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Original Article

Comparison of the Outcome of Intramedullary Nailing Versus External Fixator Fracture Repair in Gustilo Type IIIA Tibio Fibular Fracture

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ABSTRACT

Objective: To compare the outcome of intramedullary nailing versus external fixator fracture repair in patients presenting with Gustilo Type IIIA tibiofibular fracture.

Study Design: Cross-sectional study.

Place and Duration of Study: Department of Orthopaedics, Jinnah Postgraduate Medical Center, Karachi Pakistan, from Feb to Nov 2020.

Methodology: A total of 200 patients were included. Patients were divided into two Groups. In Group-1, intramedullary nailing was done. In Group-2, uniplanar external fixation was done. Both Groups were followed up for six months for assessment of bone union.

Results: The mean age in the Intramedullary Nailing (IMN) Group was 39.21+6.24 years and in the External Fixator (EF) Group mean age was 37.48+8.41 years. In our study, it was found that 81(81%) patients in the EF-Group showed bone union, while 92 patients in the IMN-Group showed bone union. Malunion occurred in 10 in the EF-Group, while only six in the IMN Group. Non-union of bone was unfavourable in the 18 patients of EF- Group and 7 in the IMN-Group. The infection rate was also higher (16%) in patients treated with EF. We noted a significant association between union, non-union, infection and mode of treatment with the *p*-value of 0.023, 0.019 and 0.046, respectively.

Conclusion: Bone union outcome of Gustilo IIIA open tibial shaft fractures appear superior when treated by Intramedullary Nailing technique compared to External Fixation.

Keywords: Gustilo Type IIIA Fracture, Tibial Shaft, Intramedullary Nail, External Fixator, Bone union.

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INTRODUCTION

Long bone fractures are very common, with an annual global incidence of 11.5 per 100,000. Tibial fractures frequently occur because of the subcutaneous anterior-medial surface of the shaft, accounting for about 40% of all long bone fractures.[1] The incidence of tibial shaft fractures in Pakistan has been reported to be 44%, with a maximum number of cases occurring between the ages of 20-40 years.[2] The overall rate of such fractures is increasing because of rising road traffic accidents and firearm injuries.[3] 25% of tibial fractures are open fractures. The importance of soft tissue coverage in the outcome and prognosis of open tibial fractures was first described by Gustilo.[4] Imperfect or delayed union of fractured bone leads to severe, prolonged mental and physical stress to the patient.[5] Therefore, it is imperative to avoid these complications to decrease the morbidities associated with the delayed union of the fractured bone.

Open fractures of long bones require emergency treatment that involves wound debridement, repair of soft tissue injuries (muscles and tendons), fracture reduction and stabilization using external or internal fixation.[6] A higher rate of various potential complications are seen with high energy trauma, greater soft tissue disruption, bad wound contamination, altered vascular structures and unstable fractures.[7] Until now, no universal consensus has been developed for the appropriate management of open tibial fractures. Strategies like prophylactic antibiotics, tetanus toxoid, immediate soft tissue debridement and reconstruction, skeletal stabilization, prophylactic bone grafting and adjuvant treatment with rhBMP-2 have been developed to minimize complications.[8] However, Intramedullary nailing (IMN) or External Fixation (EF) of the tibia after surgical debridement are the two most common modalities for treating open tibial fractures. The final goal is to achieve fast bone union without infection, pain or movement restriction. Sinha *et al.* compared the bone union in patients presenting with

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tibia fibula fracture treated using intramedullary nailing versus external fixator fracture repair and found the prevalence of bone union to be 63.6 % vs 52%, respectively.[9]

Although several randomized controlled trials (RCTs) have been published comparing the outcome among patients undergoing intramedullary nailing versus external fixator fracture repair for tibial fracture, no study has compared Gustilo Type IIIA tibiofibular fracture both locally and internationally. Moreover, treating open tibial fractures is difficult, with no consensus on management. Therefore it provides a strong rationale for the study as our primary aim is to simultaneously compare both Groups to identify the best possible treatment for reducing morbidity and suffering of patients (psychological and financial) with a tibiofibular fracture in our population after that improving their quality of life.

METHODOLOGY

This cross-sectional study was conducted from February 2020 to November 2020 at the Department of Orthopaedics, Jinnah Postgraduate Medical Centre, Karachi Pakistan. All the patients were followed up for six months to assess bone union after the surgery. All the study protocols and purpose were explained to the patient informed consent was taken from each participant.

We study included 200 patients in this study. The sample size was calculated using the WHO sample size calculator where alpha=5%, power of the test=80, anticipated population proportion Intramedullary Nailing A=4% and anticipated population proportion External Fixator B=32%.[10] Patients were selected using a non-probability, consecutive sampling technique.

Inclusion Criteria: Patients of both genders, aged between 20-60 years who presented with Gustilo Type IIIA tibiofibular fracture (fractures having extensive laceration of soft tissue, usually larger than 10 cm, with periosteal coverage and adequate soft tissue coverage) were included in the study.

Exclusion Criteria: Patients with a history of osteoporosis, osteomalacia, malignancy and pregnancy confirmed by dating scan were excluded from the study.

The study population was divided into two equal Groups of 100 participants. One Group was called "Group-IMN", and the other was called "Group-EF". A brief history of demographic information and written informed consent in the local language (Urdu) were taken from each patient. Patients were randomly allocated using a sealed opaque envelope bearing IMN= Intramedullary nailing and EF=External fixator. All cases were operated in either Group by a surgeon with over ten years of experience and the researcher. All patients were managed according to a standard protocol. In the emergency department, patients were given a stat dose of tetanus toxoid and a first-generation cephalosporin. Wounds were cleaned and dressed, and the limb was splinted prior to urgent surgical debridement. Debridement was continued until all the devitalized tissue was removed layer by layer to the depth of the wound while respecting the integrity of important structures such as blood vessels, nerves, and tendons. All foreign material was removed either by washing or by excision of the tissue. After debridement, the wound was covered with a sterile dressing soaked with normal saline and applied pressure bandages. The fracture was splinted by a temporary POP back slab with the achievement of reduction as much as possible, and planning was done for the operation. Group-EF patients were treated with uniplanar external fixators with four half-paints inserted by stab method drilling and manual insertion of Shanz screws (AO External fixator). In Group-IMN, intramedullary nailing was done within six hours. Patients were advised to remain on partial weight bearing for the first six weeks, irrespective of their fracture configuration. Home exercises were taught to all the patients. The patients were assessed for bone union clinically and radiographically in the sixth month. Bone union was defined as the ability to fully weight bearing in the absence of pain at the fracture site and the presence of bridging callus in a minimum of three cortices (RUST score > 4) on orthogonal views at the fracture site.[11]

Statistical Package for Social Sciences (SPSS) version 20.0 was used for the data analysis. Mean and standard deviation were calculated for the quantitative variables like age, length of hospital stay, duration of injury and surgery. Frequencies and percentages were calculated for the qualitative variables like gender, diabetes mellitus type 2, hypertension, smoking status and outcome (Bone union (Yes/No). The chi-square test was applied. The *p*-value of ≤ 0.05 was considered significant.

RESULTS

A total of 200 patients were included in this study. Out of 100 patients in the intramedullary (IMN) Group mean age was 39.21+6.24 years (Range 20-60

years). At the same time, the mean duration of surgery, duration of injury and length of hospital stay was 3.54+2.78 hours, 28.47+9.67 hours and 12.30+2.54 days, respectively. Similarly, the mean age of 100 patients in the external fixator (EF) Group was 37.48+8.41 years. Whereas mean duration of surgery, duration of injury and length of hospital stay in our study was 3.97+1.56 hours, 32.22+2.54 hours and 13+1.89 days, respectively.

In our study, it was found that 81 patients in the EF Group showed bone union, while 92 patients in the IMN Group showed bone union. Malunion occurred in 10 in the EF Group, while only 6 in the IMN Group. Non-union of bone was unfavourable in 18 EF Group patients and seven patients treated with IMN. The infection rate was also higher, (16) in patients treated with EF (Upon further statistical analysis, we noted a significant association between union, non-union, infection and mode of treatment used with *p*-value 0.023, 0.019 and 0.046, respectively. However, malunion had no statistically significant association with the mode of treatment *p*-value of 0.297 (Table-I).

Table-I: Association of Form of Treatment with Favorable or Non-Favorable Outcomes (n=200)

Outcomes	Form of Treatment, Frequency		*p*-value
	External Fixation (EF) (n=100)	Intramedullary Nailing (IMN) (n=100)	
Union			
No	19	8	0.023
Yes	81	92	
Malunion			
No	90	94	0.297
Yes	10	6	
Non-Union			
No	82	93	0.019
Yes	18	7	
Infection			
No	84	9	0.046
Yes	16	7	

With respect to favourable outcomes (bone union) and other unfavourable outcomes (malunion/non-union/infection) showed that 105 (94.6%) and 68 (76.4%) had a bone union in the age Group 20-40 years and 41-60, respectively. Duration of surgery and hypertension with respect to bone union and other unfavourable outcomes (malunion/non-union/ infection) showed no significant association *p*-value was 0.178, 0.708 and 0.109, respectively. For diabetes, our study showed that 21(75%) who were diabetic had unfavourable outcomes (malunion/non-union/ infection), while 7(25%) of people with diabetes had a complete bone union. People who were smokers also had more adverse outcomes (malunion/non-union/ infection), while only 7(25.0%) of smokers had a complete bone union (<0.001) (Table-II).

Table-II: Association of age, gender, diabetes mellitus, hypertension and smoking with favorable and non-favorable outcomes (n=200)

Variables	Outcomes, Frequency (%)		*p*-value
	Malunion/Non-Union/Infection	Union	
Age(Years)			
20-40	6 (5.4)	105 (94.6)	<0.001
41-60	21 (23.6)	68 (76.4)	
Gender			
Female	8 (9.6)	75(90.4)	0.178
Male	19 (16.2)	98 (83.8)	
Surgery Duration			
≤4 Hours	14 (14.4)	83 (85.6)	0.708
>4 Hours	13 (12.6)	90 (87.4)	
Diabetes Mellitus			
No	6 (3.5)	166 (96.5)	<0.001
Yes	21 (75.0)	7 (25.0)	
Hypertension			
No	19 (11.7)	114 (88.3)	0.109
Yes	8 (21.6)	29 (78.4)	
Smoking			
No	6 (3.5)	166 (96.5)	<0.001
Yes	21 (75.0)	7 (25.0)	

DISCUSSION

A wide variety of surgical and non-surgical treatment options like plaster cast immobilization, plating, external fixators and intramedullary interlocking nail are available for diaphyseal fractures of the tibia.[11] Plaster cast has been the most common method of treatment, but the success of this treatment depends heavily on pattern, morphology and type of fracture. It is also associated with crutches, non-weight bearing for six to twelve weeks, malunion, and poor patient compliance.[12] Fixation with a dynamic compression plate requires long immobilization after fixation and is more soft tissue damage which may lead to higher rates of infection at the fracture site.[13] External fixators (EF) used to treat tibial fractures have been associated with complications like reduction in bone size, mal-alignment and delayed bone healing.[14] Intramedullary nail (IMN), on the other hand, does not cause much damage to soft tissue around the fracture site, early patient mobilization and also promotes better bone union.[15-16]

Out of 100 patients in the EF-Group, 81% showed bone union, while patients treated using IMN showed

a better rate of the bone union at 92%. Similar findings have been reported by Sinha *et al*.[9] Higher incidence of 18% of non-union was noted in the EF-Group, while only 7% of cases in the IMN-Group had non-union after the procedure (*p*-value=0.019). These findings could be attributed to less muscular and vascular damage caused during IMN. The better blood supply in the recovery period led to better bone union and a lower rate of non-union at the fracture site when IMN was used as a mode of treatment. However, Mohseni *et al*. found no significant difference with regard to the non-union of the fractured tibia when comparing the two modalities of treatment.[5] In the current study significant association was found between the rate of infection and the form of treatment used (*p*-value 0.046). Since the duration of surgery and total length of hospital stay is longer in the EF-Group, the chances of infection at the surgical site were also increased. Our findings are similar to another study done by Tornetta *et al*. included 29 patients with open tibial fracture 14 were treated with IMN and 15 with EF; of those treated with IMN, 3 had the infection, and among those managed by EF, there were 6 cases of infection.[17] On the other hand, Tu *et al*.[18] reported a lower infection rate in the EF-Group. When we analyzed the outcome in terms of malunion in the two Groups, no significant association was found in our study (*p*-value 0.297).

It was noted that older people had a significantly higher rate of unfavourable outcomes (malunion/non-union/infection) *p*-value <0.001. This could be due to slower osteoblastic activity at an advanced age. Another study with similar results to the current study was by Dailey *et al*.[19] In the current study, no statistically significant association was found between treatment outcomes and gender, duration of surgery and hypertension in the patients. Both genders showed high bone union rates irrespective of the treatment used. However, patients who were smokers or had diabetes were more likely to suffer unfavourable outcomes (malunion/non-union/infection) *p*-value <0.001. Smoking has been identified to harm bone healing after trauma or surgery. Smokers may need up to two more months for proper healing of tibial fractures.[20-21] Other researchers have also recognized diabetes as a major risk factor for bone fractures and delayed healing after fracture repair surgeries because diabetes leads to increased osteoclasts, osteoblast apoptosis, reduced numbers of osteoblasts, reduced bone formation and they have also been found to have difficulty in decreasing the inflammatory response once it has begun.[22-23] So rigorous post-operative care, better wound cleaning, and appropriate antibiotic cover must be offered to older aged patients, diabetics and smokers to achieve the best results after repair surgery of tibial fracture.

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CONCLUSION

Bone union outcome of Gustilo IIIA open tibia shaft fracture appears to be superior when treated by the intramedullary nail compared to external fixation. Advantages of the IMN include a higher rate of bone union and lower rates of infection and non-union. It may be more acceptable to patients than external fixators, and wound management is better and easier. Primary nailing provides early stabilization of fractures and helps early tissue healing and rehabilitation. Although the current study shows IMN as the better option, each department should analyze its outcomes to see whether its data align with these findings.

Conflict of Interest: None.

Author's Contribution:

PA:, FJ: Substantial contributions to the conception, Drafting, Final approval, MH:, DM:, EM, REK: Study design, Data analysis, Final approval, MS:, SK:, MB, KM: Conception, Data analysis, Final approval.

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