ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 7, Issue – 2, April – 2022 , Page No. : 331 - 335

Uniplanar vs Biplanar Distal Locking in IntramedullaryNailing of Tibial Shaft Fractures

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Citation this Article: Dr. Vinod Nair, Dr. Swaroop Solunke, Dr. Avinash Kumar, Dr. Rushikesh Abhyankar, "Uniplanar vs Biplanar Distal Locking in IntramedullaryNailing of Tibial Shaft Fractures", IJMSIR- April - 2022, Vol – 7, Issue - 2, P. No. 331 – 335.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: To compare the union times of the uncomplicated tibial shaft fractures, which were distally locked by twocoronal and one sagittal screws and by only two coronal screws.

Methods: 45 patients with tibial shaft treated with intramedullary nailing included in this study. 23 of 45 fractures were treated with uniplanar two distal interlocking (Group 1) and 22 fractures were treated with biplanar three distal interlocking (Group 2). Patients with closed fractures treated by closed nailing and having a full set of radiographs on PACS system was included. Fracture unions were evaluated by two authors.

Results: Union time was significantly shorter in biplanar distal interlocking group (Group 2) compared to uniplanar distal interlocking group (Group 1) (*P=0.02*). Mean union time in groups 1 and 2 were 14.63±4.5 and 10.77±3.0 weeks, respectively. When only distal third tibial shaft fractures were evaluated, Group 2 [11.2±3.1 weeks (n:17)] had significantly lower union time compared to Group 1 [15.07±4.8 weeks (n:14)] (*P=0.01*). Inter-observer reliability for fracture union times was high with rho= 0.89 with SE of 0.51 (*P<0.001*).

Conclusion: Biplanar distal interlocking procedure had a significantly shorter union time. Biplanar distal interlocking procedure allows a faster fracture union probably because of a more stable fixation construct.

Keywords: Distal interlocking screw, Intramedullary nailing, Tibia shaft fracture, Union time

Introduction

Intramedullary nailing is the standard treatment for diaphyseal fractures of the tibia (1). An adequate internal fixation is one of the essential principles for an appropriate fracture healing after surgical treatment of these fractures (2). However, when option the fracture line extends into the metaphysis of tibia, the stability provided by any nail decreases precipitously (3). Nailing was recommended for diaphyseal fractures of the tibia that is >5cm above the ankle joint before introduction of new nail designs which allows biplanar distal interlocking (4). As the new generation nails allow further distal interlocking screws, distal third diaphyseal

fractures treatment with intramedullary nailing is more feasible (5). Although it is well known that one distal locking screw is not sufficient to beware fixation failure, the ideal number and configuration of distal interlocking screws remain controversial (6- 9). Conventionally, medial to lateral interlocking with two screws is commonly preferred due to the ease of application. Two interlocking screws have been reported as being superior to one screw, particularly for the distal third fractures (3). We hypothesized that biplanar interlocking with three interlocking screws provides more rigid fixation that would shorten the fracture healing time of tibia diaphyseal fractures. The aim of the study was to compare the union times of the uncomplicated tibial shaft fractures, which were locked by two coronal and one sagittal screws and by only two coronal screws.

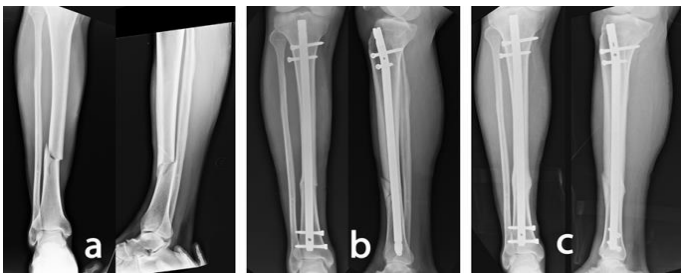

Figure 1: Tibial shaft fracture treated with mono-planar distal locking (2 coronal screws). a) before surgery b) 3 weeks after surgery c) 3 months after surgery.

Materials and Methods

A retrospective study was conducted at Dr D Y Patil Medical College and Hospital in patients who were operated for tibia diaphyseal fractures between 2019 July and 2021 February after the consent of local ethical committee (2021:4689). AO Muller type A or B, isolated and closed low-energy diaphyseal fractures were included in this study. All surgical procedures were performed by the same surgical team; with closed reduction of fracture and reaming the medullary canal. Fractures with residual distraction over 5mm on the fracture site after surgery, patients who had missing set of x-ray over a month between 6th to 20th weeks until the bone healing is completed and patients with complications that may affect fracture union as infection or implant failure were excluded from the study. Totally 45 patients (19 female, 26 male) were included and evaluated for; age, sex, fracture localization, fracture type, distal interlocking screw configurations, and fracture union time. Fractures involving 1/3 distal part of the tibial shaft were considered as ‘distal third fractures’ in the study. Entire of the nails were locked by biplanar proximal oblique locking. 23 of 45 fractures were treated with uniplanar two distal interlocking (Group 1) [Figure 1] and 22 fractures were treated with biplanar three distal interlocking (Group 2) [Figure 2].

Demographic characteristics of the patients are demonstrated on Table 1. Radiographs were imported from the PACS (Picture Archiving Communication Systems) of the institute. Two groups were compared due to fracture union time by assessing all follow up radiographs of the patients. Fracture unions were evaluated by two authors. The time for union was defined when there was bridging callus between the main fragments on at least three cortices on A-P and lateral X-rays, which was obviously denser than the opacity of the medullar canal of the intact bone. First generation cephalosphorine (cefazolin) was used for systemic antibiotic prophylaxis before surgery for all patients. No tourniquet was used during surgeries. Ankle and knee exercises were started postoperatively and partial weight bearing with crutches was allowed after first day of the operation for all patients. All patients received low molecular weight heparin for deep-vein thrombosis prophylaxis throughout two weeks after discharge. No routine nsaid were prescribed for pain control. Reliability

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between authors was tested with the correlation index between the groups. Variety of the groups was evaluated with Mann Whitney U test. Differences between the groups were evaluated with Mann Whitney U and Pearson's chi-squared tests. A P value <0.05 was accepted as significant.

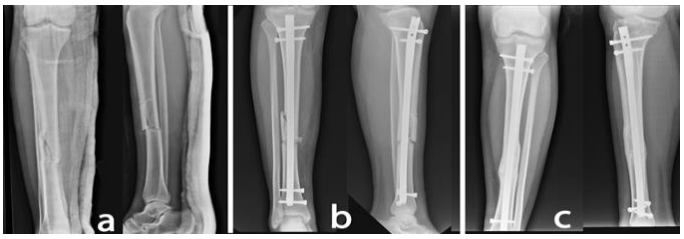

Figure 2. Tibial shaft fracture treated with bi-planar distal locking (2 coronal and 1 sagittal screws). a) before surgery b) 3 weeks after surgery c) 3 months after surgery.

Table 1: Demographic variables of the groups

	Group 1	Group 2	P value
Age	40.65 ±14.3	40.05 ±13.1	0.88
ender Women Men	9 (%39.1) 14 (%60.9)	10 (%45.5) 12 (%54.5)	0.76
Fracture Type	%74 Group A	%82 Group A	0,2
Distal Third Fractures	14	17	0,01

Results

Mean age were 40.65 ±14.3 and 40.05 ±13.1 in groups 1 and 2, respectively (P=0.88). According to AO Muller fracture classification, 17 of 23 (74%) patients in group 1, and 18 of 22 (82%) patients in group 2 had type A fractures and the rest of them were type B fractures. There was no difference between the groups with regard to fracture types (P=0.2). 9 of 23 patients in group 1 and 10 of 22 patients in group 2 were female. No difference about sex distribution was observed between groups (P=0.76). All patients had tibial shaft fractures; 14 of 23 patients in group 1 and 17 of 22 patients in group 2 had distal third tibial shaft fractures (P=0.01) [Table 1]. Union time was significantly shorter in biplanar distal interlocking group (group 2) compared to uniplanar distal interlocking group (P=0.002). Mean union time in group 1 was 14.63 ±4.5 weeks and in group 2 10.77 ±3.0 weeks [Table 2]. When only distal third fractures were considered, group 2 [11.2 ±3.1 weeks (n:17)] had significantly lower union time compared to group 1 [15.07 ±4.8 weeks (n:14)] (P=0.01) [Table 2]. İnter-observer reliability for fracture union times was high with rho= 0.89 with SE of 0.51 (P<0.001).

Table 2: Comparison of the healing time of the groups due to fracture localization

		Group 1		Group 2	
					P value
	n	Union Time (weeks)	n	Union Time (weeks)	
Entire Group	23	14.63±4.5	22	10.77±3.0	0.002
Distal Third Fractures	14	15.07±4.8	17	11.26±3.1	0.01

Discussion

Most important finding of the current study was the faster healing in the fractures which were distally locked in two planes by three screws. İt seems like two distal locking at the same plane, reinforced with another locking screw perpendicular to their axis would resist any motion much firmly than one sagittal and coronal or two coronal screws. The results of this study contradicts to Ramos et al who reported that two distal bolt screws rather than three had a shorter consolidation time by unreamed nailing (9).

However, for a better stability, we used reaming method for better fit of a larger nail to the medullary canal. The contrast results of these two studies might be a result of

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the distinct principals of reamed and unreamed nailing. Fractures occurring in the distal part of the tibial shaft are twice as likely to proceed to delayed healing or nonunion compared with other shaft fractures (10). Although distal tibial metaphyseal fractures usually unite shorter than diaphyseal ones with conservative treatment, distal third tibia fractures are prone to slow healing or nonunion, compared to diaphyseal fractures after intramedullary fixation (4, 10-13). This circumstance is due to the decreasing stability of the intramedullary fixation construct by enlargement of the medullary canal. Even group 2 had more distal third fractures compared to group 1 and expected to take longer time to unite, shorter union times were achieved in group 2 due to the increased stability of the construct by biplanar distal interlocking with two coronal and one sagittal screws. Adding only one sagittal screw to routine two screws used in coronal plane will provide promising clinical outcomes for especially distal third tibial fractures by shorter union times. Thus; we suggest using routine three interlocking screws in biplanar fashion for intramedullary nailing of distal third tibial fractures. Limitations of the study were; the relatively small sample size. Because of the exact criteria for including patients in the study we were able to assess limited number of patients. More powerful results can be obtained with further studies including more patients. Another limitation of the study was absence of clinical examinations of patients for assessment of fracture union. Also, the assessment of the true healing time of any fracture is hard to decide in practice, although our inter-observer reliability was very high. Future studies should also include clinical application of angle-stable locking systems, which have promising mechanical outcomes (14, 15).

İn conclusion, due to the results of this study, biplanar distal interlocking procedure had a significantly shorter union time. Biplanar distal interlocking procedure allows a faster fracture union probably because of a more stable fixation construct.

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