Comparison of Distal Uniplanar Locking with Biplanar Distal Locking in Intramedullary Interlocking Nailing of Fractures Distal Shaft of Tibia

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ABSTRACT

Objective: To study the effects of distal uniplanar locking and distal bi planar locking on union times in uncomplicated fractures distal shaft of tibia managed with an intramedullary interlocking nail.

Study Design: Comparative prospective study.

Place and Duration of Study: Department of Orthopedics and Trauma Combined Military Hospital Rawalpindi from Jan to Nov 2020.

Methodology: Fifty-three patients having fractures distal shaft of tibia managed with intramedullary interlocking nail were studied. Twenty-nine patients were managed using two interlocking screws distally (uniplanar) in coronal plane (group-1). Twenty-four patients were managed with three bi planar screws comprising two coronal and one sagittal distal interlocking screw (group-2). Patients were followed every 4 weeks, and bone union time was assessed. Isolated closed fractures treated with closed reduction were included.

Results: Patients treated with distal bi planar locking (group-2) had significantly reduced union time in weeks (11.25 ± 1.42) compared to uniplanar distal interlocking (group-1) (15.79 ± 1.80) (p<.001).

Conclusion: Union time for distal tibia shaft fractures is significantly reduced when treated with distal biplanar locking; it can be attributed to increased stability of the construct.

Keywords: Distal shaft of tibia fractures, Distal interlocking screws, Intramedullary interlocking nailing, Union time.

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INTRODUCTION

Fractures shaft of the tibia are the commonest fractures involving long bones, with an incidence of 17 per 10,000 persons annually; however, as developing countries are becoming more motorised, this number is decreasing.[1,2] High-energy trauma usually causes fractures and the distal shaft of the tibia. Complications include deep infections, non-united fractures, malunited fractures, and compartment syndrome. This results in pain and disability for a prolonged period, and substantial health care resources are consumed addressing these complications.[3,4]

Current surgical options for treating dia physeal fractures are external fixators, locking compression plates, or intramedullary interlocking nails. Survey data suggests that about 90% of surgeons dealing with trauma prioritise intramedullary interlocking nailing.[5,6]

One of the most essential principles for optimum fracture healing is stable internal fixation after surgical intervention of distal or proximal shaft of tibia fractures. Conventional intramedullary nails do not offer optimal stabilisation in segmental tibia fractures and proximal and distal tibia fractures with a short metaphyseal fracture fragment.[7] New intramedullary interlocking nail designs, such as expert tibia nail systems, provide better 3-Dimensional (3-D) proximal and distal locking configurations.

This improved 3-D configura-tion provides better stability to the proximal and distal shaft and metaphyseal fractures, effectively reducing fragment motion by multiplanar screw locking.[8] This also maintains axial alignment more efficiently as the nail cortex interface in these proximal or distal frac-tures is not strong enough. The conventional intrame-dullary nailing does not provide adequate stabilisation of proximal and distal shaft fractures with short fragments. New nail designs with 3-dimensional loc-king options provide better stability.[4] Additional distal bicortical locking screw creates distal three points of locking, thus, enhancing construct stability and reducing interfragmentary motion compared to,[2] interlocking distal screws in one place.[9] This biplanar three screw construct provides enhanced stability than the uniplanar two screw construct, which is expected to shorten the union time of the distal shaft of tibia

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fractures.[10]

Therefore, it is hypothesised that biplanar distal interlocking using three interlocking screws provides a more stable construct, and the early union is achieved in distal diaphyseal tibia fractures. The current study was planned to compare union times in patients managed with uniplanar distal locking to patients managed with biplanar distal locking using a reamed intramedullary interlocking nail for fractures distal shaft of the tibia.

METHODOLOGY

A prospective comparative study was conducted at the Department of Orthopaedics & Trauma Combined Military hospital Rawalpindi from Jan 2020 to Nov 2020 in patients operated with reamed intramedullary interlocking nailing for distal diaphyseal fractures of the tibia after consent from local ethical committee [121/11/2020]. The sample size was calculated using openEpi calculator, confidence interval 95% and power of test 80%, anticipated mean union time in weeks in group 1 WAS 15.07 ± 4.8 whereas, in group 2, was 11.26 ± 3.1 .[11] Consecutive non-probability sampling was done. A total of 53 patients were included in the study.

Inclusion Criteria: Patients of 19 to 59 years of age with closed and isolated fractures classified as 42 (distal 3rd of shaft of the tibia) and 43A2/43A3 (5 cm proximal to tibia plafond) as per the AO/OTA coding system were included in the study. All the fractures were reduced indirectly without opening the fracture site, and reaming of the intramedullary canal was done in all the patients.

Exclusion Criteria: Patients who failed to follow-up for more than four weeks between 6th to 16th weeks of surgery, and complicated cases by factors that affect union such as infections were not included in the study.

Patients were evaluated for age, sex, distal interlocking screw configuration and union time. All the Fractures were distracted over 5mm after fixation. All the nails were locked proximally with two oblique (biplanar) screws. 29 out of 53 nails were locked distally by two uniplanar screws in the coronal plane (Figure-1). 24 out of 53 nails were locked distally by three biplanar screws, two-coronal and one sagittal screw (Figure-2). The procedure was performed under an image intensifier. Tourniquet was not used during the procedure. Third generation Cephalosporin Cefoperazone in combination with Sulbactam intrave-nous was used as antibiotics for prophylaxis before and three doses after surgery in all patients as per hospital protocols. Knee and ankle ROM exercises and toe touching/partial weight-bearing with crutches was started in all patients from the first post-op day. 1250mg Calcium Carbonate and 125 IU of Vit D (Qalsan-D) daily were advised for all patients for 30 days. Routine NSAIDs were not prescribed for pain management. Digital radiographs immediately after surgery and on scheduled follow up visits were done at the hospital Radiology Department.

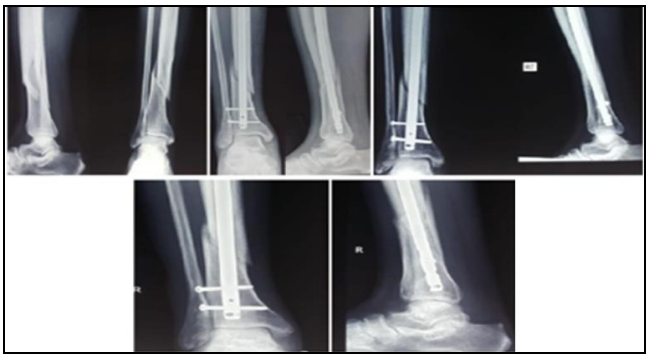

Figure-1: Uniplanar distal locking at 6, 10 and 16 weeks.

Figure-2: Biplanar distal locking at 6 and 12 weeks.

The two groups were compared for union time clinically and by reviewing serial radiographs. Union time is described when there is callus bridging (denser than the medullary canal's opacity) at least three cortices across fracture between main fragments on AP and lateral radiographs.[12] Clinically, the union was assessed by pain-free full weight-bearing without support.

Statistical Package for Social Sciences (SPSS) version 23.0 was used for the data analysis. Quantitative variables were summarized as Mean ± SD and qualitative variables were summarized as frequency and percentages. Independent sample t-test was applied to find the mean differences among the groups. The *p*-value of ≤0.05 was considered statistically significant.

RESULTS

The study comprised 53 patients, out of whom 48 (90%) were males and 5 (10%) were female patients. Their mean age was 37.96 ± 11.51 years and the mean time for a union was 13.73 ± 2.80 weeks. Independent sample *t-test* was carried out to see gender differences. Results indicated a non-significant mean difference in the gender groups with regard to union time (p=0.658) (Table-I).

Table-I : Gender differences on union time.

Gender	Male (n=48)	Female (n=5)	*p*-value
Union Time in Weeks	13.79 ± 2.89	13.2 ± 1.78	0.658

Table-II: Differences between treatment groups on union time.

Parameter	Group 1 (n=29) Uniplanar distal locking	Group 2 (n=24) Biplanar distal locking	*p*-value
Union time in weeks	15.79 ± 1.80	11.25 ± 1.42	<0.001

However, the independent sample *t-test* on treatment groups indeed suggested significant mean differences between these groups. Most importantly, union time was shorter significantly (p<0.001) in the group with biplanar interlocking at the distal end (11.25 ± 1.42) compared to the uniplanar distal interlocking group (15.79 ± 1.80) (Table-II).

DISCUSSION

This study revealed that the distal shaft of tibia fractures managed with intramedullary interlocking reamed nail have a shorter time to the union when distally locked with bi planar three locking screws. This provides additional biomechanical stability than conventional uniplanar distal locking with two screws, thus resulting in an early union. Fixing fractures involving distal tibia diaphysis and metaphysis should be stable with careful surgical dissection and implant selection to minimize soft tissue damage. Fractures of the distal shaft of the tibia have a high incidence of mal-alignment, non-union, delayed union and high rates of reoperations.[5] Improved intramedullary nail designs offering enhanced stability and minimal invasive plate osteosynthesis (MIPO) using locking compression plates help avoid the associated complications.[10,11]

The present study results were similar to Alemdaroğlu *et al*, (2019). They reported that union time is significantly reduced by locking the distal end with three biplanar screws. According to them, this provides a more stable construct that helps fractures unite faster. They studied diaphyseal fractures in general. When only fractures of the distal shaft of the tibia were considered, the time to union was significantly shorter (p=*0.01*).[9] Results contradict a study by Ramos *et al*, (2012) that revealed there is no difference between two or three distal locking screws constructed in treating distal tibia fractures using unreamed intramedullary nailing.[12] Contradiction may be due to the difference of implants, undreamed and reamed intramedullary nails.

Intramedullary interlocking nailing for a shaft of tibia fractures is the preferred management method, but when considering fractures distal shaft of the tibia, its role is not well defined. Most surgeons are well familiar with intramedullary fixation devices. Extensive soft tissue dissection is avoided, extra osseous blood supply is preserved, and its ability to share load allows early weight-bearing. Avilucea *et al*, concluded that ORIF results in an increased rate of non-union and significantly increased chances of developing a complication compared with intrame-dullary nailing for treating open fractures of the distal tibia.[13] Diver-sity of fractures that can be managed with intrame-dullary interlocking nails has increased significantly because of newer nail designs. Intramedullary inter-locking nails acceptance for treatment in a distal shaft of tibia fractures was slow due to concerns like reduction difficulties, fracture propagation distally and less stable fixation resulting in mal-alignment.[14]

Gorczyca *et al,* demonstrated that by removing 1 cm of nail tip distally, screws for distal locking could be placed more distally even in fractures as close as 5 cm to the ankle joint. This modification provides enough strength to fixation comparable to intramedullary nailing of tibia shaft of tibia fractures. Although fixation was strong enough, it could not resist strong compression and bending forces, so patients were strictly advised to avoid weight-bearing until some bone union occurs.[15]

Signifying no distal screws in tibia diaphyseal fractures Kneif *et al,* reported failure of the intramedullary nail with a single distal locking screw is significantly high (59%) compared to intramedullary nail with two distal locking screws (5%).[16] Further validating number of screws, stability of construct and its effect on union Mohammed *et al,* compared union in patients with fractures involving distal shaft of tibia managed with interlocking intramedullary nails with a single distal locking screw to patients with two locking distal screws. Sixty-five patients treated with intramedullary interlocking nailing were assessed retrospec-

tively. They concluded that the non-union rate was significantly higher in patients managed with one distal locking screw (80% of non-unions) compared to patients managed using two locking distal screws (20% of non-unions). It was significant statistically (p<0.01). This concluded that intramed-ullary interlocking screwin fractures involving the distal shaft of the tibia should preferably be locked using a minimum of two distal locking screws.[17]

With the advancement in nail designs, expert tibia nails were introduced. These nails have options for multi planar distal locking screws with distal locking options even at the nail tip. It provides enhanced angular stability. Fractures of the distal shaft of the tibia are vulnerable to non-union when treated with a conventional intramedullary interlocking nail. Isik *et al,* demonstrated the efficacy of tibia expert nails in treating distal tibia shaft fractures. Union of fracture was achieved within six months in 90 % of patients and one year in the rest of the patients.[4] Wähnert *et al*, concluded angle-stable locking system (ASLS) provides a significantly higher primary stability to intramedullary locking nails compared to conventional distal interlocking in a single plane. This prevents loss of reduction and incidence of mal-union and non-union.[18] These studies signify that the number and angulation of distal screws increase fracture stability and load-bearing capacity of intramedullary nail construct, thus encouraging union.

Our study concludes biplanar distal loc-king in the intramedullary interlocking nail with two coronal and one sagittal screw involving distal diaphyseal and metaphyseal fracture of the tibia enhances the stability of the construct and reduces union time significantly.

CONCLUSION

Union time for distal tibia shaft fractures is significantly reduced when treated with distal bi planar locking; it can be attributed to increased stability of the construct.

Conflict of Interest: None.

Authors' Contribution

RSA: Conception, data collection, literature search, article drafting, MSA: Article drafting, proof reading, MOR: Data collection, article drafting, proof reading, BH: Data entry and analysis, article drafting, JI: Literature search, article drafting, data entry, AQ: Data collection literature search.

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