ORIGINAL ARTICLE

Effects of Dynamization on Delayed Union of Tibial Shaft Fractures After Reamed Intramedullary Interlocked Nailing

Pervez Ali[1], Dost Mohammad[1], Mian Sajjad[1], Muzafar Hussain[1], Fahad Jatoi[1], Ejaz Matlo[1], and Riaz Elahi Khoso[1]

ABSTRACT

Objective: To determine the efficacy of dynamization in delayed union of tibia diaphyseal fractures
Methodology: A descriptive cross sectional study was done at the Department of Orthopaedic Surgery, Jinnah Postgraduate Medical Center, Karachi, Pakistan, from July 2020 to April 2021. A total of 97 consenting patients who suffered from delayed union following intramedullary interlocking nailing were included in the study. Dynamization involved removal of proximal or distal locking screws in statically locked intramedullary nail. Patients were followed up for six months to check for delayed bone union. All the collected data were entered into a pro forma and used electronically for research purpose.
Results: Over all union was achieved in 72 (74.2%) cases after dynamization. The mean age of our study population was 39.42+13.79 years. Advanced age, smoking, fresh or old fracture, the time of initial intramedullary nailing, and diabetes were associated with decreased efficacy of dynamization, with p-value <0.001, 0.033, 0.007, and <0.001 respectively. While no significant association was found between gender, BMI, hypertension, and union (p-value >0.05).
Conclusion: The findings of this study support the idea that dynamization can be an effective method to promote healing in tibia diaphyseal fractures for delayed union. More randomized comparative clinical trials are necessary to evaluate the effectiveness of dynamization.

Key Words: Delayed Union, Dynamization, Efficacy, Tibia Diaphyseal Fractures

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INTRODUCTION

Tibial shaft fractures are one of the commonest fractures that an orthopedic surgeon sees in his day to day practice. There are several ways to deal with it. Since the introduction of reamed intramedullary nails, they have become the mainstay of treatment for such fractures, because of quick healing, and reduced complications.[1-3] However, complications like delayed union and nonunion have also been reported following insertion of reamed intramedullary nails[4]. Because of these complications, patient may suffer from residual pain, impaired daily functionality and about 12-60% cases may finally need reoperation for correction of delayed union or non union[4].

1 Department of Orthopaedic Surgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan

Correspondence: Dr. Pervez Ali, Assistant Professor, Department of Orthopaedic Surgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan

Email: pervez73@hotmail.com

The definitions of delayed union and non union are related to the time bone healing takes following the fracture. If there is sluggish or no callus formation and signs of bone healing are absent even after 3 to 6 months of fracture, then it is called delayed healing[5]. The main reasons for delayed union are reduced blood supply, instability, and infections[6]. This delayed union may require exchange nailing, compression plating with bone grafting, distraction osteogenesis and vascularized fibular transfers to promote union in such fractures[7].

Two of the most common secondary surgical techniques for treatment of delayed union are dynamization and exchange nailing. Exchange nailing consists of the removal of the existing IM nail, debridement of the medullary cavity, followed by insertion of new larger IM nail. This procedure helps to stimulate bone growth and healing[8]. On the other hand, dynamization involves conversion of a static nail into a dynamic nail. The surgeon removes proximal or distal locking screws in a statically locked IM nail allowing weight bearing in order to promote osseous growth at the site of fracture[9].

Currently, no research data is available in the region to assess the effects of dynamization on delayed union of tibia fracture. Our study aimed to generate local data on effects of dynamization on healing in tibia fractures and various factors associated with the success of the procedure in our Pakistani population. Our study generated data on benefits of dynamization on healing of delayed union of tibia fractures, keeping in view its simplicity, cost effectiveness, decreased morbidity, and excellent healing rates.

METHODOLOGY

This cross sectional study was done at the Department of Orthopaedics, JPMC, from July 2020 to April 2021. The Institutional Review Board of JPMC approved this study by certifying it with IRB certificate No. F.2-81/2021-GENL/64328/JPMC. And patients were followed up for nine months for assessing the efficacy of dynamization procedure. The study procedure and purpose was explained and informed consent was taken from each participant.

Our study included 97 patients. Sample size was calculated on the WHO sample size calculator with the following assumptions: efficacy of dynamization =50%[5], confidence interval=95%, margin of error=10% (because the patient sample size was small). Patients were selected using non-probability, consecutive sampling technique.

Patients of both genders, with ages between 20-60 years who presented with tibial fracture that did not heal within six months after reamed intramedullary interlocked nail, along with persistent pain, tenderness, and inability to bear full weight were included in the study. Patients with associated tibial plateau fracture, vitamin D Deficiency, arthritis, and unwillingness to participate were excluded from the study.

Pre-operative assessment in the form of routine blood, urine, and radiological investigations was performed; additional investigation as per patient's requirements was done. Data on age, sex, height (measured through stediometer), weight (measured through electronic weight machine), BMI [BMI=weight in kilograms/ height in meter^2], mechanism of trauma, American Society of Anesthesiology (ASA) status for surgery, smoking (more than five cigarettes/day for two years), age of fracture at the time of reamed intramedullary interlocked nailing (fresh <3 weeks or old >3 weeks), diabetes, and hypertension were recorded. Dynamization was done in patients with tibial shaft fractures with transverse or short oblique type. Nail dynamization was done by the removal of interlocking screws either proximal or distal to the fracture site to permit bony compression at the fracture site. The decision for removal of screw depends upon the distance away from the fracture site, that is, screw will be removed from site farther away from the fracture site. Post dynamization, all patients in our study were managed with physical methods such as early mobilization, manual compression of the calf, and elastic stockings. Patient was followed up for six months. If bone was completely healed (appearance of callus on three cortices on X-ray) within six months of dynamization, then the procedure was considered to have good efficacy. Data was entered and analyzed using SPSS version 21.0. Mean±SD was computed for all the quantitative variables such as age, height, weight, and BMI. Frequency and percentage were computed for all the qualitative variables such as gender, smoking, diabetes, hypertension, fresh or old fracture, and efficacy. Effect modifiers such as age, gender, BMI, smoking, fresh/old fractures, diabetes, and hypertension were controlled through stratification. Post stratification, Chi square test was applied. P-value<0.05 was considered significant.

RESULTS

In this study, 97 patients were assessed for the efficacy of dynamization in delayed union of tibia diaphyseal fracture. The mean±SD of age, height, weight, and BMI is shown in Table 1. Sixty-four (65.9%) patients were male while the rest were females. Forty-eight (49.5%) were smokers, diabetes mellitus was documented in 20 (20.6%), hypertension was noted in 39 (40.2%) patients, 41 (42.2%) patients had fractures for about less than three weeks, while 56 (57.7%) had more than three weeks old fractures. Mechanism of trauma showed that 70 (72.2%) had trauma by RTA while 27 (27.8%) fell from heights. In classification of ASA status, 45 (46.4%) patients had ASA-1 while 52 (53.6%) patients were with ASA-2 status. Overall union (good efficacy of dynamization) was achieved in 72 (74.2%) cases after dynamization. Mean time for union after dynamization was 21.4±2.5 weeks. Upon further analysis, it was found that advanced age, smoking, freshness or oldness of the fracture, the time of initial intramedullary nailing, and diabetes in the patient were associated with decreased efficacy of dynamization, with p-value <0.001, 0.033, 0.007, and <0.001 respectively as shown in Table 1.

Table-1: Descriptive statistics of study population

Variable	Mean+SD	95% CI	Range
Age (years)	39.42+13.79	36.64-42.20	20-70
Height (cm)	163.1+12.3	160.62-165.57	138-186
Weight (kg)	63.4+10.4	61.30- 65.49	45-105
BMI (kg/m^2)	26.8+6.3	25.53- 28.06	16-34

On the other hand, no significant association was found between gender, BMI, hypertension, and union after dynamization (p-value >0.05) (Table 2).

Table 2: Association of age, gender, BMI, smoking, freshness/oldness of the fracture, diabetes, and hypertension with efficacy of dynamization of delayed union of tibial shaft fractures after reamed intramedullary interlocked nailing

Variables	Efficacy of Dynamization		p-Value
Age	**No**	**Yes**	
20-40	2 (3.2%)	60 (96.8%)	
>40	23 (65.7%)	12 (34.3%)	<0.001
Gender			
Male	34 (51.5%)	32 (48.5%)	
Female	17 (54.8%)	14 (45.2%)	0.760
BMI			
16-24	15 (34.1%)	29 (65.9%)	
>24	10 (18.9%)	43 (81.15)	0.070
Smoking status			
Smoker	20 (41.6%)	28 (58.4%)	
Non-smoker	31 (63.2%)	18 (36.7%)	0.033*
Fresh/old fracture			
<3 weeks	5 (12.2%)	36 (87.8%)	
>3 weeks	20 (35.7%)	36 (64.3%)	0.007*
Diabetes			
Yes	16 (80.0%)	4 (20.0%)	
No	9 (11.7%)	68 (88.3%)	<0.001*
Hypertension			
Yes	23 (59.0%)	16 (41.0%)	
No	28 (48.3%)	30 (51.7%)	0.204

* p-value is significant at <0.05

DISCUSSION

Dynamization is one of the treatment modalities for delayed union and nonunion of the femur or tibia. Although the tibia and femur differ significantly in their healing processes, dynamization is a first line treatment for delayed union or nonunion of both, and dynamization causes increased compression at the fracture site without interrupting the biology of a healing fracture. Dynamization involves removing the proximal or distal interlocking screws. This process has a number of benefits like increased contact area at the fracture site, better osteogenesis, and enhanced transmission of forces around weight-bearing areas. All this result in faster and better fracture healing[10-14].

The mean age of our study population was 39.42+13.79 years. Another study done by Somani had almost similar age[15]. In the current study, the mean height was 163.1+12.3 cm and the mean BMI was 26.8+6.3 kg/m^2. Vicenti[16] reported roughly the same BMI as 23.6±2.78 kg/m^2. More patients were male (n=66, 68.04%) in our sample population, which could be due to the fact that generally more men are involved in outdoor activities making them vulnerable to fractures and thus repair surgeries. Other researchers have also reported a higher proportion of male patients in their studies[15,16].

Tibial shaft injuries were found to occur more commonly as a result of road traffic accidents (n=70, 70.2%). This observation can be explained by the fact that the majority of the patients in this study are from the younger age group who would require a high energy fall to have tibial fracture, as compared to older people who can have tibial fractures even from low energy falls. Our study statistics are in concordance with other researchers who also found that younger populations were more likely to have tibial fractures after road traffic accidents and older people suffer tibial fractures mostly from falls[15,18].

The efficacy of dynamization following delayed union of tibial fracture was found to be 74.2%, which is comparable to studies done by Perumal[17]. In order to check the effect of age on the success of dynamization, we divided our patients in two groups: 20-40 years and >40 years. We found that better results were achieved when this procedure is done on younger patients (p-value=<0.001). However, another study has stated otherwise[17]. Confounders like gender, BMI, and hypertension had insignificant effect on efficacy of dynamization with p-values 0.760, 0.070, and 0.204 respectively. Similar findings have been reported by Litrenta[19].

To further gain an understanding of factors changing the outcome of dynamization procedure, we analyzed the diabetic and non-diabetic patients and found that diabetes mellitus adversely affects the rate of union after dynamization (p-value <0.001). Diabetic patients have been proven to have prolonged healing times of fractures and also poorer outcomes following revision surgeries[20-22]. Poor healing was observed in patients who smoked (p-value 0.033). Smoking has been reported to have deleterious effects on tibial fracture healing[23]. However, another study has reported otherwise[17].

We acknowledge that our study has some limitations. Firstly, this was a single center study with limited number of patients. Secondly, no control group was created among patients. Limb shortening is considered as one of the main disadvantages of dynamization[24,25], but our study failed to comment on this aspect of the procedure.

CONCLUSION

The findings of this study support the idea that dynamization can be an effective method to promote healing in tibia diaphyseal fractures for delayed union. More randomized comparative clinical trials are necessary to evaluate the effectiveness of dynamization. Additional studies are required to confirm our findings probably with a larger sample size and with more parameters in multiple study centers in Pakistan to validate the findings of the present study.

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Conflict of Interest: The authors declare that they have no conflict of interest.

Authors' Contribution: PA was the principal investigator, wrote the paper and compiled data, DM worked on data interpretation, MS, MH, FJ, EM and REK collected data. All authors have proofread and approved the manuscript.

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