International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor (2018): 7.426

Observational Study: Intramedullary Nailing versus Plating in Distal Tibial Metaphyseal Fractures

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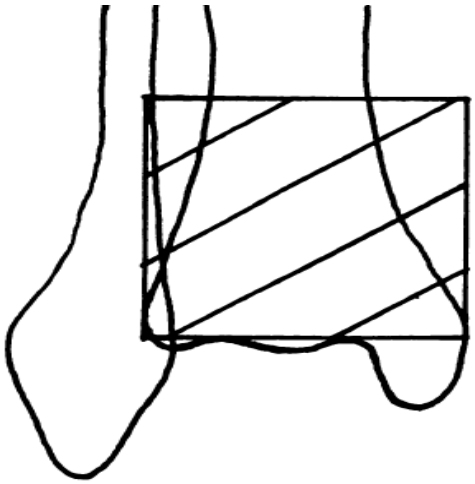
Abstract: Background: The mechanism of injury and the prognosis of extraarticular distal tibia fractures are different from pilon fractures, but their proximity to the ankle makes the surgical treatment more complicated than the treatment of tibial midshaft fractures. **Methods:** A total number of 30 patients with distal tibia metaphyseal fractures were enrolled. They were randomly divided into two groups. 15 of which were treated with intra-medullary nailing and 15 were treated with distal tibia plate. **Results**: In our study total 30 patients were treated by intramedullary nail (15 patients) and plating (15 patients) with mean age of 36.6 years and 43.47 years respectively. The mean time for Full weight bearing was 13.2 weeks (range 8-20 weeks) and 16.64 weeks (range 14-20 weeks) respectively.The mean time for radiological union was 20.33 weeks in Interlocking nail group that was significantly less than in plating group i.e. 23.21 weeks. **Conclusion:** We conclude that i.m. interlocking nail is a reliable and satisfactory method for the treatment distal tibia metaphyseal fractures with good functional results and high union rates with comparatively low complications.

Keywords: Distal tibia, extraarticular, i.m. nailing, plating

1. Introduction

Fractures of distal tibia metaphysis occur typically as a result of axial and rotational forces on lower extremity and represents approximately 10% of the fractures of distal end of tibia[(2).]



Distal tibial metaphysis

Distal tibia fractures are primarily located within a square based on the width of the distal tibia [(3).] On the basis of the fracture location in the bone; distal tibia fractures have the second highest incidence of all tibia fractures after the middle fracture of tibia [(4).] The management of distal tibia fractures is often more complex than the treatment of diaphyseal fractures because of its unique anatomical characteristics of subcutaneous location with precarious blood supply and proximity to the ankle joint, leading to the potential for postoperative complications and poor outcome.

It was in 1969 the treatment of distal tibia fractures got revolutionized by the study done by Reudi and Allgowers[(6)].The treatment of this type of fracture is of current research interest. With focus on the stabilization of the fracture and management of soft tissue injury. Multiple methods of treatment are available for managing these fractures[(8,9)]. Conservative treatment and external fixation are likely cause of loss of reduction and leads to malunion. The goal of management is to provide stable fixation and early mobilization with minimal soft tissue complications[(8)] . Plate fixation and intramedullary nails are two well accepted and effective methods. Newer nails have become the mainstay of treating tibial fractures.[(10)]. Various tibial nails have been designed to treat various tibial fractures, which includes universal tibial nail, proximal tibial nail and distal tibial nails. Intramedullary nail is a load sharing device, spares the extra-osseous blood supply, avoids soft tissue injury and allows early ambulation[(10)].

Technical problems of nail are accurate reduction of fractures[(7)] .Guide-wire placement should be in the exact center of the tibial plafond and rigid locking screw fixation is needed for the better outcome.

Conventional ORIF techniques involve extensive dissection and periosteal stripping leads to vascular damage, which increases the risk of soft tissue complications. Recent studies have suggested that the circulation of distal tibia is mainly from the anastomotic network of arteries from the anterior and posterior tibial arteries, which enter tibia from medial surface[(11,12,13)].As a result, less-invasive methods were developed to treat distal tibial fractures, which include intramedullary nailing and MIPPO[(14,15)].

Although different treatment methods have been developed for distal tibal fractures there is currently no consensus on

the optimal mode of management[5]. The main goal of treatment of distal tibial fractures are fracture reduction and stabilization till union, restoration of joint surface, delicate handling of overlying soft tissue, early functional recovery and bony union without limb length discrepancy.[14]

Pathoanatomy
Fractures in the metaphysis or in the transition zone between the metaphysis and the diaphysis may be caused by compressive or tensile forces.

If caused by compressive forces, the fractures are often crushed and axially mal-aligned. Healing of this cancellous bone may be rapid, but in an unacceptable position and dis-impaction of the fracture changes it from a stable to an unstable one.

Transition zone fractures caused by shear forces may be due to direct or indirect trauma and are usually markedly unstable. The same may be true of those caused by indirect trauma, with torsional forces.

A shearing injury through the metaphysis or the transition zone between the metaphysis and diaphysis is a high-energy one and may be associated with considerable instability and displacement. Since cancellous metaphyseal bone heals quickly if compressed and slowly if displaced, open reduction and compression of some fractures in the metaphysis or the transition zone may be desirable.[25]

2. Materials and Methods

The Prospective randomized study was conducted on 30 adult patients admitted at a tertiary care institute, to evaluate the results of Extra articular distal tibial metapyseal fractures. Patients treated with intramedullary nailing will be placed in Group-A and those requiring plating will be placed in Group-B.

Inclusion criteria
- Close displaced fracture and open fracture of distal tibia GUSTILO ANDERSON GRADE I &II only,in adults with or without associated fibula fracture.

Exclusion criteria
- Fracture in paediatric age group/ pathological/ infection/ associated fractures other than described in inclusion criteria.
- Pre-operative broadspectrum antibiotics were given on the day of surgery and antibiotics was continued for three to five days post-operatively.
- The surgery was performed under general or spinal or epidural anesthesia depending upon choice of anesthesiologist.

Commonly used techniques are:

Surgical technique for plate fixation:
A slightly curved skin incision was performed on the medial aspect of the distal tibia till the tip of the medial malleolus.

The incision was carried straight across the subcutaneous fat, preserving the greater saphenous vein and saphenous nerve, and advanced down onto the periosteum. In this anatomical space the tunneling towards the diaphysis was achieved with the blunt tip of the plate.

Tibial length, angulation and rotation was restored indirectly with manual traction and assisted by plate application. Open reduction was done as per need. Plate positioned centrally on the anteromedial aspect of the tibia with small incision (2-3cms) proximally if needed for plate positioning.

For spiral and short oblique fracture patterns, lag screw used to enhance the overall construct stability.

Plate was positioned very close to the bone, especially at the supramalleolar level, to prevent soft-tissue irritation by the plateby conventional screw or manually pressing plate to the bone, allowing the insertion of a locking head screw. For transverse type fractures, fracture compression was achieved by using eccentric placement of screws in non-locking holes. Post op below knee posterior plaster slab was applied to all patients.

Surgical technique for Intramedullary nailing:
A vertical patellar tendon splitting incision over skin extending from centre of the inferior pole of patella to the tibial tuberosity was made about 3cms long.

In the metaphyseal cancellous bone an entry portal was createdby careful placement of curved bone awl, making sure it was in line with the centre of the medullary canal. A guide wire was passed into the medullary canal of the proximal fragment. After accurate reduction by traction under image intensifier, the tip of the guide wire was passed till it enters the subchondral bone of distal tibia in centre in both AP and lateral views. Sequential reaming was done starting with size 8 mm with one mm increment till the scratching sound of the isthmus was felt.

Size of the nail was assessed as one mm less than the diameter of the last reamer. Then a properly selected and assembled nail was passed into the medullary canal over the guide wire. Distal locking was always done firstby free hand technique with two mediolateral screws or one mediolateral and one anteroposterior screw as per size of distal fragment. This was followed by proximal locking with the help of the zig using 4.9 mm Interlocking bolts of appropriate length both static and dynamic.Pollar screws used as per requirement either to aid in reduction and nail placement or stabilizing fracture.

Follow up and Result Evaluation
All patients were followed up for 6months. Regular check-ups were made at 24 hours, 3rdpost operative day, 7thpost operative day, 11thpost operative day, at 6 weeks, 12 weeks and then finally at 6 months.

Figure 1: Tibia nailing preop, postop and 6m followup

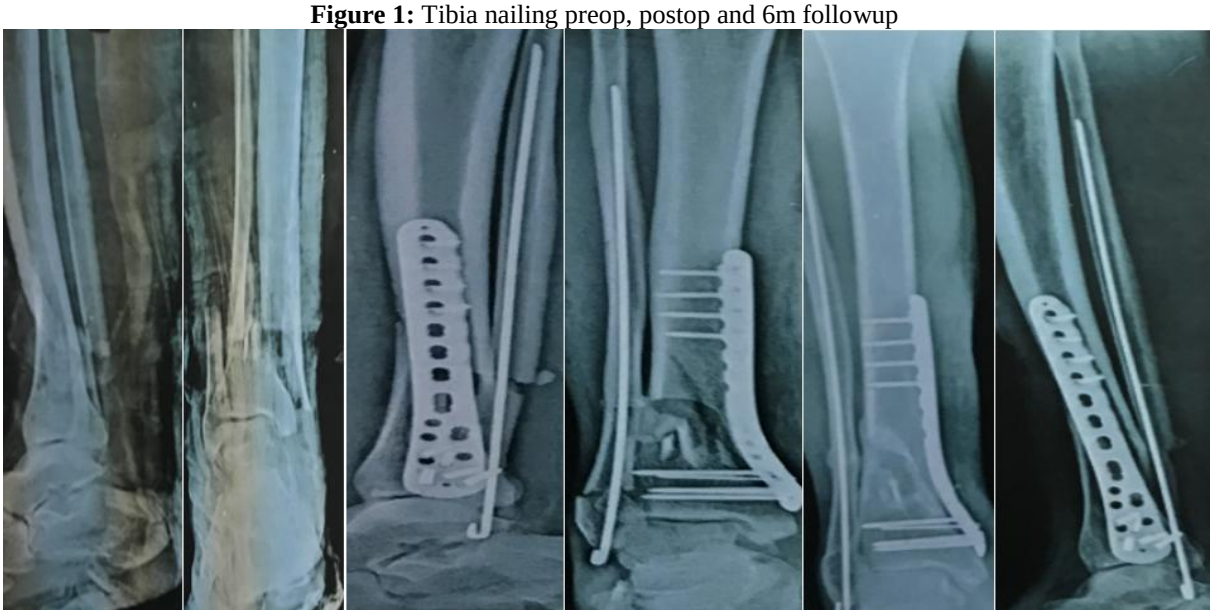


Figure 2: Tibia plating preop, postop and 6m follow up

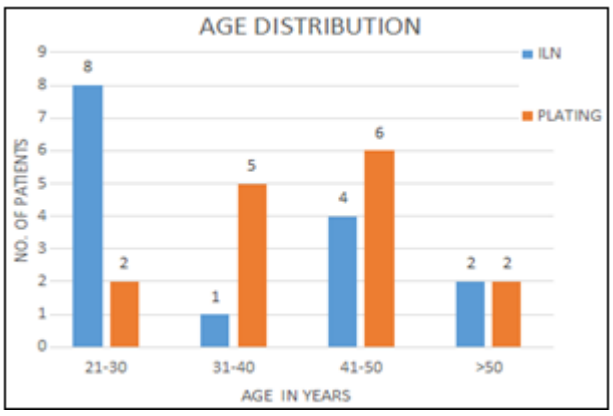
Criteria for Evaluation of Results

Final evaluation in case of distal tibial fractures was done as per Tenny and Wiss[34] (1993) clinical assessment criteria for fractures around ankle joint.It is based on 100 point system and clinical results were graded as excellent, good, fair or poor.

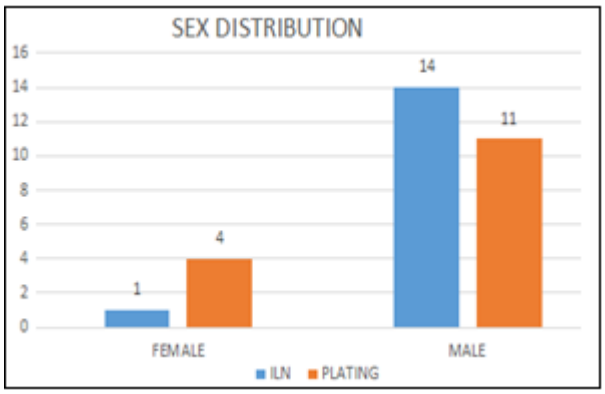
Excellent	>92
Good	86-92
Fair	65-85
Poor	<65

3. Results

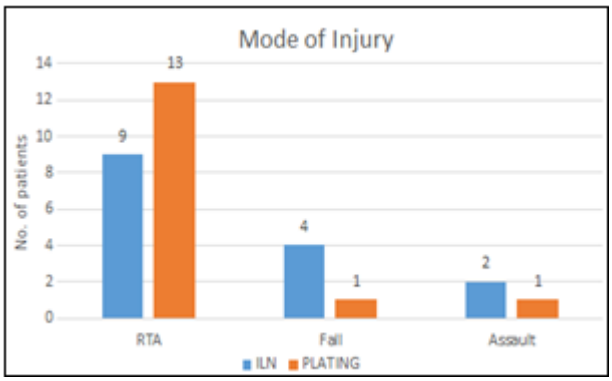
We included all patients between 21 to 74 years age. The mean age was 36.6 years and 43.47 years for Interlocking nail and plating, respectively. The p value is not significant so both groups were comparable. The most common age group was 21- 50 years that is the highly mobile age group.



Males were predominantly affected in our study accounting for 83.3% as compared to females (16.7%).The p value was not significant so both groups were comparable.



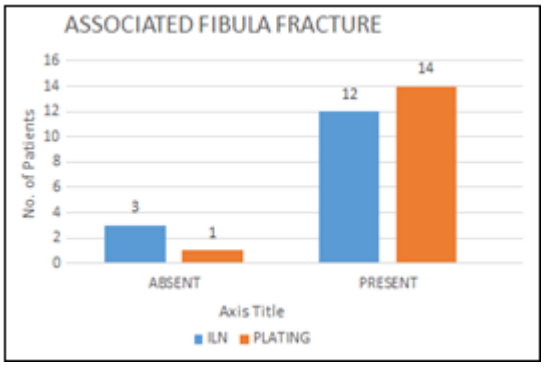
Commonest mode of injury was high velocity road traffic accidents that accounted for 73.33%. The p value was not significant so both groups were comparable.



Most common fracture pattern seen was type 43-A1 (30%) and type 42-A3 (16.66%) and 43-A2 (16.66%). In our study we included distal 42 type A, 42 type B, 42 type C and 43 type A fractures i.e. extra-articular fractures.

In our study 5 patients were Diabetic, 3 were Hypertensive and 1 was Hypothyroid. Delay in surgery occurred in order to control these comorbidities.

The right side was more involved i.e. 63.33%, as compared to left side. There was significant predilection for the fibular involvement 86.66%. Suggesting fibula was very commonly involved



In our study 53.33% patients had closed fractures, 36.66% had Gustilo Anderson type I fracture and 10% had Gustilo Anderson type II fractures. These patients were looked for dressing before they were operated

The mean delay in surgery in ILN group was 2.6 days and in plating group was 3.37 days. The minimum time was 1 day and the maximum was 10 days, as this patient had history of Diabetes and hypertension.

Mean Operative time was 77.33 mins in Interlocking group ranging from 70-100 mins was significantly less than 94.67 mins in plating group ranging from 80-115 mins ($p<0.001$).

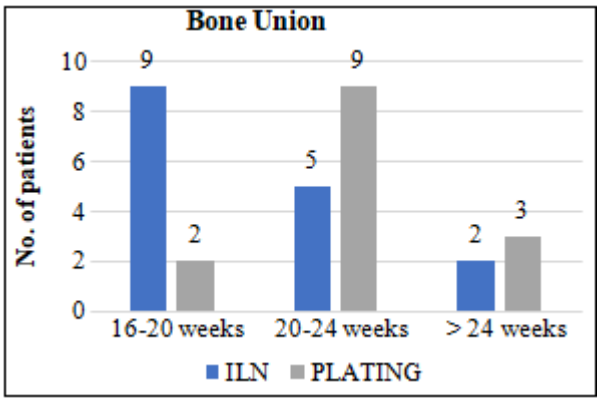
Mean duration of Hospital stay in Interlocking group was 6.6 days ranging from 4-11 days that was significantly less than plating group which was 9.27 days ranging from 6-16 days (p value 0.005).

Partial weight bearing was started in 7.2 weeks in Interlocking group (range 3-12 weeks) which was significantly early than 9.33 weeks in plating group (range 6-14 weeks).

Full weight bearing was started in 13.2 weeks in Interlocking group (range 8-20 weeks) which was significantly early than 16.64 weeks in plating group (range 14-20 weeks).

Union was defined clinically as ability to walk without any support and pain and radiologically as solid callus bridging the fracture fragments taking average mean time of 20.33 weeks in Interlocking nail group and 23.21 weeks in plating group. Majority of fractures united within 16-24 week duration.

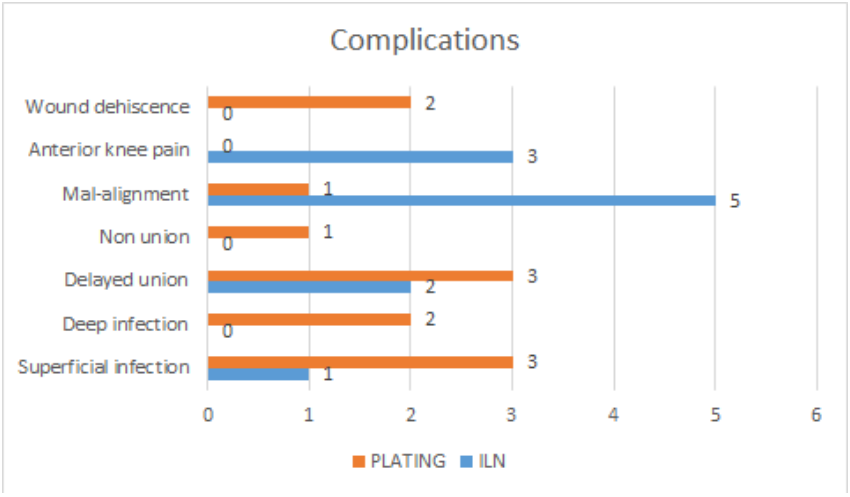
1patient of plating group showed no signs of union either clinically and radiologically at 9 months of duration. This patient was having Diabetes mellitus and hypertension and complicated by deep infection requiring repeated wound washing and secondary suturing. Bone grafting was also done in this patient.



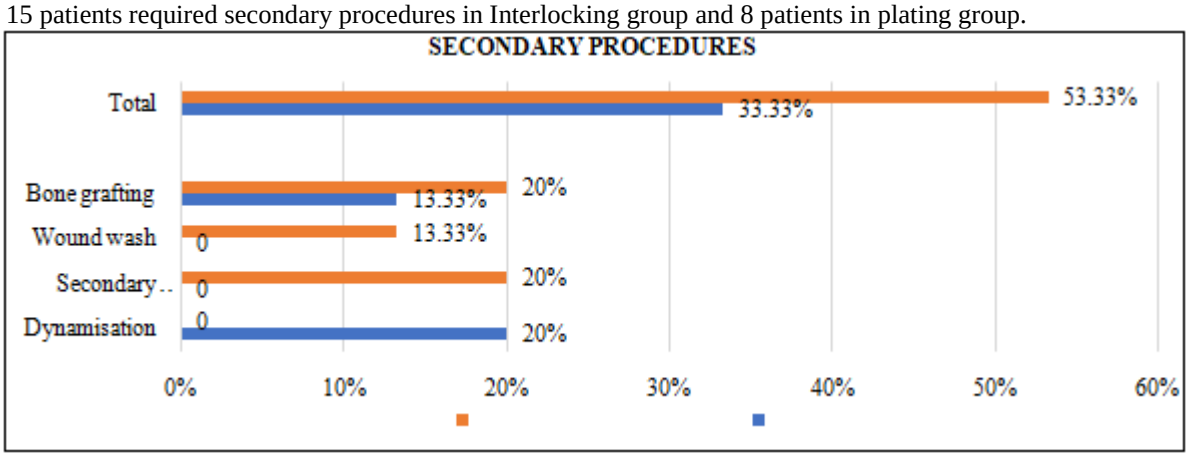
4 cases from Interlocking nail and 1 case from plating group had significant valgus (6˚-10˚). Other patients either had no varus/valgus or had acceptable 5˚ varus /valgus.

One patient from Interlocking nail group had anteversion of 6˚-10˚. Other patients either had no angulation or had ≤ 5˚anteversion /recurvation.

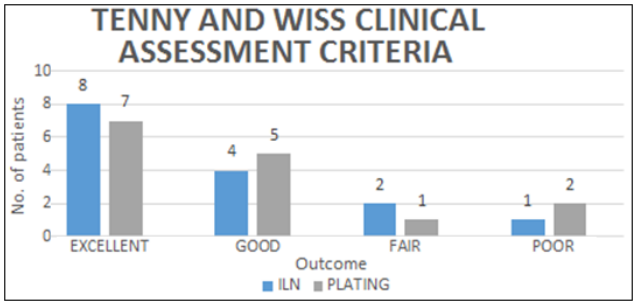
Postoperative complication like wound infection and delayed union was more in plating group than in Interlocking group whereas Mal-alignment and anterior knee pain was more common in Interlocking group



5 out of 15 patients required secondary procedures in Interlocking group and 8 patients in plating group.



TENNY and WISS Clinical Assessment Criteria



In our study, excellent results were more common in Interlocking nail groups (53.33%), compared to plating group (46.66%). The poor results according to TENNY AND WISS CLINICAL ASSESSMENT CRITERIA were more common in plating group (13.33%) in comparison to (6.66%) the Interlocking nail group. These differences were not statically significant p value 0.839.

4. Discussion

The aim of our study was to assess and compare, the final outcome of plating and Interlocking nail techniques in distal tibia fractures by Tenny and Wiss clinical assessment criteria and also compare the complications of these two techniques.

Age Distribution

In our study the mean age, in Interlocking nail group was 36.6 years and in the plating group was 43.47 years. In their retrospective study of 111 patients with 113 extra-articular distal tibial fractures treated with either plating or Interlocking nailing, **Vallier H A et al[15] (2008)** reported mean age of 39.1 years. In their prospective study**, Vallier H A et al[21] (2011)** reported mean age was 38.3 years in 104 fractures of distal tibial. **Adel E et al[22](2012)** in their study on malrotation following reamed intramedullary nailing in closed tibial fractures also reported mean age 33.4±13.3 years. All of these observations were comparable to our study.

Gender Distribution

Males were predominantly affected in our study accounting for 83.3% as compared to females 16.7%. **Adel E et al[22] (2012**) series had incidence similar to our study, having males 88.4%. **Holagundi L et al [19](2014)** found males 80% females 20% in their study. **Pawar E D et al[18] (2014**) found 90% male and 10% females.

Mode of Injury

In our study, the commonest mode of injury was road traffic accidents which accounted for 73.33%. The incidence of injury due to RTA was almost similar to series of **Pawar E D et al[18] (2014**) (60%), **Holagundi L et al [19](2014)** (73%).

Vaza J V et al[17](2014) reported RTA as most common mode in both the groups. Fall from height and physical assault were other causes of injury.

Delay in Surgery

We tried to operate the patient as soon as possible as they came to hospital. The mean delay in surgery was 3.16 days. **Pawar E D et al[18] (2014**) and **Paluvadi et al[23]**(2014) reported it as 6.89 days and 4.36 days respectively.

Fracture Pattern

In our study, we included OTA/ AO Type 42-A, B, C (distal) and 43-A fractures. OTA/ AO Type 43-B and 43-C fractures were excluded from our study. Most common fracture pattern seen was type 43-A1 (30%) and type 42-A3 (16.66%) and 43-A2 (16.66%). The pattern of fracture was similar to reported by **Pawar E D et al[18] (2014)** with OTA/AO type 43-A1 most common pattern (46.66%).

Concomitant Fibula Fracture

Concomitant fibular fracture was present in 26 out of 30 cases (86.66%) of both the groups. In study by **Vallier H A et al[21] (2011)** reported 12.5% (13 patients out of 104) had an intact fibula (n=4) or proximal fibula fracture (n=9).

Duration of Surgery

The average duration of surgery was 77.33 minutes in Interlocking group and 94.67 minutes in plating group. Which was comparable to studies done by **Li Y et al[16] (2012) & Guo et al (2010)** that was 60 minutes & 81.2 minutes in Interlocking group and 70 minutes & 97.9 minutes in plating group respectively**.**

Duration of Stay

In our study patients in Interlocking group had a significantly shorter length of hospital stay (mean 6.6 days) compared with those in plating group (mean 9.2 days) (p value 0.005) which would result in reduced health cost. **Li Y et al[16] (2012)** found similar results with hospital stay in Interlocking group 5.8 +/- 2.1 days and plating group 8.9 +/- 3.1days.

Weight Bearing

The average time to partial weight bearing was 7.33 weeks in Interlocking group and 9.33 weeks in plating group. Which was comparable to studies done by **Pawar E D et al[18](2014)** and **Vaza J V et al[17] (2014)**

		Average time for partial weight bearing	
Author	Year	Interlocking(weeks)	Plating (weeks)
Pawar E D et al	2014	4.4	7.07
Vaza J V et al	2014	7.6	9.5
Present study		7.33	9.33

Average Full weight bearing was 13.2 weeks in Interlocking group and 16.64 weeks in plating group. Which was comparable to studies done by **Li Y et al[16] (2012)**, by **Pawar E D et al[18](2014)** and **Vaza J V et al[17] (2014)**

		Average time for full weight bearing	
Author	Year	Interlocking (weeks)	Plating (weeks)
Li Y et al	2012	9.0 +/- 1.4	11.1 +/- 1.7
Pawar E D et al	2014	9.53	13.29
Vaza J V et al	2014	14.25	17.32
Present study		13.2	16.64

Bony Union-

Bony union was defined clinically as ability to walk without any support and pain and radiologically as solid callus bridging the fracture fragments taking mean time of 20.33 weeks in Interlocking nail group and 23.21 weeks in plating group (ranging from 16 weeks to 28 weeks). One patients of plating group showed no signs of union either clinically and radiologically at 9 months of durations, This duration was similar to studies done by **Li Y et al[16](2012)** (21.3+/- 3.5 in ILN group and 23.1+/- 3.6 in plating group). **Vaza J V et al[17](2014)** also reported 23.45 weeks in ILN and 26 weeks in plating group. In study by **Pawar E D et al[18] (2014)** found time of radiological union 17.43 weeks in Interlocking nail group and 21.40 weeks in plating group. There was significant difference in union time between two groups. Because ILN is less invasive procedure and early weight bearing may be allowed, the bony union was significantly early with ILN group.

Malunion-

There were non-significant differences (p=.252) in incidence in varus and valgus angulations in 2 groups, that was 4 cases (26.66%) from Interlocking nail and 1 (6.66%) case from plating group had significant valgus (6˚-10˚). 9 patients out of 15 patients in plating group were not having varus/valgus angulation. This ratio was quite high as compared to Interlocking nail group in which 5 patients out of 15 were without any varus/valgus angulation. While **Vallier H A etal[15] (2008)** reported angular malalignment ≥5˚ in 22 patients with nails (29%) and 2 with plates (5.4%, P=0.04) and 8 patients had malunion ≥10˚. while **Vallier H A et al[21] (2011)** reported angular malalignment of ≥ 5˚ in 13 patients with Interlocking nails (23% of all nails) and 4 with plates (8.3% of all plates; P=0.02 for plates versus nails).

The incidence of anteversion / recurvations were found more in Interlocking nail groups i.e. 2 patients (1-5mm) and 1 patient (6-10mm) out of 15 as compared to plating groups which had 1 patient (1-5 mm) out of 15 patients. **Li Y et al[16](2012)** found similar results with anteversion / recurvations in Interlocking group (1 patient) and no patient in plating group.

Complications

Complications encountered in Interlocking nail group were superficial infections in 1 patients, delayed union in 2 patient and anterior knee pain in 3 patients. Whereas in plating groups there were 3 delayed union, 1 non-union, superficial infections in 3 patients, deep infections & wound dehiscence in 2 patients (in which wound wash and secondary suturing was required). In the study of **Vallier H A etal[15] (2008)** founded total of 10 patients (8.8%) with complications of delayed union / non-union, out of that 8 cases (12%) were from Interlocking nail group and 1 case (2.7%) was from plating group. While in other **Vallier H A et al[21] (2011)** reported 8 patients with delayed / non-union, out of which 5 were from Interlocking nail group and 3 were from plating group.

In our study, the results were evaluated according to the Tenny and Wiss criteria. There were 80% good to excellent results in both the groups treated with plating and Interlocking intramedullary nailing. Similar results were

found in the studies conducted **by Obulapathy D et al[20](2015) and Hegazy G et al[1](2015)**

5. Conclusion

The data was assessed, analyzed, evaluated and the following conclusions were made- In osteosynthesis of extra-articular distal tibia fractures Intra-medullary nailing as well as plating deserve a place. However, in our study Intra-medullary nailing showed better outcome as it offers advantage in terms of mean operating time, less invasive surgery, hospital stay, partial & full weight bearing time and union time. But these results should be considered with caution because of modest sample size. Large rigorous RCTs are required for determination of most optimum course of management. The final choice of management should always be according to injury pattern, clinical condition and surgeon's expertise.

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