

Original Research Article

Tertiary care orthopedic hospital experience to find Effect of dynamization in delayed union tibia shaft fracture

Abstract:

Objective: Our study was designed to evaluate the effect of dynamization in delayed union tibia shaft fractures.

Methodology: This prospective study was conducted at Orthopedic department, Shaheed Mohtarma Benazir Bhutto Medical College from march 2020 to march 2021. During this timeframe total of 20 patients underwent dynamization for reamed intramedullary nailing were recruited. After two successive visits those patients whose fracture failed to show progressive signs of callus formation underwent dynamization. For performing the dynamization procedure we removed the single static screw from the longer fracture segment. To provide additional stability to the proximal fragment, we inserted a poller screw slightly medial to the nail from anterior to posterior. Statistical analysis was performed by using SPSS 23.0. For evaluating the success of dynamization Chi-square test was used.

Results: The mean age of recruited patients was reported as 35.92 years ranging from 16 years to 63 years old. Out of these twenty cases, 17 were male (85%). The mean time duration of nailing was reported as 35.4 hours. Total fourteen patients were immediately treated with nailing within 20 hours of injury while the rest six underwent delayed nailing. Total four cases of tibial fracture was turned out as failure because the patient failed to achieve union after dynamization and underwent augmentation plating with bone grafting for the complete union.

Conclusion: Delayed dynamization is a convenient and cost-effective technique to achieve union in femoral shaft fractures. Overall, our study reported an 80% success rate but failed to achieve early dynamization in comminuted fractures.

Keywords:

Intramedullary nailing, dynamization, Tibial shaft

Introduction:

Intramedullary nailing is considered a standard treatment for healing tibial shaft fractures with a 90% to 100% union rate¹⁻². However, some fractures cause complications in terms of delayed

union and nonunion³. After nailing 0% - 5% risk of nonunion in tibial shaft fractures were reported^{4,5}. Fracture location, instability, infection and insufficient blood supply are one of the major risk factors in tibial nonunion^{3,4}. Risk of nonunion increases in areas involving isthmus due to expanding diaphysis which causes tension between nail and cortex⁶. Treatment of nonunion tibial fractures includes nail dynamization, plate augmentation, and exchange nailing with aiming to obtain mechanical stability of the fracture⁷. Cases of the delayed union are widely treated with less time-consuming and cost-effective nail dynamization procedures. Dynamization involves the withdrawal of distal statically locked screws from the intramedullary nail which helps in promoting the bone union⁸. Dynamization helps in the enhancement of micromovements at the fracture gap and results in bone healing⁹. Usually, the best suitable time for dynamization was reported as two to three months after surgery^{10,11,12}. Unstable fractures involving proximal or distal 1/3 tibial diaphysis dynamization did not provide suitable results of fracture compression. Moreover, complex fractures such as oblique and multifragmentary fractures lead to loss of reduction. This reduction sometimes causes proximal angulation¹³. In past, a variety of studies on nail dynamization reported contrasting results in terms of union. These results vary from 19% to 82% success rates^{10,11,12}. A very limited amount of literature was produced in past to evaluate the role of dynamization in the delayed union. Our study was designed to evaluate the effect of dynamization in delayed union tibia shaft fractures.

Methodology:

This prospective study was conducted at Orthopedic department, Shaheed Mohtarma Benazir Bhutto Medical College from march 2020 to march 2021. During this timeframe total of 20 patients underwent dynamization for reamed intramedullary nailing were recruited. This dynamization procedure was conducted after twelve weeks from index surgery and followed for six months. To identify the demographic parameters of the patients we reviewed the medical records of the patients from the department of medical records. From medical records, we further gathered information related to fracture type, index surgery details, dynamization time, and smoking details. Before initiating the study we obtained ethical clearance from the institution. All the patients with pathological fractures, fractures associated with tibial plateau, type 3 fractures were excluded from the study. We further excluded all the patients who underwent interlocking nails for the delayed union. After two successive visits those patients whose fracture failed to show progressive signs of callus formation underwent dynamization. For performing the dynamization procedure we removed the single static screw from the longer fracture segment. To provide additional stability to the proximal fragment, we inserted a poller screw slightly medial to the nail from anterior to posterior. To analyze the position of the proximal screw Picture archiving and communication system tool was used in the dynamic hole of the nail. This procedure was carried out under local anesthesia and patients were immediately allowed to weight-bearing. Furthermore, patients were followed up at one, three, six months, and till union. We calculated callus and bone diameter by using pre dynamization radiographs. These radiographs helped obtain the Fracture healing index (FHI) by taking the radiological ratio of the

largest callus diameter in two planes and the adjacent normal bone diameter. Union was defined as osseous bridging of three cortices on follow-up radiographs whereas those radiographs without progressive callus increase were defined as dynamization failure¹⁴. Statistical analysis was performed by using SPSS 23.0. For evaluating the success of dynamization Chi-square test was used.

Results:

Our study included twenty-one cases of tibial shaft fractures from 2018 to 2020. Out of these twenty-one cases, a total of 20 cases underwent delayed nail dynamization. The mean age of recruited patients was reported as 35.92 years ranging from 16 years to 63 years old. Out of these twenty cases, 17 were male (85%). Total nine cases (45%) were open injuries while the rest of them were closed (55%). According to Gustilo Anderson's classification total of six cases (66.6%) were type I and open and the rest 3 (33.3%) were type II open injuries. These open fractures were treated with nailing with primary skin closure. The mean time duration of nailing was reported as 35.4 hours. Total fourteen patients were immediately treated with nailing within 20 hours of injury while the rest six underwent delayed nailing. The reason for delayed nailing was observed as polytrauma (5%) in one patient. One patient (5%) reported fat embolism and delayed representation was reported in four patients (20%). Nineteen tibial fractures were undergone fixation with standard locking nails while in one case of proximal fracture we used an expert nail. We used an average 9.8mm diameter nail for all patients. For stable fractures, we immediately allowed weight-bearing while the comminuted fractures were suggested to walk without weight-bearing for the initial month. After the index procedure, none of the patients underwent the ultrasound stimulation. The average time duration of dynamization from nailing was reported as 19.11 weeks. The total dynamization duration was ranging from 12 weeks to 36 weeks. In our study, we observed that majority of the fractures are comminuted or transverse.

Total sixteen cases achieved union after dynamization. The total mean time of union from surgery was reported as 6 months. Total four cases of tibial fracture was turned out as failure because the patient failed to achieve union after dynamization and underwent augmentation plating with bone grafting for the complete union. Fourteen cases were dynamized within 20 weeks and the rest six cases were dynamized after 20 weeks. We did not find any significant correlation between age, sex, smoking status. Unfortunately, we failed to achieve statistical significance in terms of open fractures and dynamization time $P > 0.05$. We observed that comminuted fractures had poor outcomes in terms of delayed dynamization. We observed 92.8% union rates among cases with > 1.18 FHI score whereas the study of Vaughan et al observed a 93% union ratio among cases > 1.17 .

Parameters	Frequency %	p- value
Age in mean	35.92	0.84

Sex		0.66
Male	17 (85%)	
Female	3 (15%)	
Smokers	12 (60%)	1.00
Fracture type		0.77
Open fractures	9 (45%)	
Closed fractures	11 (55%)	
Mean duration of index nailing in hours	35.4	1.00
Mean duration of dynamization in weeks	19.11 (12-36 weeks)	0.58
Mean diameter of nail in diameter	9.8 mm	0.77

Table 1: Demographic characteristics of recruited patients¹⁴

Gustilo Anderson's classification	Frequency %
Type I open fracture	6 (66.6%)
Type II open fracture	3 (33.3%)

Table 2: Gustilo Anderson's classification¹⁴

Anatomy	Frequency (%)
Comminuted	11 (55%)
Oblique	1 (5%)
Segmental	1 (5%)
Spiral	1 (5%)

Transverse	6 (30%)
------------	---------

Table 3: Fracture type

Anatomy	Union from dynamization		Chi square	p- value
	No N (%)	Yes N (%)		
Comminuted	3 (27.2%)	8 (72.7%)	9.48%	0.05
Oblique		1 (100%)		
Segmental	1 (100%)			
Spiral		1 (100%)		
Transverse		6 (100%)		

Table 4: Union rate after dynamization

Discussion:

For enhancing union in the tibial shaft, nail dynamization is considered an effective and cheap method. It assists at fracture site by improving contact area to achieve union in a shortened period⁸. Researchers claimed that nail dynamization should be done two to three months after nailing^{10,11,12}. This would help in achieving sufficient callus to prevent excess mobility at the fracture site. However, nail dynamization also has some cons in terms of limb length discrepancy in patients with comminuted and long oblique fractures. Researchers suggest that it would be suitable for transverse, wedge, and short oblique fractures¹⁴.

In our study, we observed an 80% success rate after 12 weeks of surgery. These results are comparable with the previous study of Chalidis et al¹⁶, Kempf et al¹⁰ and Pihajamashi et al¹⁷. Although the mean duration of dynamization was shortened in these mentioned studies still results are parallel to ours. In our study, the mean duration of dynamization was reported as 19.11, range 12- 36 weeks whereas the study of Wu and Shi et al¹⁸ reported a mean duration of 12 weeks with a max time frame of 30 weeks. The study of Wu and Chen et al¹⁹ obtained 50-60% successful results in less than 16 weeks while the maximum duration of Wu et al²⁰ observed was 24 weeks. In a study by Wu and Shi¹⁸, they reported a 54% (out of twenty-two cases of tibia and femur fractures) success rate after dynamization. Overall their mean duration from nail dynamization was thirty weeks still they failed to observe statistical significance between

dynamization time and fracture union. A similar study by Wu et al²⁰ also reported a 54% union ratio within 5.2 ± 2 months. On the other hand, we observed 6 months as a mean duration of the union from dynamization.

Our observations revealed that after dynamization comminuted fractures had poor results as compared to oblique fractures ($P = 0.05$). Overall the comminuted fractures had a 72.7% success ratio. These results are parallel to the literature in which researchers claimed that dynamization in comminuted fractures causes loss of reduction and shortening²¹. We observed 100% union in transverse fracture. During the study, we observed that one case of segmental fracture also failed to achieve union. So, our study contributed that poor dynamization can be observed in segmental comminuted fractures²¹. Pre dynamization of fracture healing index was another important variable to predict successful union. In our study, we observed 92.8% union rates among cases with > 1.18 FHI score whereas the study of Vaughan et al²² observed a 93% union ratio among cases > 1.17 . These results reflect that there should be some amount of callus present at the fracture site before proceeding with the procedure for successful results.

Conclusion:

Delayed dynamization is a convenient and cost-effective technique to achieve union in femoral shaft fractures. Overall, our study reported as 80% success rate but failed to achieve early dynamization in comminuted fractures. Patients should be aware of the nonunion so that the early representation of delayed union can be treated easily.

References:

1. Winqvist RA, Hansen Jr ST, Clawson DK. Closed intramedullary nailing of femoral fractures: a report of five hundred and twenty cases. *J Bone Joint Surg Am.* 1984; 66: 529-539
2. Wolinsky PR, McCarty E, Shyr Y, Johnson K. Reamed intramedullary nailing of the femur: 551 cases. *J Trauma.* 1999; 46: 392-399
3. Gelalis ID, Politis AN, Arnaoutoglou CM, et al. Diagnostic and treatment modalities in nonunions of the femoral shaft: a review. *Injury.* 2012; 43: 980-988.
4. Zelle BA, Bhandari M, Espiritu M, Koval KJ, Zlowodzki M. Evidence-Based Orthopaedic Trauma Working Group. Treatment of distal tibia fractures without articular involvement: a systematic review of 1125 fractures. *J Orthop Trauma.* 2006 Jan;20(1):76–20.
5. Rupp M, Biehl C, Budak M, Thormann U, Heiss C, Alt V. Diaphyseal long bone nonunions - types, aetiology, economics, and treatment recommendations. *Int Orthop.* 2018;42(2):247–58

6. Song S-H. Radiologic Outcomes of Intramedullary Nailing in Intraisthmal Femur-Shaft Fracture with or without Poller Screws. *Biomed Res Int.* 2019;2019:9412379
7. Lai D, Chen CM, Chiu FY, Chang MC, Chen TH. Reconstruction of juxta-articular huge defects of distal femur with vascularized fibular bone graft and Ilizarov's distraction osteogenesis. *J Trauma Acute Care Surg.* 2007; 62: 166-173
8. Wu CC, Shih CH. A small effect of weight bearing in promoting fracture healing. *Arch Orthop Trauma Surg.* 1992; 112: 28-32.
9. Huang K-C, Tong K-M, Lin Y-M, Loh E-W, Hsu C-E. Evaluation of methods and timing in nail dynamisation for treating delayed healing femoral shaft fractures. *Injury.* 2012 Oct;43(10):1747–20.
10. Kempf I, Grosse A, Beck G. Closed locked intramedullary nailing: its application to comminuted fractures of the femur. *J Bone Joint Surg Am.* 1985; 67: 709-720
11. Klemm KW, Börner M. Interlocking nailing of complex fractures of the femur and tibia. *ClinOrthopRelat Res.* 1986; 212: 89-100.
12. Litrenta J, Tornetta P, Vallier H, Firoozabadi R, Leighton R, Egol K, et al. Dynamizations and Exchanges: Success Rates and Indications. *J Orthop Trauma.* 2015 Dec;29(12):569–20.
13. Brumback RJ. The rationales of interlocking nailing of the femur, tibia and humerus. An overview. *ClinOrtop.* 1996; 324: 292-320.
14. Ramesh P, Vijey S, Basha R. Is nail dynamization beneficial after twelve weeks – An analysis of 37 cases Perumal, Ramesh et al. *Journal of Clinical Orthopaedics & Trauma.* 2017; 9(4): 322 - 326
15. Krettek C, Schandelmaier P, Tscherne H. Nonreamed interlocking nailing of closed tibial fractures with severe soft tissue injury. *Clin Orthop.* 1995; 1: 34-47.
16. Chalidis BE, Petsatodis GE, Sachinis NC, Dimitriou CG, Christodoulou AG. Reamed interlocking intramedullary nailing for the treatment of tibialdiaphyseal fractures and aseptic nonunions: can we expect an optimum result?. *Strategies Trauma Limb Reconstr.* 2009; 4: 89-94.
17. Pihlajamäki HK, Salminen ST, Böstman OM. The treatment of nonunions following intramedullary nailing of femoral shaft fractures. *J Orthop Trauma.* 2002; 16: 394-402.
18. Wu CC, Shih CH. Effect of dynamization of a static interlocking nail on fracture healing. *Can J Surg.* 1993; 36: 302-306.
19. Wu CC, Chen WJ. Healing of 56 segmental femoral shaft fractures after locked nailing: poor results of dynamization. *Acta Orthop Scand.* 1997; 68: 537-540.
20. Wu CC. The effect of dynamization on slowing the healing of femur shaft fractures after interlocking nailing. *J Trauma.* 1997; 43: 263-267
21. Lynch JR, Taitsman LA, Barei DP, Nork SE. Femoral nonunion: risk factors and treatment options. *J Am Acad Orthop Surg.* 2008; 16: 88-97.

22. Nizam Ahmed, Madan Lal, Niaz Hussain Keerio, Ghazanfar Ali Shah, Aftab Alam Khanzada, Muhammad Raḅique Joyo, Syed Shahid Noor. Results of non-surgical treatment of isolated closed tibial shaft fractures. IJRPS. 2021Oct.6 ;12(4):2303-7

UNDER PEER REVIEW