

## A Study of Management of Diaphyseal Fractures of Tibia with Intramedullary Interlocking Nailing in Adults without the help of an Image Intensifier

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### Abstract:

**Background:** The tibia is more commonly fractured and sustains an open fracture than any other long bones due to its subcutaneous position. Intramedullary interlocking (IMIL) tibial nailing has biological and biomechanical advantage over plate osteosynthesis, and is usually performed using an image intensifier. Among orthopaedic surgeons, radiation induced cancer is a growing problem. Hence, to replace/supplement freehand distal locking techniques, there is need to develop a radiation safe and a near perfect method. This nail over nail technique decreases our dependence on the image intensifier. This work will also help to introduce this mode of treating fractures in resource-poor regions of the world, where image intensifiers are not widely available.

**Materials and Methods:** In this cohort study, 70 patients of 18 years or above of age, both males and females belonging to adult age group with closed and type I open diaphyseal fractures of tibia according to Gustilo Anderson classification were included and studied with outcome variables of fracture union rate, incidence and severity of complications, residual functional disability, duration of surgery, partial weight bearing.

**Results:** In our study, statistical analysis shows time required for surgery and starting for partial weight bearing were low in case of interlocking nailing. Major complications too were low in case of nailing. On the contrary, anterior knee pain and dropped hallux syndrome were detrimental to patient's satisfaction.

**Conclusion:** Good precised distal locking can be achieved with this technique without any exposure to radiation and intraoperative time was also less.

**Key Word:** Intramedullary interlocking tibia nailing; Image Intensifier; Tibia fracture; Radiation Exposure.

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### I. Introduction

The tibia is more commonly fractured and sustains an open fracture than any other long bones due to its subcutaneous position with an annual incidence fracture of 2 per 1000 individuals.<sup>1</sup> The blood supply of tibia is relatively poor, therefore, complications and major disability are frequent outcomes.<sup>2,3</sup> The methods used to achieve skeletal stabilization vary considerably depending on the configuration of fracture line and geographical location of the surgeon's practices.<sup>4</sup>

Internal fixations used were rush nails, kuntshner nails, Dynamic compression plates and screws and Intramedullary nailing. Intramedullary interlocking (IMIL) tibial nailing has biological and biomechanical advantage over plate osteosynthesis, and is usually performed using an image intensifier.<sup>5</sup> but being expensive, it is not available in the most of the hospitals of resource-poor countries of the world.

Among orthopaedic surgeons, radiation induced cancer is a growing problem, linked with a relative risk for cancer of 5.37 as compared to the general population.<sup>6</sup> Hence, to replace/supplement freehand distal locking techniques, there is need to develop a radiation free and a near perfect method in this green world to decrease carbon emissions. This nail over nail technique decreases our dependence on the image intensifier.

This work, which describes my experience in using this method, is expected to contribute to knowledge in our sub region, since there is a paucity of literature on this subject matter. This work will also help to introduce this mode of treating fractures in resource-poor regions of the world, where image intensifiers are not widely available.

## **II. Material And Methods**

This Cohort study was carried out on patients of Department of Orthopaedics at Regional institute of Medical Sciences, Imphal, Manipur, India from August 2017 to August 2019. A total of 70 subjects (both male and females) of aged  $\geq 18$ , years were for in this study.

**Study Design:** Cohort study

**Study Location:** This was a tertiary care teaching hospital based study done in Department of Orthopaedics, at Regional institute of Medical Sciences, Imphal, Manipur, India.

**Study Duration:** August 2017 to August 2019.

**Sample size:** 70 patients.

**Sample size calculation:** Sample size was calculated using two proportion sample size formula.

Here  $p_1$  is the union time for diaphyseal fractures of tibia in 24 weeks (17.24%) and  $p_2$  is the union time for diaphyseal fractures of tibia in 30 weeks (3.45 %) as per a study conducted by Kamruzzaman A et al.<sup>7</sup>

Here,  $e$  = margin of error which is taken as 5.

$$\frac{p_1(100 - p_1) + p_2(100 - p_2)}{e^2} = 70$$

**Subjects & selection method:** The sample frame included all patients 18 years or above of age who had presented to Department of Orthopaedics, RIMS, Imphal consecutively with diaphyseal fracture of tibia without comminution or segmental defects till the sample size is reached.

### **Inclusion criteria:**

1. Either sex
2. Aged  $\geq 18$  years,
3. Diaphyseal fractures of tibia.
4. Segmental and comminuted diaphyseal fractures of tibia.

### **Exclusion criteria:**

1. Compound fractures of Tibia Type 2, Type 3A, Type 3B and Type 3C, according to Gustilo Anderson classification.
2. Patient medically unfit for surgery.
3. Patients with open physis.
4. Patients having fractures with intraarticular extension.
5. Patients with comorbidities or associated fractures which may influence the outcome of the study.
6. Patients not consenting for the study.
7. Osteoporotic patients.
8. Pregnancy.
9. Compartment syndrome and other such fracture associated diseases which may influence outcome.

### **Procedure methodology**

After written informed consent was obtained, the study proceeded after getting clearance from the Research Ethics Board and included all 70 cases that satisfied inclusion criteria and had given an informed written consent. All cases with tibial diaphyseal fractures equal to or more than 18 years age who came for treatment in RIMS, Imphal, from august 2017 to august 2019 were undergone intramedullary interlocking nailing without the help of image intensifier.

This is done through the technique, When the nail was fully introduced another nail was placed over the skin parallel to the first one to act as a jig and kirschner wires was passed through the holes in it to mark small insertion on the anterior cortex of the tibia. The kirschner wires was removed and skin incisions was made to locate the small impressions made by the wires on the bone. A 4.5 mm drill hole is made at the judged entry point and countersunk to prevent the screw head abrading the tibialis anterior tendon and to improve the view of the nail. A fine sucker and a direct vertical light allow the nail to be seen, and a kirschner wire wire to be used to locate the hole. Alignment may be improved by small movements of the nail. A 3.2 mm drill is then passed through the hole in the nail to drill the far cortex. The hole is tapped and a 4.5 mm screw inserted. The procedure was repeated for all the other holes. After suturing the periosteum with vicryl, skin closure done. Compression bandage applied and the tourniquet was removed and above knee slab had been applied.

Cephalosporin antibiotic was continued till suture removal. Active knee and ankle mobilization was started immediately after 5 days postoperatively. Partial weight bearing with 2 axillary crutches was started according to the surgeon's opinion and the patient's tolerance. Gait training on the parallel bars was done on review after 1 month. Advice regarding full weight-bearing was given on the basis of pain and the stability of the fracture fixation. The patients were followed up for 7 to 9 months depending on the progress and assessed

clinically, radiologically and functionally. Functional assessment was done using the modified Klemm and Borner criteria.



**Fig 1** Insertion of guide wire through midline patellar incision



**Fig 2** Locating the distal hole using same size nail



**Fig 3** Distal hole of the nail can be seen after osteotomy



**Fig 4** Locking bolt insertion for distal locking

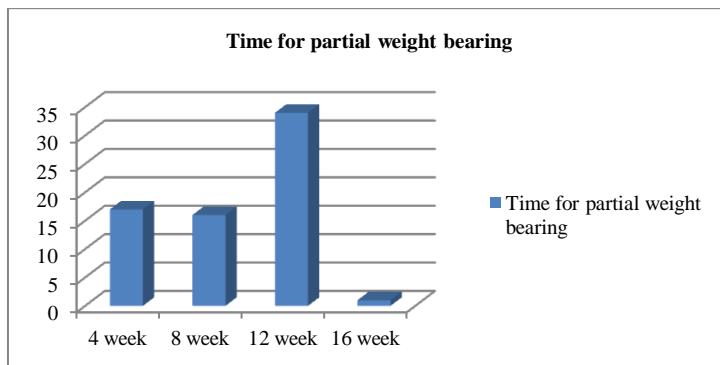
### **Statistical analysis**

Statistical analysis was done by using SPSS software (version 21.0). Data will be presented in the form of Descriptive statistics like frequency, mean and tables, bar graphs and pie charts were used.

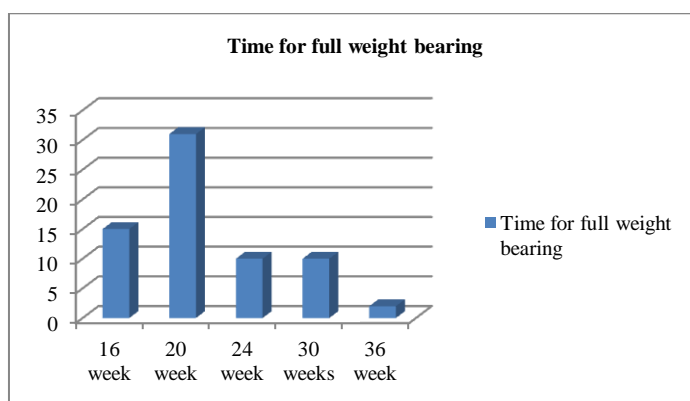
### **III. Result**

Of the 70 patients included in the study, 2 patients were lost in the follow up. Per protocol analysis was used and their data was excluded. 68 patients completed follow up to at least 7 months. In the present study 5% patients were 18-20 years old, 25% were 20-30 years old and another 25% were 30 to 40 years old. Of the remaining 10 15% were 40 to 50 years old, 17.5% were 50-60 years old and 12.5% were of 60-70 years old with the mean age being 40 years. There were 36.8% females and 63.2% males in the present study. With being Road Traffic Accident (RTA) was the most common mode of injury accounting for 64.7% cases, fall from height accounted for 20.6% cases and fall from standing height accounted for 11.8% of the cases. 2.9% presented with fracture after assault. In our study 82.4% of the population had closed fractures and rest 17.6% had type 1 open fracture. Transverse fracture accounted for 33.8% cases, oblique fractures for 26.5% cases and spiral fracture accounted for 39.7% cases. In the present study, duration of surgery was <60 minutes in 10.3% cases, 60-120 minutes in 77.9% cases and >120 minutes for 11.8% cases. The duration of hospital stay in the hospital was <7 days for 1.5% case, 7-14 days for 47% cases and >14 days for 51.5% cases.

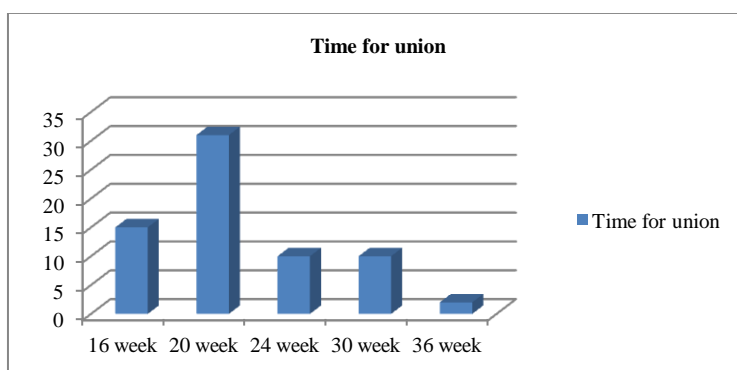
In the present study, supported partial weight bearing walking was started in 4 weeks by 17 (25%) patients. At 8 weeks 16 (23.5%) patients, at 12 weeks 34 (50%) patients and at 16 week 1 (1.5%) patient started partial weight bearing. The mean time for starting partial weight bearing in our study was 9.11 weeks.



In the present study unsupported full weight bearing walking was started in 16 weeks for 15 (22.1%) of the patients, at 20 weeks in 31 (45.5%) patients, at 24 weeks 10 (14.7%) patients, at 30 weeks 10 (14.7%) patients and at 36 weeks in 2 (3%) patients who had delayed union. The mean time for starting full weight bearing was 21.35 weeks



In the present study union was achieved in 16 weeks for 15 (22.1%) of the patients, at 20 weeks in 31 (45.5%) patients, at 24 weeks 10 (14.7%) patients, at 28 weeks 10 (14.7%) patients and at 36 weeks in 2 (3%) patients who had delayed union. The mean time for union was 21.35 weeks.



**Table 1: Distribution of participants' follow-up findings following operation up to 28 weeks (N=68)\***

Weeks	ROM-Ankle		ROM-Knee		Weight bearing			Union of fracture		Limb length		Radiological alignment		Muscle Atrophy	
	full	partial	full	partial	no	partial	full	Not united	united	equal	Not equal	normal	abnormal	absent	present
4	98.5	1.5	98.5	1.5	75	25	0	100	0	100	0	98.5	1.5	98.5	1.5
8	98.5	1.5	98.5	1.5	51.5	48.5	0	100	0	100	0	98.5	1.5	98.5	1.5
12	98.5	1.5	98.5	1.5	1.5	98.5	0	100	0	100	0	98.5	1.5	98.5	1.5

16	98.5	1.5	98.5	1.5	1.5	76.5	22.1	77.9	22.1	100	0	98.5	1.5	98.5	1.5
20	98.5	1.5	98.5	1.5	1.5	30.9	67.6	32.4	67.6	100	0	98.5	1.5	98.5	1.5
24	98.5	1.5	98.5	1.5	0	16.2	83.8	17.6	82.4	100	0	98.5	1.5	98.5	1.5
30	98.5	1.5	98.5	1.5	0	2.9	97.1	2.9	97.1	100	0	98.5	1.5	98.5	1.5

\*follow-up findings are expressed in percentages

**Clinical functional and radiological outcome:**

In this present study it was calculated using the modified Klemm and Borner scoring. According to this score 67 (98.5%) patients had excellent and 1 (1.5%) patient had good score for range of motion ankle, muscle atrophy and radiological alignment. For pain at fracture site 66 (97.1%) patients had excellent and 2 (2.9%) patients had good score. For union time 59 (86.8%) patients had good score, 7 (10.3%) patients had fair score and 2 (2.9%) patients had poor score. In final total scoring 67 (98.5%) patients had excellent scoring and 1 (1.5%) patient had good scoring.

score	R.O.M ankle	Muscle atrophy	alignment	Pain	union
Excellent	67(98.5%)	67(98.5%)	67(98.5%)	66(97.1%)	0
Good	1(1.5%)	1(1.5%)	1(1.5%)	2(2.9%)	59(86.8%)
Fair	0	0	0	0	7(10.3%)
Poor	0	0	0	0	2(2.9%)

**Table 2: scoring of individual parametes by Modified klemm and borner scoring**

Final total score	No. of patients	Percentage
Excellent	67	98.5%
Good	1	1.5%

**Table 3: Final scoring by Modified klemm and borner scoring**



**Fig 5** Post Operative radiograph in Anteroposterior and Lateral views



**Fig 6** ROM after union – sitting crossed leg



**Fig 7** ROM after union – Full knee flexion



**Fig 8** ROM after union – Full knee extension and ankle Plantar flexion



**Fig 9** ROM after union – Ankle dorsiflexion

#### **Complications:**

There were 2 patients who had delayed-union and required secondary procedure in the form of dynamization and had achieved union. The 4 patients with nailing who had persistent anterior knee pain were managed with lifestyle modification, regular physiotherapy as advised by designated physiotherapist of the hospital and NSAIDs. The 4 cases of superficial wound infection (including 1 stitch abscess was managed by local wound care and intravenous antibiotics (cefoperazone and sulfbactam) over 5 days continued by oral clindamycin (300 mg twice daily) for next 5 days. Knee stiffness, ankle stiffness and calf muscle atrophy was managed by appropriate physiotherapy supervised by a designated physiotherapist of the hospital. Dropped hallux syndrome was self limiting and spontaneously recovered by 6 months. However, methylcobalamin was supplemented to hasten the recovery. The patient with valgus malunion was asymptomatic but was instituted physiotherapy. There was no case of implant breakage or exposure of implant outside the skin in the present study.

#### **IV. Discussion**

The tibia is more commonly fractured than any other long bones due to its subcutaneous position. Intramedullary interlocking (IMIL) tibial nailing has biological and biomechanical advantage over plate osteosynthesis, and is usually performed using an image intensifier.<sup>5</sup> But being expensive, it is not available in the most of the hospitals of resource-poor countries of the world. Among orthopaedic surgeons, radiation induced cancer is a growing problem, linked with a relative risk for cancer of 5.37 as compared to the general population.<sup>6</sup> Malignancies of exposed personnel range from cancers of solid organs (e.g. thyroid and pancreas), to skin and hematopoietic cancers.<sup>8</sup> Hence, to replace/supplement freehand distal locking techniques, there is need to develop a radiation safe and a near perfect method in this green world to decrease carbon emissions. This nail over nail technique decreases our dependence on the image intensifier. Hence this study will help to

introduce this mode of treating fractures in resource-poor regions of the world, where image intensifiers are not widely available.

In our study, the mean age of the patients was found to be 40 years (range-18-68 years), similar observation were made by studies conducted by Neeraj et al<sup>9</sup> and Stinik et al.<sup>10</sup> Major population in our study was males (63.2%) and it may be due to the fact that they are involved more in outdoor activities and RTA is more common in them. And RTA itself is the most common mode of injury in our study (64.7%). In our study duration of most of the surgeries were between 60-120 minutes for 53 (77.9%) cases. In our study, the mean time for union was 21.35 weeks. 2 case of intramedullary nailing had delayed union and required dynamization before union. Saied et al<sup>11</sup> and Vallier et al<sup>12</sup> also made similar observations. The average time of starting of partial weight bearing was 9.11 weeks. The average time of full weight bearing was 21.35 weeks.

Modified Klemm and Borner criteria in our study showed 67 (98.5%) excellent for range of motion ankle, muscle atrophy and radiological alignment. Regarding pain 66 (97.1%) patients had good score and for union time 59 (86.8%) patients had good score. In total scoring by modified klemm and borner scoring 67 (98.5%) patients had excellent score and 1 (1.5%) patient had good score. Mertens et al<sup>13</sup> and Gunaki et al<sup>14</sup> also made similar observations. Anterior knee pain has been reported in 4 cases (20%) of the limbs among patients studied. In the meta analysis by Katsoulis et al<sup>15</sup>, incidence of anterior knee pain has been found to vary between 10% and 86% in various studies with mean of 47.4%. In our study, decreased range of knee motion compared to contralateral knee was found in 1 (1.5%) patient and, decreased range of ankle motion compared to contralateral ankle was found in 1 (1.5%) patients. The loss of motion was less than 10° arc in the knee in all patients. Calf atrophy was found in 1 patient. Similar observation was made by study conducted by Lefavre et al<sup>16</sup>. Dropped hallux syndrome was found in 3 (7.5%) of the affected limbs. However, all our cases were self limiting and recovered without exploration within 6 months. In the pioneering work, Robinson et al<sup>17</sup> reported a similar incidence.

In our study, statistical analysis shows time required for surgery and starting for partial weight bearing were low in case of interlocking nailing. Major complications too were low in case of nailing. On the contrary, anterior knee pain and dropped hallux syndrome were detrimental to patient's satisfaction.

## V. Conclusion

The following conclusions can be drawn from our study. Good precised distal locking can be achieved with this technique without any exposure to radiation and intraoperative time was also less. The nail over nail technique can also be used when an image intensifier is unavailable or goes out of order per operatively. Due to few intraoperative complications, fast mobilization and high union rate and less incidence of major complications, interlocking nailing without image intensifier is a good option for tibial diaphyseal fractures.

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