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FUNCTIONAL OUTCOME OF STATIC VERSUS DYNAMIC NAILING IN CLOSED LONG BONE DIAPHYSEAL FRACTURES (32A2\32A3\42A2\42A3)

Orthopaedics

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ABSTRACT

Background: Modern intramedullary nails allow for two different fixation modes, namely static and dynamic modes. The objective of this study was to compare the speed and quality of healing of the type A(simple oblique and transverse) fractures of the femur and tibia treated by static or dynamic intramedullary nails. **Material & Methods:** 32 patients were divided into two groups, group A and group B of 16 patients each. In group A closed static intramedullary nailing was carried out and in group B closed dynamic intramedullary nailing was done. Static locking involved placement of two proximal and distal locking screws. Dynamic nailing was done with one locking screw placed in proximal dynamization screw hole and one distal locking screw placed on distal side of the fracture in femur and two in tibia. **Implant Used:** Interlocking femur and tibia nail. **Classification System:** AO classification. **Results:** Thoresen's criteria for femur and Karlstrom-Olerud Criteria for tibia was used to evaluate the functional outcome. Excellent results in 21, Good results in 6 subjects, fair (satisfactory and moderate) in 5, and poor result in 0 patients out of 32 patients. The average time of fracture union in case of dynamically and statically interlocked nailed long bone is 15.94 and 17.63 weeks respectively (P=0.0032). In our study, statistically significant difference was observed. **Conclusion:** It was concluded that that Primary Dynamic locking is a better option as compared to primary static locking in simple diaphyseal fractures of long bones of lower limb as it leads to faster fracture healing and early return to function.

KEYWORDS

Static versus dynamic, intramedullary interlocking nailing, Thoresen's criteria and Karlstrom-Olerud Criteria

INTRODUCTION

In the modern world with the increase in speed and number of fast-moving vehicles there is a great increase in number and severity of lower limb fractures. [1] Fracture site fixation by intramedullary nailing provides early mechanical stability that promotes revascularization, which is vital for fracture healing. The main goal of fracture is to gain strength and permanent placement of the implants which is achieved by intramedullary nailing which promotes synthesis and consolidation of fracture fragments.[2,3]

In the static nailing technique interlock nail is locked on both sides using screws in upper side in only static hole or dynamic and static holes both, leading to a static relation of bone and nail and movement of the bone relative to nail is not allowed.

In dynamic nailing proximally the screws are placed in only dynamic hole, so the nail will just telescope through the proximal medulla till the fracture fragments are brought together. This telescopic movement would repeat with every load that occurs on walking.

Routinely the nails are locked in the static mode because to provide better fixation, rotational control and better control over the fixed bone. However, static nailing doesn't allow the axial load on the fracture site. [4,5] Today the debate for nailing in static mode and dynamic mode since beginning is going on.

AIMS AND OBJECTIVES:

To determine whether there is a difference in the speed of healing of the type A diaphyseal fractures of the femur and tibia treated by static or dynamic intramedullary nails and to compare the results.

MATERIAL AND METHODS

This descriptive study of 32 cases was carried out at the department of Orthopaedics Surgery, Jawahar Lal Nehru Hospital, Ajmer, Rajasthan from September 2020 to Feb 2022. Patients was divided into two groups, group A and group B of 16 patients each. In group A closed static intramedullary nailing was carried out and group B closed dynamic intramedullary nailing was carried out.

Inclusion Criteria

1. All closed non comminuted diaphyseal fractures of femur and tibia
2. Age ≥18 years.

Exclusion Criteria

1. Open fracture
2. Pathological fracture
3. Already infected fracture
4. Young patients below 18 years of age
5. Comminuted fracture

Surgical Management

Closed reduction internal fixation done in all surgeries were done under image control on plain table in tibia fracture and on traction table in femur fracture in supine position under Spinal/EA/Spinal+EA/General Anaesthesia.

Static locking involved placement of proximal and distal locking screws fixing the fracture in place. Dynamic locking involved placing the shaft screw within the oblong interlocking screw and distal locking on distal side of the fracture that allows for the intramedullary nail to move relative to the shaft screw while also providing the rotational stability.

Figure: Patient position for femur nailing

Figure: Patient position for tibia nailing

The success and healing time of fractures of the femur and tibia treated using static or dynamic intramedullary nail was declared on the basis of clinical and radiological results. Follow up clinical evaluation was repeated every month for 1year. Time to union & regaining patients mobility were noted. Complications if any was also noted. Delayed union was defined as the failure of the fracture to heal in the time frame that would be expected. Generally, the time frame for delayed union is between 3 to 6 months. Non union is defined as established when a minimum of 9 months has elapsed since injury and fracture shows no visible progressive signs of healing for 3 months. The functional outcome was evaluated according to Thoresen`s criteria [6] for femur fracture and Karlstrom-Olerud Criteria [7] for Tibia fracture. The results were graded as excellent, good, fair, or poor according to the alignment of the fractured bone fragments, the range of motion of the ipsilateral knee joint, and the degree of pain and swelling for femur fracture and Excellent, Good, Satisfactory, Moderate and poor according to score of Karlstrom-Olerud Criteria for Tibia fracture. Full, pain-free function of the extremity was considered as excellent result. Evaluation and data analysis for the retrospective variables was noted and evaluated from the available data of MRD. Student's paired t test and Chi Square test were applied to the results of both the groups for comparison. We considered satisfactory and moderate results of Karlstrom-Olerud Criteria for tibia as fair results for ease of comparison with Thoresen`s criteria for femur. And we compared the excellent and good results of both criteria with rest of the results for obtaining the significance level of our study.

RESULTS

All 32 cases of tibia and femoral fractures treated by static or dynamic intramedullary nailing according to their allocated group. The mean age was 35.16 ± 14.56 years in Group A and 38.81 ± 14.73 years in Group B. Among these 12 and 10 were males and 4 and 6 were females in Group A and Group B respectively. In each of the group femur and tibia fractures were equal (8 patients in both groups). The left side was involved in 9 and 6 cases and right side in 7 and 10 patients in Group A and Group B respectively. The mode of injury was that of a Road Traffic Accident in 9 and 8 patients, domestic injury in 3 and 4 patients, fall from height in 1 and 2 patients and sports and others in 3 and 2 patients in Group and Group B respectively. Both groups were comparable according to all these parameters with non-significant p value (>0.05). **(Table -1)**

Table - 1: Demographic profile and mode of injury

Parameters	Group A (n=16)		Group B (n=16)		p value
	Mean	SD	Mean	SD	(significance)
Age (years)	35.13	14.56	38.81	14.73	0.483 (NS)
Male/Female	12/4		10/6		0.446 (NS)
Femur/Tebia	8/8		8/8		1.000 (NS)
Right/Left	7/9		10/6		0.288 (NS)
Mode of injury					
Time	No	%	No	%	P value
Domestic injury	3	18.75	4	25.00	0.669 (NS)
Fall from height	1	6.25	2	12.50	0.544 (NS)
Motor vehicle accident	9	56.25	8	50.00	0.723 (NS)
Sports	2	12.50	1	6.25	0.544 (NS)
Others	1	6.25	1	6.25	1.000 (NS)

Values are expressed as mean±SD, ratio, number and %, NS = non sigificant

AO/OTA class of fracture were also comparable in both groups. 32A2 (3 and 4), 32A3 (5 and 4), 42A2 (4 and 3) and 42A3 (4 and 5) in Group A and Group B respectively.

Table - 2: AO/OTA classification

AO/OTA class of fracture	Group A (n= 16)		Group B (n= 16)		X^2 value	p value
	No.	%	No.	%		
32A2	3	18.75	4	25.00	0.254	0.614 (NS)
32A3	5	31.25	4	25.00		
42A2	4	25.00	3	18.75		
42A3	4	25.00	5	31.25		
Total	16	100	16	100.00		

In our study union time was significantly faster in Group B (15.94 ± 1.53 weeks as compared to Group A (17.63 ± 1.45 weeks) with p value of 0.0032. Functional outcome according to **Thoresen's criteria** for femur and **Karlstrom-Olerud Criteria** for tibia Excellent results was seen in 8 and 13 out of 16 subjects, good results in 3 and 3 and a Fair result in 5 and 0 patient in Group A and Group B respectively. On comparison of excellent and good results there was significantly greater number of patients in Group B as compared to Group A (p=0.015). **(Table-3)**

Table - 3: Mean time for radiological union and functional outcome of fractures

Parameters	Group A (n=16)		Group B (n=16)		p value
	Mean	SD	Mean	SD	(significance)
Mean time of radiological union	17.63	1.45	15.94	1.53	0.0032 (S)
Functional outcome					
	No	%	No	%	P value
Excellent	8	50.00	13	81.25	0.015 (S)
Good	3	18.75	3	18.75	
Fair	5	31.25	0	0.00	
Poor	0	0.00	0	0.00	

Values are expressed as mean±SD, ratio, number and %, NS = non sigificant

Movement restriction was found in 3 patients in group A in comparison to 1 patient in group B. Both groups were comparable regarding complications with non-significant *p* value **(0.285)**. Sequential evaluation of patients with post-op radiographs showed some complications in both groups. Delayed union was seen in 2 and 0, malunion in 1 and 1, limb length discrepancy in 1 and 2 patients in Group A and Group B, which were clinically and statistically insignificant (p>0.05). (Table-4)

Table - 4: Distribution of complication occurred in both groups

Complication	Group A (n= 16)		Group B (n= 16)	
	No.	%	No.	%
Yes	3	18.75	1	6.25
No	13	81.25	15	93.75
Result (P value)	0.285 (NS)			
Delayed union	2	12.50	0	0.00
Malunion	1	6.25	1	6.25
Limb length discrepancy	1	6.25	2	12.50
P value	0.666 (NS)			

DISCUSSION

The rigidity of the implant plays an important role in the early bone healing. It lets on the conditions for rapid recovery of medullary circulation, which is important for the formation of callus. It was proven that transmission of axial loads through the bone and the fracture, which can be achieved by dynamization, allows micro movements at the point of fracture, accelerates the process of osteogenesis, with the explanation that axially move fragments simultaneously reduces fracture gap, accelerates maturation of the fracture callus and bone remodeling. Dynamic nailing from the beginning of the procedure was intended to allow contact between the bone fragments in order to prevent interfragmentary gaps.

In present study, the patients were in the range of 19 – 65 years. The mean age of patients in group A was 35.13 ± 14.56 and in group B was 38.81 ± 14.73 years, which was comparable in both groups.

Of the 16 patients in both groups, 12 were males and 4 were females in group A and 10 were males and 6 were females in group B. Male

preponderance was seen in our study as seen in earlier studies also, which can be attributed to more outdoor activities and heavier labor undertaken by males as compared to females.

In study done by **Kishor BH et al** [8] they found that the mean age was 33.60 years (range 24-57 years). Out of 17 patients, 14 were males and 3 were females.

Similar finding was also found in studies done by **Jafree Sb et al** [9] (34 males, 6 female), **Drosos GI et al** [10] (119 male, 42 female) **Solooki S et al** [11] (53 male 8 female). Similar male involvement has been seen in study conducted by **Hernández-Vaquero D et al.** [12] and **Somani AM et al** [13].

Maximum fractures in our study were due to motor vehicle accidents (9 patients in group A and 8 patients in group B), followed by fall from height (3 patients in group A and 4 patients in group B). Rest of the patients (4 patients in both groups) had fractures due to sports, domestic or other injuries.

Similarly in the study done by **Kishor BH et al** [8] maximum fractures were due to road traffic accidents in 11 (64.70%), followed by fall from height (FFH) in 4 (23.52%) and assault in 2 (11.76%) patients whereas in study by **Wasudeo Gadegone W et al** [14] (42 patients were of RTA, 13 patients were of FFH and 46 patients were of assault & others)

In our study right side involved in 7 patients in group A and 10 patients in group B whereas left side involved in 9 patients in group A and 6 patients in group B. The side involved in both groups were comparable. In study done by **Kishor BH et al** [8] The left side was involved in 10 cases (58.8%), and 7 in the right side.

In our study, the dynamic group (group B) showed a faster time to radiological union (15.94 ± 1.53 weeks) as compared to static group (group A) with mean union time 17.63 ± 1.45 weeks. **Somani AM et al** [13] in their study also found faster union time in dynamic group (21.97 ± 10.01 weeks) as compared to static group (26.78 ± 9.78 weeks) which was statistically significant. Another study conducted be **Vaughn J et al** [15] have also published similar results demonstrating faster union in dynamic group. similar results of better union with dynamization have also been observed by **Hernández-Vaquero D et al** [12] Mean union time was 21 weeks in the dynamic group and 26 in the static group ($p = 0.051$). although their results did not show statistical significance. various other studies like **Basumallick MN et** [16] **and Wu CC et al** [17] have also shown similar results. **Kishor BH et al** [8] found the average time of fracture union in the case of dynamically and statically interlocked nailed tibia is 13.00 and 15.22 weeks respectively.

In our study there was few complications in both groups like malunion was seen in 1 patient and nonunion was seen in 2 patients in group A as compared to malunion in 1 patient in group B. This comparison of complications was comparable in our study. **Somani AM et al** [13] showed only 2 patients with rotational deformity and 1 patient with shortening through the nonunion, and this was treated successfully with an exchange nail. In contrast to previous reports, the current study did not find shortening of limb in both groups. **Hernández-Vaquero D et al** [12] found that in both groups 3 cases of nonunion were noted. In the dynamic group there was 1 case of delayed union and 1 case of malunion. In the static group, 5 cases of delayed union and 5 cases of malunion were found. Four reoperations were required in the dynamic group, whereas 10 were needed in the static group ($p > 0.05$). Initial degree of interfragmentary gaps had an impact on the mean time to union and the appearance of biological complications in both groups. In the study of **Kishor BH et al** [8], no cases of delayed union and nonunion were found, whereas in studies by **Drosos GI et al** [10] (4 cases of nonunion) and **Alho A et al**[18] (2 nonunion and 1delayed union) have occurred. **Ekeland et al.** [19] reported shortening of 1cm - 3 cases while 2 cm - 1 Case, **Melcher GA et al.** [20] (interlocking AO UTN nail) reported shortening of 0.5-1cm - 5 cases (25%).

In our study excellent results were seen in 8 and 13 out of 16 subjects, good results in 3 and 3 and a Fair result in 5 and 0 patient in Group A and Group B respectively. On comparison of excellent and good results there was significantly greater number of patients in Group B as compared to Group A. Similarly, **Kishor BH et al** [8] used Johner and Wruh's criteria for functional outcome and showed Excellent results in 9 out of 17 subjects, good results in 7 out of 17 subjects and a Fair result in 1 patient.

CONCLUSION

From the results of our study, we concluded that primary dynamic locking is a better option as compared to primary static locking in simple transverse or short oblique diaphyseal fractures of femur and tibia as it leads to faster fracture healing and early return to function.

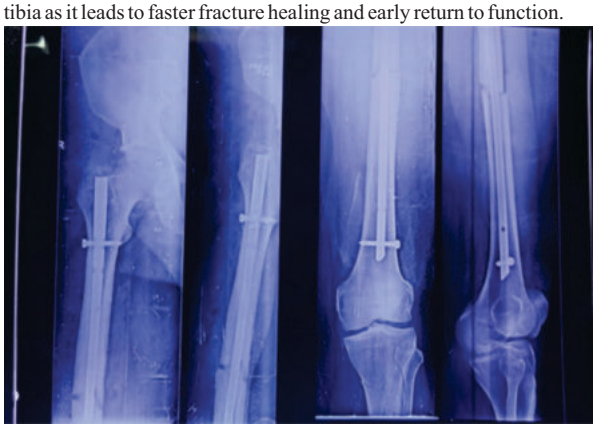

Figure 1: Dynamic femur nail

Figure 2: Dynamic tibia nail

Figure 3: Static femur nail

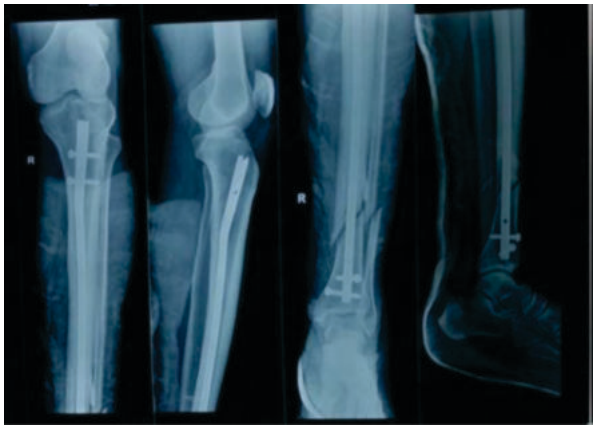

Figure 4: Static tibia nail

Figure 5: Static tibia nail: patient condition at 18 week

Figure 6: Dynamic tibia nail: patient condition at 15 week

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