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A comparative study of outcome of locking plate fixation and closed intramedullary interlocking nail in the management of extra articular distal tibial fractures

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Abstract
Introduction: Distal tibia fractures are often caused by high energy axial compressive, direct bending or low energy rotation forces. These fractures constitute less than 7% of all the tibial fracture and less than 10% of all lower extremity fractures. Management of distal tibia fracture is challenging because of its subcutaneous location with precarious blood supply, proximity to the ankle joint and associated soft tissue injury. To date, locked plates, intramedullary nails and external fixation are the three most used techniques.
Aim: The aim of this study is to 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
Methods: This was a prospective study conducted in Department of Orthopaedics at Government general Hospital/Medical college between August 2018 and March 2020.The study consisted of 30 consecutive patients with Extra-articular Distal tibia fracture (distance from the joint between 40 and 100mm) divided into two groups based on the mode of management surgically with either Intramedullary interlocking nailing (IMIL) group or Open reduction and internal fixation (ORIF) or Minimally invasive percutaneous plating (MIPPO) group. The Clinico-Radiological evaluation of patients was regularly followed up for a period of 1year 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 with knee and ankle for union of the fracture. All patients were graded using The American Orthopedic Foot and Ankle Society (AOFAS) score[11] and Functional score of Olerud and Molander[12]
Results: Age range of the patients was 18-65 yr. Most common mode of trauma in both the groups is
Road traffic accident. Associated fibula fracture was present in 18 (90%) participants in group 1 and 17(85%) patients in group 2. Difference between 2 groups regarding duration of surgery is not significant. No significant intraoperative complications were noted in both groups 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. Malalignment was found in 25% of patients in group 1 and 10% of patients in group 2. Angulationin group 1 was 3.4 degree (range, 0-12) and 1.0 degree (range, 0-9) in group2 (p=0.04).
Conclusion: Our study results indicate a superiority of IMN over LP in terms of lower rates of infections and statistically significant shorter time to full weight bearing. Whereas LP appeared to be advantageous over IMN in terms of leading to a better anatomical and fixed reductions of the fracture and a lower rate of union complications. The two treatments achieved comparable results in terms of operation time, hospital stay, union time and functional outcomes. We recommend fibular fixation whenever intramedullary nailing or locking plate fixation is used in distal tibiofibular fractures.

Keywords: plate, nail, extra-articular distal tibia, outcome, surgical management distal tibia

Introduction

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.
It was in 1969(4) the treatment of distal tibia fractures got revolutionized by the study done by Reudi and Allgower where

74% of patients after surgery were pain free with good functional outcome at 4 years follow-up. Therefore in 1970's and 80's widespread use of internal fixation for distal tibia fractures became popular. However this was also accompanied by a high rate of major complications like malunions 42%, Superficial infections 20%, non-union in 18% and osteomyelitis in 17%. These high rates of complications emphasized the importance in handling soft tissues during fracture management. This led to methods which caused less soft tissue damage and yielded better results. The new techniques used were Intra Medullary nailing (IM nailing), hybrid fixators and biological minimally invasive plate osteosynthesis (MIPO). 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 metaphy seal fractures.

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

Study design: A comparative study of outcome of locking plate fixation and closed intramedullary interlocking nail in the management of extra articular distal tibial fractures was undertaken in the department of orthopedics, Mediciti Institute of Medical sciences, Medchal from July 2015 to March 2018 after obtaining ethical clearance.

Patient's enrollment: The study included both male and female patients. The patients operated after July 2015 were studied and followed prospectively.

Sample size: 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.. All the patients had fresh fractures and were traumatic in nature. Group A consisted of patients who were treated by closed intramedullary interlocking nail and group B consisted of patients who were treated locking plate by MIPO/Open. 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.

Inclusion criteria

1. Age more than 18 years.
2. Closed extra-articular distal tibia fractures within 40-100mm of ankle joint.
3. Patients who gave consent to participate in the study and procedure.

Exclusion criteria

1. Age less than 18 years.
2. Patients refusing to provide consent to in the study and procedure.
3. Open fractures of distal tibia.
4. Intra-articular fractures of distal tibia.
5. Pathological fracture.
6. Patients with associated medical condition as Diabetis mellitus

Management protocol

All 30 patients were received in emergency room following which on admission of the patient, a careful history was elicited from the patient and/or attenders to reveal the mechanism of injury and the severity of the trauma. Local examination of the injured extremity revealed swelling, deformity and loss of function. Palpation revealed abnormal mobility and crepitus at the fracture site. Distal neurovascular status was assessed by the posterior tibial artery and dorsalis pedis artery pulsations, capillary filling, local temperature, pallor and paraesthesia. Then trauma series, relevant X-rays including the affected leg with knee and ankle joints antero-posterior and lateral views were taken. Fracture patterns were classified based on the AO/OTA classification [9]. The limb was then immobilized in an above knee Plaster of Paris slab till definitive fixation was done.

All patients received treatment with Intramedullary interlocking nailing or open reducation and internal fixation or minimally invasive percutaneous plating on surgeons choice and fracture pattern.

The patients were operated under regional anaesthesia in supine position on standard radiolucent table.

Intramedullary nailing was done with Patellar splitting approach. Under image intensifier nailing was done using standard technique and all fractures were fixed with one proximal and two/three distal interlocking screws.

The patients who underwent plate osteosynthesis were operated through anteromedial approach/MIPO approach, reduction of fracture was achieved and fixed using Locking Compression plates and appropriate screws under the guidance of image intensifier. The decision for adjunctive fibular stabilization as well as number of orientation of distal interlocking screws was made at Surgeons discretion. Duration of surgery and blood loss intraoperatively was estimated for all patients.

Postoperative Protocol

Radiographic evaluation was done with standard antero-posterior

and lateral view of tibia with knee and ankle joint. Static quadriceps strengthening exercise were started on 2nd day in all patients. Active range of motion of knee and ankle exercises was started on next day of surgery in patients managed by intramedullary nailing. In patients managed with open reduction and internal fixation or MIPPO active range of motion of knee and ankle was started on 7th-10th day.

All patients were given 3-5 days of broad spectrum intravenous antibiotics. Wound inspection was done on 3rd and 5th postoperative day.

Suture removal was done on 12th to 14th postoperative day.

Patients were maintained on non- or toe-touch followed by partial weight bearing until clinical or radiographic signs of healing were seen after which full weight bearing was allowed.

Clinical and Radiographic Evaluation

All 30 patients were followed-up for clinical evaluation using The American Orthopedic Foot and Ankle Society (AOFAS) score[11] and Functional score of Olerud and Molander[12] Clinical Radiological evaluation 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. Fracture union was defined as healing of atleast 3 of 4 cortices on biplanar plain radiograph. Delayed union was defined as a lack of healing on plain radiograph within 3 months. Nonnion was defined as lack of any healing on plain radiographs within 6 months. Malunion was defined as more than 5 degree of angular deformity or shortening of more than 1cm 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

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* 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 SJ36 in 2004, J. J. Guo, N. Tang, H. L. Yang, T.S. Tang8 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 Kampen10 in 2006, Bahari S. *et al* 38 in 2007, T. W. Lau, F. Leung, C. F. Chan, S. P. Chow40 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.

Table 1: Classification of Fractures – AO type

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%)

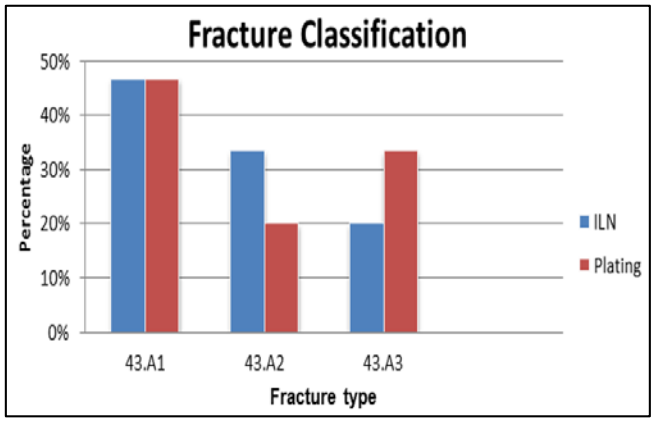

Fig 1

Table 2: Duration of Surgery

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 3: Duration from surgery to starting total weight bearing

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 4: Time taken for radiological union

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

Table 5: Complications

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

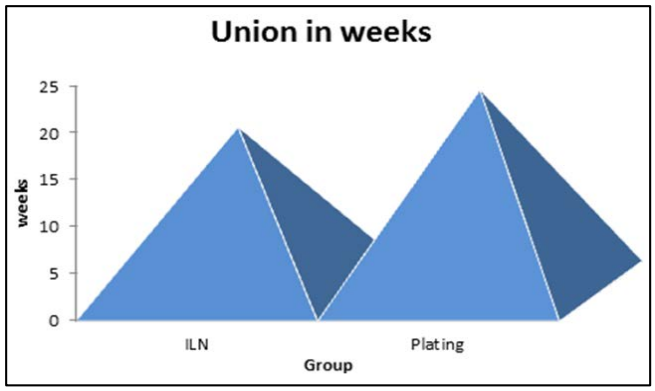

Fig 2

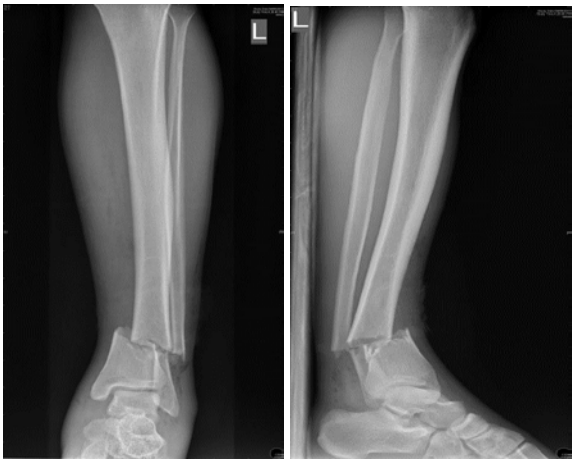

Fig 1: Preoperative Radiograph of Extra articular Distal Tibia Fracture In Anteroposterior And Lateral Views.

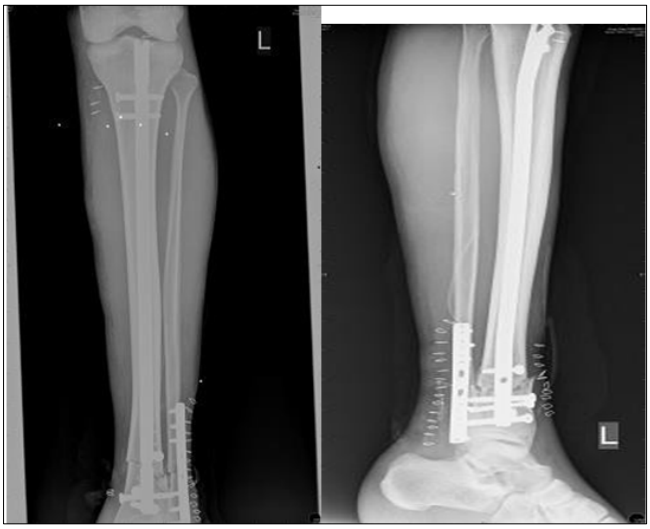

Fig 2: Immediate Post-operative Radiograph of Closed Intramedullary Interlocking Nail for Extra articular Distal Tibia Fracture in Anteroposterior and Lateral Views.

Fig 3: Clinical Picture Showing Full Rom of Ankle Joint and Squatting

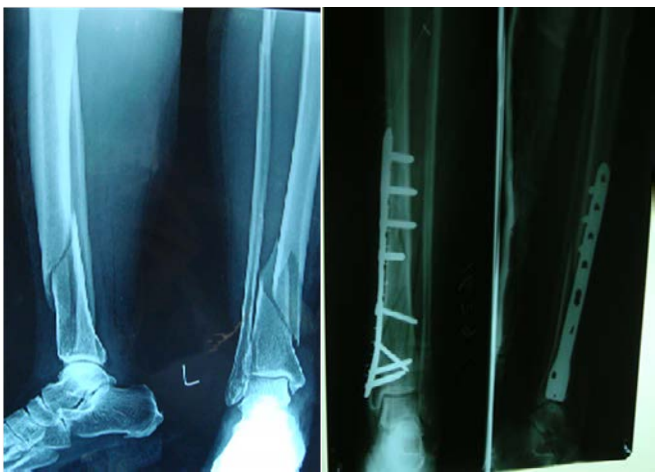

Fig 4: Preoperative and Immediate Postop Radiograph of Extra articular Distal Tibia Fracture in Anteroposterior and Lateral Views with LCP Osteosynthesis

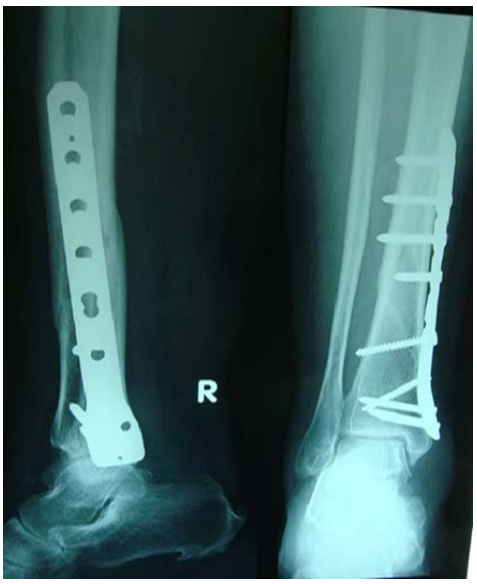

Fig 5: Follow Up Radiograph of Extra articular Distal Tibia Fracture in Anteroposterior and Lateral Views Showing Fracture Union

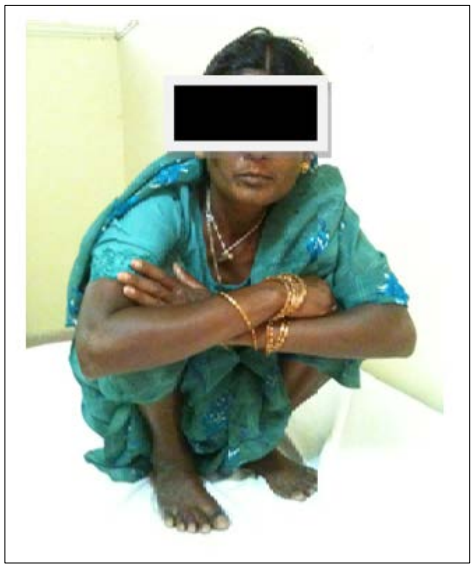

Fig 6: Clinical Picture Showing Full Dorsiflexion of Ankle Joint Squatting

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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