

E-ISSN: 2395-1958  
P-ISSN: 2706-6630  
IJOS 2022; 8(2): 230-235  
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Received: 02-01-2022

Accepted: 06-02-2022

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## Comparison between Clinico-radiological outcomes of primary closed static and dynamic interlocking nailing in transverse or short oblique diaphyseal fractures of tibia: A prospective study

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DOI: <https://doi.org/10.22271/ortho.2022.v8.i2d.3139>

### Abstract

**Introduction and Background:** The objective of the study is to evaluate the comparative efficacy in terms of clinico-radiological outcomes in primary static versus primary dynamic intramedullary interlocking nailing of tibia. The principle of fixation for a tibial middle third fracture is to stabilize at the proximal metaphyseal region, the isthmus and the distal metaphyseal region. This 3 point fixation provides adequate resistance to the deforming axial and torsional forces at the fracture site. Two types of Locking techniques exist for the intramedullary nailing, Static and Dynamic.

**Materials and Method:** A total of 17 patients of either sex who presented with closed trauma of transverse or short oblique diaphyseal fractures of tibia, which were observed between the years 2015-2017. Randomly, static and dynamic locking was done to the equal populations presented. The aims of the study conducted were to analyze time to union, functional recovery and incidence of complications. Johner and Wruh's Criteria was used to analyze the functional outcome. All patients were followed for a period of 18months.

**Results:** Upon evaluation with regard to Johner and Wruh's criteria showed *Excellent results* in 9 out of 17 subjects, *Good results* in 7 out of 17 subjects and a *Fair result* in 1 patient. The average time of fracture union in case of dynamically and statically interlocked nailed tibiae is 13.00 and 15.22 weeks respectively. Therefore, the difference was 2.22 weeks. In our study, the results of tibia nailing was found to be in consonance with the earlier studies.

**Conclusion:** We conclude that Primary Dynamic locking is a better option as compared to primary static locking in simple transverse or short oblique diaphyseal fractures of tibia as it leads to faster fracture healing and early return to function.

**Keywords:** Static versus dynamic, intramedullary interlocking nailing, clinic radiological outcome Functional outcome

### Introduction

Tibia is the most commonly fractured long bone in body with an annual incidence of tibial shaft fractures is 2 per 1000 individuals <sup>[1]</sup>. Tibia is subcutaneous in a third of its surface area amounting to the common open injuries as observed. Road traffic accidents, auto-pedestrian injuries, fall from height, and gun shot injuries amount for the most common mechanism of injury to long bones in the human body, especially in the adult population.

Hence, to provide an ambulatory status to those affected at the earliest feasible in 1930 Gerhard Kuntscher invented a metallic intra medullary nail (in the shape of a V) initially for the Sub Trochanteric region in the femur to begin with, and later introduced to treat Tibia midshaft fractures. Kuntscher called this 'elastic nailing' and coined the term elastic impingement (radial compliance) to describe the mode of action <sup>[2]</sup>.

Later on, with modernization in 1972, interlocking GK Tibial nails with the advent of screws to hold the fracture proximally and distally was developed by Klemm and Schelman <sup>[3]</sup>, thereby imparting added stability and adequate load sharing properties to the fractured bone so as to avail early weight bearing and mobilization to carry out activities of daily living.

The principle of fixation for a Tibial Middle third fracture is to stabilize at the proximal

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metaphyseal region, the isthmus and the distal metaphyseal region. This 3 point fixation provides adequate resistance to the deforming axial and torsional forces at the fractured site [4].

Two types of Locking techniques exist for the intramedullary nailing, Static and Dynamic. The former provides rigidity to the fracture pattern by means of a screw at both ends of the nail. It is better suited for axially unstable fracture patterns i.e. Comminuted fractures, that are likely to displace on guarded weight-bearing. Dynamic Locking is instituted, on the other hand for axially stable fractures and in those where healing is delayed. Proximal locking is with a screw in an oblong hole, whereas distal locking is with two screws. The purpose is to provide micro-motion at the fracture site on weight-bearing, thereby facilitating union, by means of complete transfer of axial pressure on bone fragments.

There has been a controversy about using static or dynamically locked nails in simple transverse and short oblique fractures of long bones of lower limbs. Upon doing a through review of the literature, there have been conflicting views on the use of static or dynamic locking in these fractures. This study is being undertaken to evaluate which method of locking i.e. static versus dynamic leads to a better outcome in respect of of the time of union, early weight-bearing and return to pre-injury level of activity in long bone fractures of lower limbs i.e., femur and tibia in our institute.

### Materials and Methods

This study was conducted in Government Multi-Speciality Hospital Chandigarh-16, Chandigarh between the years 2015-2017. It was a prospective comparative study. Total of 17 patients presented with closed trauma of transverse or short oblique diaphyseal fractures of the tibia, treated by closed reduction and intramedullary nailing, with a minimum follow-up being 6 months and a maximum being 18 months.

Tibial diaphyseal fractures were classified using AO classification, AO type 44 - A2 short oblique fracture, AO type 44 - A3 simple transverse were noted. 2 groups were made, so as to have an equal population of 17 subjects managed by primary static and dynamic locking intramedullary nailing techniques in the tibia.

Clinical examination was performed with an appropriate

questionnaire on sequential monthly follow-up after suture removal. Clinical signs of healing emphasize: the rigidity and lack of crepitation at the fracture site, no pain at the fracture site with palpation and percussion rough, and the absence of pain in full support and walk on limb fractures healed. These findings, in comparison with the radiographic analysis i.e., "cortical bridging", which was based on the data evaluation of the fractures healed radiographically considered if there is a bypass on three of the four cortical fracture cracks (tricortical union), which formed the bench mark in the study. Clinical Outcome will be measured by the Johner and Wruh's Criteria [5] for tibia nailing.

The aims of the study were to analyze, a). Time to union. b) Functional recovery and, c) Incidence of complications

### Inclusion criteria

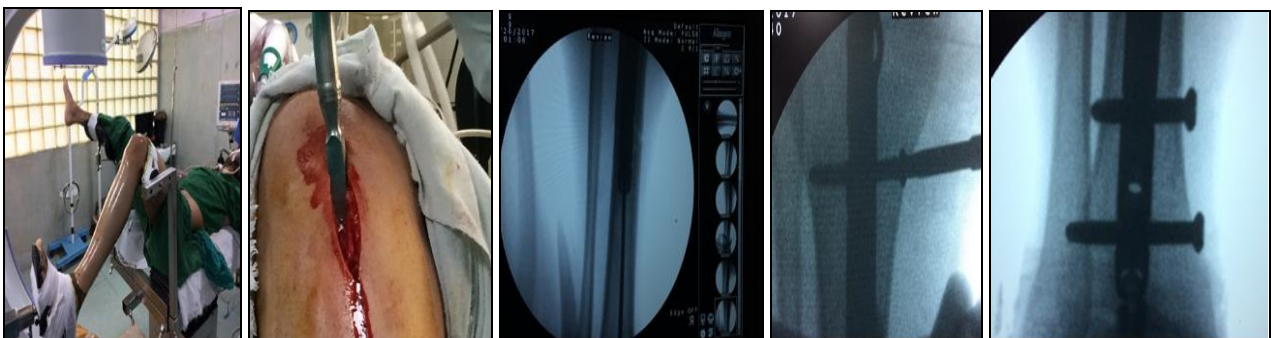
1. Skeletally Mature group (above 18 years),
2. simple Transverse or short oblique diaphyseal Fractures of Tibia
3. Closed fractures.

### Exclusion criteria

1. Previous history of tibial fracture.
2. Bilateral fractures.
3. Associated neurovascular injuries.
4. Pathological fractures.
5. Ipsilateral femoral and tibial fractures together.

### Surgical technique: Figure 1

Under spinal anesthesia patient was positioned on OT table. 5-cm Linear Skin incision along the medial border of the patellar tendon from the inferior pole of patella towards the Tibial tuberosity made. Deep Transpatellar tendon dissection was made. Entry made with awl at the junction between anterior and superior aspects of the proximal tibia under C-arm guidance. A guidewire is inserted into the tibial canal, and pass it across the fracture site. Sequential reaming performed. Initially Distal Locking was done using two bolts. In case of primary dynamic nailing only dynamic slot of the nail is fixed with screw and static slot is left alone. In case of primary static locking both static and dynamic slots locked.



**Fig 1:** Surgical procdure steps of closed Intramedullary nailing of tibia.

All the patients were followed up every monthly. An objective evaluation with a radiograph was made to check for the presence of callus. During this period objective

assessment of the parameters related to the aims of the study was made using Johner and Wruh's Criteria [5] (Table 1).

**Table 1:** Johner wruh's criteria

Criteria	Excellent	Good	Fair	Poor
Non-union/infection	None	None	None	Yes
NV Injury	None	Minimal	Moderate	Severe
<b>Deformity (in degree)</b>				
Valgus/varus	None	2 - 5	6 - 10	>10
Pro/recurvatum (in degree)	0 - 5	6 - 10	11 - 20	>20
Rotation	0 - 5	6 - 10	11 - 20	>20
Shortening	0 - 5 mm	6 - 10 mm	11 - 20 mm	>20 mm
<b>MOBILITY</b>				
Knee	Full	80%	>75%	>75%
Ankle	>75%	>75%	>50%	<50%
Subtalar	None	>50%	<50%	
Pain	None	Occasional	Moderate	Severe
Gait	Normal	Normal	Mild limp	Significant
Sternous activities	Possible	Limited	Severe restriction	Impossible
Results (n)	79 (70.54%)	29 (25.90%)	4 (3.56%)	0

### Observation

Total of 17 cases of tibial fractures treated by Intramedullary nailing. The mean age was 33.60 years [range 24-57 years]. Among these 14 were males and 3 were females. The *left side* was involved in 10 cases (58.8%), and 7 in the right side. The mode of injury was that of a Road Traffic Accident in 11 cases (65%), Fall from height in 4 cases and assault in 2 cases. 9 cases were managed by primary static nailing and 8 were managed by primary dynamic nailing (53% vs 47%).

14 out of the 17 cases (84%) did not have any infection, whereas 2 cases developed Superficial Surgical Site infection and 1 case got infected post-operatively. No neurovascular injuries were seen.

In the present series union time was 12-19 weeks. 12 cases showed union between 12-14 weeks (70.6%), 4 cases between 15-17 weeks (23.5%) while 1 case united after 17 weeks.

Sequential evaluation of patients with post-op radiographs showed a frequency of ~11.8% for a Maximum Varus angulation of 13 and 14 degrees whereas the valgus angulation was insignificant. The Antero-Posterior angulation had a maximum frequency of 17.6% for 3 degrees of Anterior Angulation, whereas Posterior Angulation was ~6% for a maximum of 11 degrees.

Most of the patients ~59% didn't have any anterior knee pain, whereas moderate degrees of pain was noted in ~30% of patients and occasional pain in about 11% of subjects when followed up for a period of 6 months on average with full weight bearing and subjecting to muscle endurance exercises. At the end of follow-up on an average of 6 months a mild limp was noted in ~35% of patients, whereas only ~12% of

patients had a significant limp. However, more than half of the patients ~53% didn't show any evident limp on follow-up. Range of movements (ROM) restriction beyond the physiological Knee range to carry out daily activities i.e. 5-85 degrees, secondary to mal-alignment of fractured fragments was noted in 6 out of 17 patients. ROM restriction, secondary to Mal-alignment and superimposed Surgical Site infection was noted in 2 patients. However, 9 patients didn't have any post operative complications.

Upon dynamic locking, 8 patients showed union in 12-14 weeks (100%). An equal number of i.e. 4 patients showed union in 12-14 weeks and 15-17 weeks, respectively (44%), whereas 1 patient took more than 17 weeks to unite when Locked statically (11.1%) (Table 2). The respective clinical images with radiographs are illustrated in Figures 2,3.

In summary, evaluation with regard to Johner and Wruh's criteria showed *Excellent results* in 9 out of 17 subjects, *Good results* in 7 out of 17 subjects and a *Fair result* in 1 patient.

**Table 2:** Union (Weeks)

		Union(wks)			Total
		12-14 weeks	15-17 weeks	>17 weeks	
Static or dynamic	Dynamic	8	0	0	8
		100.0%	0.0%	0.0%	100.0%
	Static	4	4	1	9
		44.4%	44.4%	11.1%	100.0%
Total		12	4	1	17
		70.6%	23.5%	5.9%	100.0%



**Table 3:** Result (Johner Wruh's Criteria) \* group

Crosstab					
			Group		Total
			Dynamic	Static	
Result (J&W Criteria)	Excellent	Count	5	4	9
		% Within group	62.5%	44.4%	52.9%
	Fair	Count	0	1	1
		% Within group	.0%	11.1%	5.9%
	Good	Count	3	4	7
		% Within group	37.5%	44.4%	41.2%
Total		Count	8	9	17
		% Within group	100.0%	100.0%	100.0%

**Fig 2:** Primary Dynamic nailing of tibia clinical and Radiological pictures, 2 cases

First case (upper row) functional outcome at the end of 12 weeks with patient's x-rays of preoperative, immediate postoperative and after complete union at the end of 12 weeks.

Second case (lower row) functional outcome at the end of 14 weeks with patient's x-rays of preoperative, immediate postoperative and after complete union at the end of 14 weeks.

**Fig 3:** Primary Static nailing of tibia clinical and Radiological pictures

First case (upper row) functional outcome at the end of 14 weeks with patient's x-rays of preoperative, immediate postoperative and after complete union at the end of 14 weeks.

Second case (lower row) functional outcome at the end of 19 weeks with patient's x-rays of preoperative, immediate postoperative and after complete union at the end of 19 weeks.

## Discussion

Fractures of the diaphysis of tibia are one of the most commonly encountered cases because of increased vehicular and road traffic accidents. The majority of these fractures require operative management. The goal of the operative treatment is to obtain anatomical realignment of bone and provide enough stability to allow early motion. Intramedullary nailing is an effective method of treating these fractures. Since then unacceptable rates of malunion and non-union, which occurred with conservative treatment have fallen dramatically. One of the primary advantages of intramedullary nailing is that it can be used as a closed technique with low infection rates, early mobilization, faster recovery. There are two methods of providing stability in closed locked nails viz. primary static v/s primary dynamic locking. The present study was undertaken to determine the comparative efficacy of primary static versus dynamic locking in intramedullary nailing in transverse and short oblique diaphyseal fractures of tibia. The objective of primary Dynamisation from the start of the treatment was to allow the contact between the bone fragments to achieve early union.

In the present study, the patients were in the range of 18–47 years, Of the 17 patients, 14 were males and 3 were females in comparison to studies Syed Baqir Hussain *et al.* [6] (34 male, 6 female), G. I. Drosos [7] (119male, 42 female) S Solooki *et al.* [8] (53 male 8 female) and Daniel Hernández-Vaquero *et al.* [9] in Spain. Predominant young male patients involvement was seen in this study which can be attributed to more RTA and heavier labor undertaken by males as compared to females in the Indian set up. Similar young male involvement has been seen in a study conducted by Syed Baqir Hussain *et al.* [6]. Most of the fractures of our studies are due to road traffic accidents (RTA) (64.70%), followed by fall from height (FFH) (23.52) and ZERO Assault (ASLT) (11.36%) cases whereas in studies by Wasudeo Gadegone *et al.* [10] (42RTA, 13FFH, 46Assault or others)

In the present study, the average time of fracture union in the case of dynamically and statically interlocked nailed tibiae is 13.00 and 15.22 weeks respectively. The results were statistically significant compared to the static group. Similar results of better union with dynamization have also been observed by A. ALHO *et al.* [11] *et al.* and Đemil Omerović [12] *et al.*, Josh Vaughn *et al.* [13] have also published similar results demonstrating faster union in a dynamic group.

In our study, no cases of delayed union and nonunion were found, whereas in studies G. I. Drosos *et al.* (4 cases of nonunion) and A. ALHO *et al.* [11] (2 nonunion and 1 delayed union) have occurred. Our study had 2 cases of 1 cm shortening and 6 cases of 1-2 cms shortening, Ekeland *et al.* [14] reported shortening of 1cm - 3 cases while 2 cm - 1 Case, Melcher *et al.* [15] (interlocking AO UTN nail) reported shortening of 0.5-1cm - 5 cases (25%). A. ALHO *et al.* [11] showed that there was a shortening of 1 cm in nine cases, 2 cm in two and 3 cm in two. In our study we noticed 9 patients of tibia nailing with rotational deformities. A. ALHO *et al.* [11], reported that One patient had an internal rotation deformity of 20° and one an external rotation of 15° malrotation in one dynamically nailed fracture

We reported all cases of tibia nailing with varus or valgus angulation ranging from 3 to 15° in our study. A. ALHO *et al.* [11] reported that Varus malalignment was 6° to 10° in four cases and valgus 6° to 10° in six cases. Melcher *et al.* [15], in their study reported Varus/Valgus deformity (Max 5°) in 2 cases (10%)

In our study, Out of 17 patients of tibia nailing, 9 patients had full knee range of motion, 3 patients had >90° knee range of motion and 5 patients had <90° knee range of motion, Bradford Henley [16] reported Restricted knee motion in one case.

## Conclusion

The average time of union was shorter (13 weeks) in Dynamically locked patients as compared to statically locked patients (15.22 weeks). The difference in time to union was significant between the two groups. In our study, the results of tibia nailing was found to be in consonance with the earlier studies [7, 11, 12]. In terms of time to fracture union, in the previous studies as well, the dynamically locked patients showed earlier union (2.22 weeks) as compared to statically locked patients. The reason for this could be that tibia fracture cases were mobilised in previous studies also, as is the case in our study. So, in the study conducted at our institute, we conclude that Primary Dynamic locking is a better option as compared to primary static locking in simple transverse or short oblique diaphyseal fractures of tibia as it leads to faster fracture healing and early return to function.

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