: a laboratory comparison of intramedullary nails with locked plates,” Journal of Orthopaedic Trauma, 2007; 21(3): 172–177.
27. Li C, Li Z, Wang Q, Shi L, Gao F, Sun W. The role of fibular fixation in distal tibia-fibula fractures: a meta-analysis. Advances in Orthopedics. 2021 Feb 25; 2021.
28. E. J. Strauss, D. Alfonso, F. J. Kummer, K. A. Egol, and N. C.Tejwani, The effect of concurrent fibular fracture on the fixationof distal tibia fractures: a laboratory comparison of intramedullarynails with locked plates, Journal of OrthopaedicTrauma, 2007; 21(3): 172–177.
29. Zelle BA, Bhandari M, Espiritu M, et al. Treatment of distaltibia fractures without articular involvement: a systematic review of 1125 fractures. J Orthop Trauma 2006; 20: 76-9.
30. S. A. Stufkens, C. J. van Bergen, L. Blankevoort, C. N. van Dijk, B.Hintermann, and M. Knupp, “The role of the fibula in varuand valgus deformity of the tibia: a biomechanical study,” Journalof Bone and Joint Surgery, 2011; 93(9): 1232–1239.