DOI: 10.14260/jemds/2014/2823

# ORIGINAL ARTICLE

## A COMPARATIVE STUDY OF INTRAMEDULLARY INTERLOCKING NAIL AND LOCKING PLATE FIXATION IN THE MANAGEMENT OF EXTRA ARTICULAR DISTAL TIBIAL FRACTURES

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**HOW TO CITE THIS ARTICLE:**
Eknath D. Pawar, Saurabh R. Agrawal, Atul W. Patil, Sandeep Choudhary, Ghaniuzzoha Asadi. "A Comparative Study of Intramedullary Interlocking Nail and Locking Plate Fixation in the Management of Extra Articular Distal Tibial Fractures". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 24, June 16; Page: 6812-6826, DOI: 10.14260/jemds/2014/2823

**ABSTRACT: INTRODUCTION:** Distal tibial fractures are very commonly encountered by orthopaedic surgeons. Our aim is to study and compare clinical and radiological outcome in extra articular fractures of distal tibia treated by interlocking intramedullary nails and locking plates with reference to rate of healing, functional outcome and complications. **MATERIAL AND METHODS:** In this study 30 patients with distal tibia extrarticular fractures, AO type 43 A were randomly selected and 15 of them were operated with interlocking nailing and remaining 15 with a locking plate. The patients were regularly followed up for a period of 1year and were evaluated clinically and radiologically with respect to tenderness at fracture site, abnormal mobility, infection, pain on movement of knee, ankle joints and anteroposterior and lateral radiographs of the leg for union of the fracture. **RESULTS:** In Interlocking group average time for union was 17.43 weeks compared to 21.40 weeks in plating group which was significant (p value <0.05). Also the average time required for partial and full weight bearing in the nailing group was 4.4 weeks and 9.53 weeks respectively which was significantly less (p value <0.0001) as compared to 7.07 weeks and 13.29 weeks in the plating group. Lesser complications in terms of implant irritation, ankle stiffness and infection (superficial and deep) were seen in interlocking group as compared to plating group.
**KEYMESSAGE:** we recommend fibular fixation whenever intramedullary nailing or locking plate fixation is used in distal tibiofibular fractures. We concluded that due to early weight bearing, early union of the fracture and decreased implant related problems and closed intramedullary interlocking nailing is preferable in treatment of distal tibia fractures.
**KEYWORDS:** Distal Tibia Fractures, Fibular Fixation, Locking Plate, Interlocking Nailing.

**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 fractures. The goal of fracture treatment is to obtain union of the fracture in the most compatible anatomical position which allows maximal and full restoration of the extremity.[1]

Tibia is one of the most commonly fractured long bone of the body. Distal tibia fractures are primarily located within a square based on the width of the distal tibia.[2] 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.[3] 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.[4] Considering its anatomy, it is commonly difficult to achieve and maintain reduction of distal tibia fractures.[5] Although different treatment methods have been developed for distal tibia fractures, there is currently no consensus on the optimal mode of management. Distal tibia fractures can be managed conservatively with closed reduction and casting or operative intervention such as closed reduction and intramedullary nailing or open reduction and internal fixation with plating or closed reduction and percutaneous plating or external fixators.[6, 7, 8, 9] Each of these techniques has their own merits and demerits.

Distal tibia metaphyseal fractures can be managed with open reduction and plate fixation. This approach often necessitates extensive soft tissue dissection and devitalisation, creating an environment, less favorable for fracture healing and more prone to infection and postoperative ankle stiffness.[9, 10, 11] As a result other methods such as intramedullary nailing, percutaneous plating have become the standard treatment for distal tibia fractures. Fracture fixation with intramedullary nails was developed in an effort to limit these potential operative complications. The use of intramedullary nails obviates the need for extensive surgical dissection, spares the extraosseous blood supply, and allows the device to function in a load-sharing manner.[12,13,14,15] However, intramedullary management of distal tibia metaphyseal fractures is accompanied by its own complications, including malalignment, hardware failure, and the risk of fracture propagation into the ankle joint.[12,16,17,18] Locked plate designs act as fixed-angle devices whose stability is provided by the axial and angular stability at the screw-plate interface instead of relying on the frictional force between the plate and bone, which is thought to preserve the periosteal blood supply around the fracture site.[2,19,20,21,22,23] Locked plates are indicated for fracture management in osteoporotic bone and in periarticular fracture patterns, making them a feasible treatment option for distal tibia metaphyseal fractures.[24,25,26,27,28,29]

Due to absence of defined criteria in the literature for the surgical treatment to extra articular distal tibia fractures, this study is conducted to compare the treatment results of intramedullary nailing and locking plate technique in terms of rate of healing, functional outcome and complications.

**METHODS:** In this study, 30 patients with distal tibia extrarticular fractures, AO type 43 A 30 were randomly selected and 15 of them were operated with interlocking nailing and remaining 15 with a locking plate. Patients with age more than 18 years, closed distal tibia fractures within 5 cm of ankle joint and with valid consent to undergo the operative procedure were included in this study while those with age less than 18years, open fractures and intra articular fractures of distal tibia were excluded.

Any emergency management if required was done and the patients were evaluated with respect to the pre operative investigations. Radiographic evaluation was done as Antero Posterior (AP) view and lateral view of the affected leg. Patients were operated under anesthesia as per the fitness of patient. Prophylactic IV (intravenous) antibiotic usually, a third generation cephalosporin was given 15minutes before surgery. All patients were given supine position following anesthesia, on a radiolucent table top to facilitate the use of image intensifier. Pneumatic tourniquet /Esmarch rubber tourniquet was used in all patients. The affected limb was thoroughly scrubbed from mid thigh to foot with betadine scrub and savlon. The limb was painted with betadine solution from mid thigh to foot. Rest of the body and the other limb were properly draped with sterile drapes. Cases in which fibula was fixed in addition to nailing or plating of tibia, was done either with a one third semitubular plate, a reconstruction plate or a rush nail. In cases fixed with plating, incision was taken just posterior to fibula, soft tissues were dissected and the reduction of the fracture fragments was achieved after cleaning the fracture site. The fracture was fixed with a six or seven hole plate with screws. In cases of rush nail fixation it was passed percutaneosly over a stab incision at the tip of lateral malleolus after reduction of the fracture manually. The passage and location of the nail was checked under image intensifier.

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. The patellar tendon was split vertically in its middle and retracted to reach the proximal part of tibial tuberosity. Next step was to determine the point of insertion. Essential for the success of the procedure is the correct choice of the insertion point. As a general rule, the insertion point should be slightly distal to the tibial plateau, just medial to lateral tibial spine on a true AP view and exactly in line with the medullary canal on lateral view.

If the insertion point is too distal, there is danger of fracturing the distal cortex of the main proximal fragment. On the other hand, insertion far too proximally bears the risk of opening the knee joint, patella comes in way of the zig or removal of nail may be difficult. After selecting the point of insertion curved bone awl was used to breach the proximal tibial cortex in, so that from perpendicular position its handle comes to be parallel to the shaft. In the metaphyseal cancellous bone an entry portal was created, making sure it was in line with the centre of the medullary canal. After widening the medullary canal with a curved awl, a guide wire of size 3mms diameter x 950mms length was passed into the medullary canal of the proximal fragment.

Reduction of the fracture fragments under image intensifier by maintaining longitudinal traction in line of the tibia was done. Accurate closed reduction of the fracture was verified under image intensifier before insertion of the guide wire in the distal tibial metaphysis. After reduction, the tip of the guide wire was passed till it enters the subchondral bone of distal tibia. In both AP and lateral views the guide wire should lie in the centre of the tibial plafond. Reaming was initiated with hand reamer of size 8 millimeter, and then with one millimetre increment till the scratching sound of the isthumus was felt. Exact length of the nail was measured from the length of the guide wire remaining inside the medullary canal from the entry point.

Size of the nail was assessed as one milimeter 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 first. It was done under image intensifier control by free hand technique. Cases in which the distal fragment was large enough to accommodate two mediolateral screws, two mediolateral screws were passed, and cases in which distal fragment was too small one mediolateral and one anteroposterior screw were passed. 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. Screw positions were confirmed under C-arm image intensifier. After this, zig was removed and stability was checked by performing flexion and extension at knee and ankle joint. Then all incisions were closed in layers. Sterile dressing was applied over the wound.

Surgical technique for locking plate fixation: The key concept of this approach was to preserve the soft-tissues and blood supply in the metaphyseal fracture area by not exposing them surgically. A straight or slightly curved skin incision was performed on the medial aspect of the distal tibia. The length of the incision varied from 3-5cms, depending on the type of the planned plate.

The incision stopped distally at the tip of the medial malleolus. The incision was carried straight across the subcutaneous fat, preserving the greater saphenous vein and saphenous nerve.

DOI: 10.14260/jemds/2014/2823



They were held anteriorly with a blunt retractor. The dissection was advanced down onto the periosteum which was completely preserved. In this anatomical space the tunneling towards the diaphysis was achieved with the blunt tip of the plate. For the insertion of the proximal screws in the diaphysis, separate stab incisions usually were taken.

Tibial length and rotation was restored indirectly with manual traction. Angulation was approximated in the same way, but was definitively corrected by plate application. The plate was inserted after proximal tunneling with the plate itself. Depending on the fracture situation, the plate was positioned on the anteromedial aspect of the tibia. Proximally, above the fracture zone, a small incision (2-3cms) was aided for plate positioning. It is important that the plate and proximal screw be centered on the tibia, particularly if locking head screws are planned.

Temporary fixation was performed with K-wires through the screw holes to approximate the final plate position before screw insertion. For spiral and short oblique fracture patterns that were anatomically reduced, we placed a lag screw to enhance the overall construct stability. It is possible to apply this screw in a percutaneous fashion under image intensifier control. Alternatively, depending on the fracture plane, the lag screw can be placed independent of the plate. Once accurate position of the plate had been achieved, a conventional screw was inserted in one of the most distal plate holes to approximate the plate close to the bone.

Alternatively, the plate could be manually pressed to the bone, allowing the insertion of a locking head screw instead of the conventional screw. It was crucial that the plate was positioned very close to the bone, especially at the supramalleolar level, to prevent soft-tissue irritation by the plate. For transverse type fractures, fracture compression was achieved by applying tension with the plate, using eccentric placement of screws in non-locking holes. Further proximal and distal screw insertion was completed. All incisions were closed in layers. Sterile dressing was applied over the wound and below knee posterior plaster slab was applied to all patients.

Post-operatively radiographs were taken. Passive knee and ankle range of motion was started in the 1$^{st}$ post operative week depending on the type of fracture and stability of fixation. Active movements were started in the second week once the pain had subsided. The weight bearing was planned as per the type of fracture, fixation and general condition of the patient. Initially partial weight bearing was advised between 4 to 8 weeks and then full weight bearing was advised when there was radiological evidence of callus formation and process of union of the fracture.

Clinical follow-up examination was performed at 4 weeks, 6 weeks, 10 weeks, 3months, 6 months and 1 year. All the patients were assessed clinically and radio graphically with following terms such as tenderness at fracture site, abnormal mobility, infection, pain on movement of knee and ankle joints and anteroposterior and lateral radiographs of the leg for union of the fracture. Student's paired t test and Chi Square test was applied to the results of both the groups for comparison.

**RESULTS:** We included a total of 30 patients in the study, 27 males (90%) and 03 females (10%) with an average age of 41.66 years (range22-68 years). The most common mode of injury in both the groups was road traffic accidents (60%), with falls being the second most common cause. Left side was the most commonly involved side in both interlocking group (53.33%) and plating group (60%). There were 7 AO type 43A.1, 5 43A.2 and 3 43A.3 type fractures in interlocking group as compared to 7 AO type 43A.1, 3 43A.2 and 5 43A.3 type fractures in plating group which was not significant (p value 0.588). Average duration from trauma to surgery in treatment of distal tibia fractures in our study was 6.83 days (1 – 19 days). Fracture of fibula associated with fracture distal tibia was seen in 09 (60%) cases in nailing group whereas it was seen in 14 (93.33%) cases in plating group. The association of fibula fracture between two groups was not statistically significant (p value 0.084).

The average duration of surgery in interlocking group was 57.20 minutes (40 – 75 minutes), and the average duration of surgery in plating group was 70.36 minutes (45 – 100 minutes). Hence the time required for interlocking nailing was less than required for plating in distal tibia fractures which was significant (p value 0.011). The average time required for partial and full weight bearing in the nailing group was 4.4 weeks (3-6 weeks) and 9.53 (8-12 weeks) respectively which was significantly less (p value <0.0001) as compared to 7.07 weeks (3-10 weeks) and 13.29 weeks (8-16 weeks) in the plating group. In Interlocking group average time for union was 17.43 weeks compared to 21.40 weeks in plating group.

So the healing rate was faster in nailing group as compared to plating group. This difference was significant (p value <0.05). Anterior knee pain and valgus angulations were the most common complications seen in interlocking group (33.33%), whereas implant irritation and ankle stiffness were the most common complications in plating group (26.66%). Deep infection was seen in two patients (13.33%) in plating group, superficial infection in two patients (13.33%) of plating group. There occurred a case of non union with implant failure in interlocking group whereas non union was not seen in plating group. However there was no significant difference in the number of complications between the two groups.

**DISCUSSION:** Distal tibia fractures are a common consequence of road traffic accidents and injuries due to fall. Its management still continues to be a problem with several unanswered questions. Distal tibia fractures generally require operative management and can be managed with closed reduction and intramedullary nailing or open reduction and internal fixation with plating or closed reduction and percutaneous plating or external fixators.[3]

Locked intramedullary nailing has the advantage of a shorter operating time, less rate of infection and early weight bearing and easier removal of the implant. Intramedullary nailing enables closed stabilization while preserving vascularity of the fracture site and integrity of the soft-tissue envelope. Open reduction and internal plate fixation results in extensive soft tissue dissection and may be associated with wound complications and infection.

Recently percutaneous plating is a popular method and has been recommended as an alternative method that minimizes the risk of infection and soft tissue problems for unstable distal tibia fractures. Locked plate designs act as fixed-angle devices whose stability is provided by the axial and angular stability at the screw-plate interface instead of relying on the frictional force between the plate and bone, which is thought to preserve the periosteal blood supply around the fracture site.[16]

In present series**,** 30 cases of extrarticular distal tibia fractures were treated primarily over a period of two years with follow up ranging from 12 months to 22 months. We evaluated our results and compared them with the result of various studies in the literature. In present study, the average duration of surgery in interlocking group was 57.53 min and the average duration of surgery in plating group was 69.33 min which was comparable to the studies done by J. J. Guo, et al[8] in 2010 and Yang Li, et al[31] in 2012. In present study, fracture of fibula was seen in 9 cases in ILN group whereas in 14 cases in plating group.

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Fixation of fibula was done in 04 cases in ILN group whereas in 11 patients in plating group which was comparable to Seyed Abas Behgoo et al[32] in 2009, Stamatios paraschou et al[33] in 2009, J. J. Guo, N. et al[8] in 2010, M. Ehlinger et al [34] in 2010, Heather A. Vallier,[35] in 2011, Yang Li et al[31] in 2012. They concluded that fixation of associated fibula fracture reduced the incidence of non union in distal tibial fractures. In present study, in the interlocking group average time to weight bearing was 9.53 weeks whereas in the plating group average time to full weight bearing was 13.06 weeks which was comparable to studies done by Redfern DJ, Syed SU, Davies SJ[36] in 2004, J. J. Guo, N. Tang, H. L. Yang, T. S. Tang[8] in 2010 and Yang Li et al[31] in 2012.

In present study**,** average time for union was 17.43 weeks in interlocking group compared to 21.40 weeks in plating group which was comparable to the studies done by Redfern DJ, Syed SU, Davies SJ[36] in 2004, Fan CY et al[37] in 2005, Kasper W. et al [10] in 2006, Bahari S. et al[38] in 2007 and M. Ehlinger et al[34] in 2010. In our study anterior knee pain and valgus angulations were the most common complications seen in interlocking group (33.33%), whereas implant irritation and ankle stiffness were the most common complications in plating group (26.66%). Deep infection was seen in two patients (13.33%) in plating group, superficial infection in two patients (13.33%) of plating group. There occurred a case of non union with implant failure in interlocking group whereas non union was not seen in plating group. These results were comparable to the studies done by Shan-Wei Yang et al [39] in 2005, Kasper W. Janssen & Jan Biert & Albert van Kampen[10] in 2006, Bahari S. et al[38] in 2007, T. W. Lau, F. Leung, C. F. Chan, S. P. Chow[40] in 2008, J. J. Guo et al[8] in 2010, M. Ehlinger et al[34] in 2010 and Yang Li et al[31] in 2012.

**CONCLUSION:** Our results have shown that both closed intramedullary nailing and locking plating can be used safely to treat OTA type-43A distal metaphyseal fractures of the tibia. Closed nailing has the advantage of shortened operating time, early weight bearing, decreased wound problems, early union of the fracture, decreased implant related problems and overall reduced morbidity, hence we prefer closed intramedullary interlocking nailing in treatment of distal tibia fractures. For fractures of the distal tibia and fibula, the proportion of patients with mal-alignment was significantly greater without fixation of fibula after intramedullary nailing or locking plate fixation. Thus, we recommend fibular fixation whenever intramedullary nailing or locking plate fixation is used in distal tibiofibular fractures.

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DOI: 10.14260/jemds/2014/2823



| AO Classification | Group | | Total |
|---|---|---|---|
| | ILN | Plating | |
| 43A.1 | 07 ( 46.66% ) | 07(46.66%) | 14(46.66%) |
| 43A.2 | 05 ( 33.33% ) | 03 ( 20% ) | 08 ( 26.66% ) |
| 43A.3 | 03 ( 20 %) | 05 (33.33%) | 08 ( 26.33% ) |
| Total | 15 (100% ) | 15 ( 100% ) | 30 ( 100% ) |

Table -1: Classification of Fractures – AO type

| Duration of Surgery | ILN | | Plating | | Total |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| 40-60 min | 10 | 66.66% | 06 | 40% | 16(53.33%) |
| 61-80 min | 05 | 33.33% | 06 | 40% | 11(36.66%) |
| >80 min | 00 | 00% | 03 | 20% | 03(10%) |
| Total | 15 | 100% | 15 | 100% | 30(100%) |

Table 2: Duration of Surgery

| Duration | ILN | | Plating | | Total |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| 8-10 weeks | 12 | (80%) | 02 | (13.33%) | 14(46.66%) |
| 11-12 weeks | 03 | (20%) | 04 | (26.66%) | 07(23.33%) |
| 13-14 | 00 | (0%) | 06 | (40%) | 06(20%) |
| >14 weeks | 00 | (0%) | 03 | (20%) | 03(10%) |
| Total | 15 | 100% | 15 | 100% | 30(100%) |

Table 3: Duration from surgery to starting total weight bearing

S.D =1.51 and 1.98

| Group | N | Mean | |
|---|---|---|---|
| ILN Union in weeks Plating | 14 | 17.43 | t=1.697 |
| | 15 | 21.40 | <p=0.05 |

Table – 4: Time taken for radiological union

| Complications | ILN | | Plating | | |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| Anterior Knee Pain | 05 | 33.33% | 0 | 0% | P=0.0421 |
| Superficial infection | 0 | 0% | 02 | 13.33% | P=0.4828 |
| Deep infection | 0 | 0% | 02 | 13.33% | P=0.4828 |
| Angulation varus/Valgus >5° | 05 | 33.33% | 02 | 13.33% | P=0.3898 |
| Knee Stiffness | 02 | 13.33% | 0 | 0% | P=0.4828 |
| Ankel stiffness | 02 | 13.33% | 04 | 26.66% | P=0.6513 |
| Non-union | 01 | 6.66% | 0 | 0% | P=1.000 |
| Implant irritation | 0 | 0% | 04 | 26.66% | P=0.0996 |
| Implant failure | 01 | 6.66% | 0 | 0% | P=1.000 |

Table 5: Complications

DOI: 10.14260/jemds/2014/2823



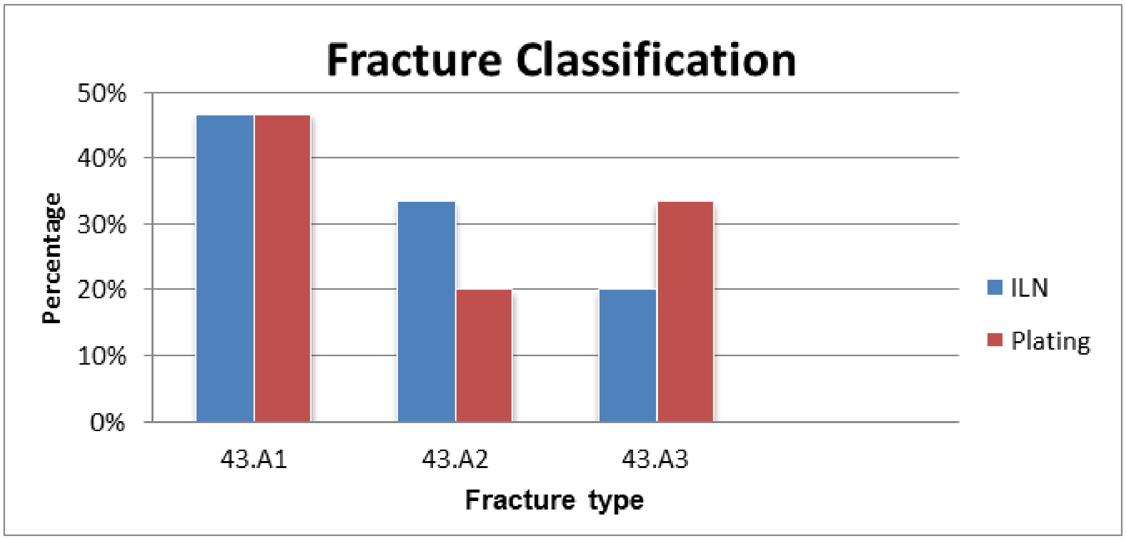


Fig. 1

**GROUP A: - Intramedullary nailing**

Fig. 2: Pre Op AP view

Fig. 2: Pre op Lateral view

DOI: 10.14260/jemds/2014/2823



Fig. 3: Immediate post op AP

Fig. 3: Immediate post op Lateral view

Fig. 4: Complete union AP view

Fig. 4: Complete union Lateral view

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**GROUP B: - Locking plate fixation**

Fig. 5: Pre op Ap view

Fig. 5: Pre op Lateral view

Fig. 5: Immediate post op AP view

Fig. 6: Immediate post op Lateral view

Fig. 6: Fracture union AP view

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Fig. 6: Fracture union lateral view

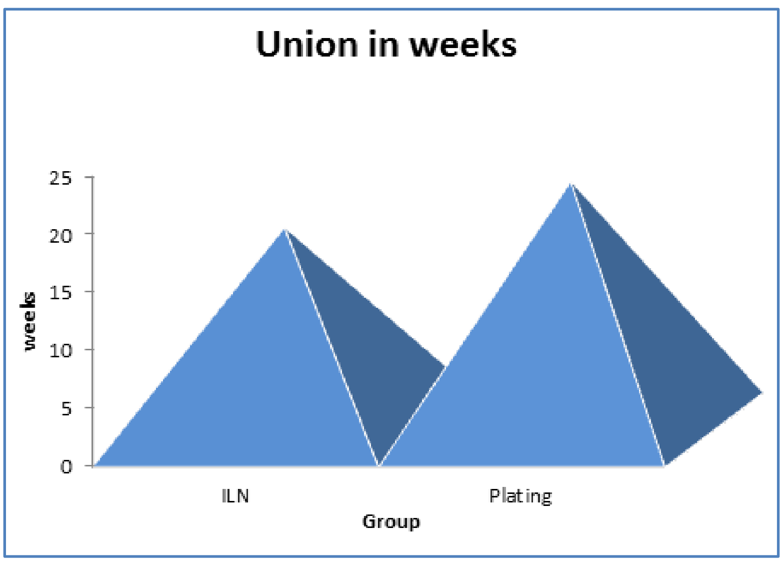


Fig. 7

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**Complications:**

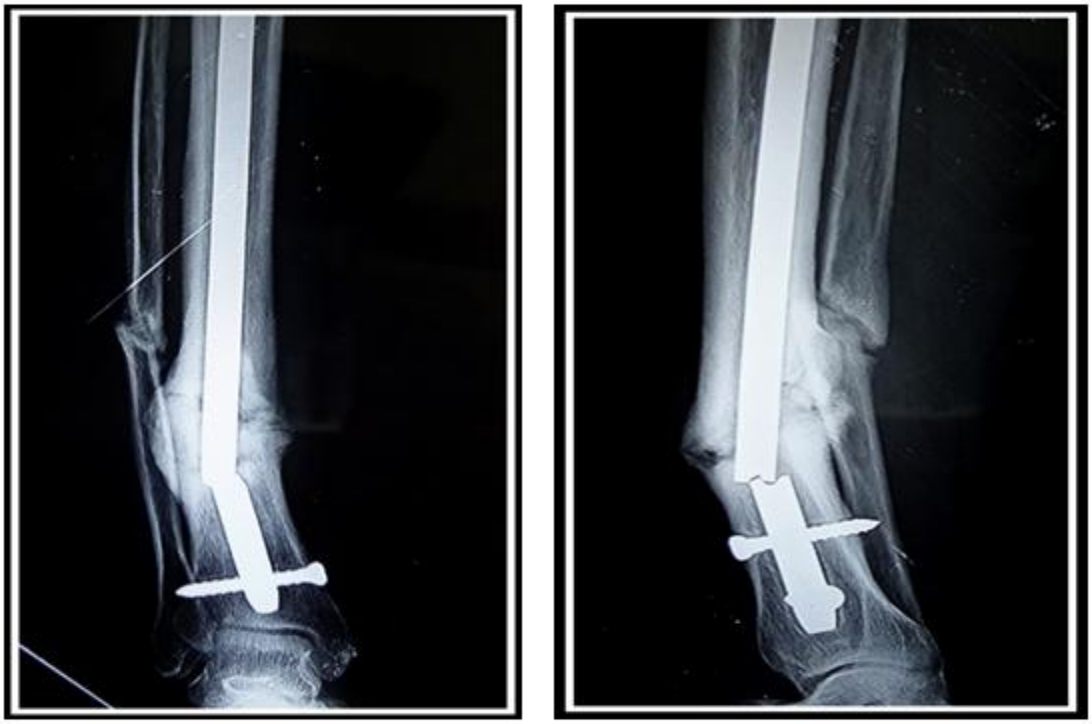

**Fig. 8: Hypertrophic non union with implant failure**

**Fig. 9: Valgus after intramedullary nailing**

**Fig. 10: Implant irritation**

DOI: 10.14260/jemds/2014/2823

# ORIGINAL ARTICLE

**Fig. 11: Deep infection after plating**

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Date of Submission: 22/05/2014.
Date of Peer Review: 23/05/2014.
Date of Acceptance: 07/06/2014.
Date of Publishing: 16/06/2014.