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Dr. Arpit Goyal
Post Graduate Trainee, Dept. of Orthopaedics, Muzaffarnagar Medical College, Uttar Pradesh, India

Dr. Hari Kripal Singh Tanwar
Assistant Professor, Dept. of Orthopaedics, Muzaffarnagar Medical College, Uttar Pradesh, India

Dr. Shubham Redhal
Post Graduate Trainee, Dept. of Orthopaedics, Muzaffarnagar Medical College, Uttar Pradesh, India

Dr. Gaurav Jain
Professor, Dept. of Orthopaedics, Muzaffarnagar Medical College, Uttar Pradesh, India

Dr. Lalit Kumar
Professor, Dept. of Orthopaedics, Muzaffarnagar Medical College, Uttar Pradesh, India

Corresponding Author:
Dr. Arpit Goyal
Post Graduate Trainee, Dept. of Orthopaedics, Muzaffarnagar Medical College, Uttar Pradesh, India

To study outcome in patients of extra articular distal tibia fractures managed with interlocking nail

Dr. Arpit Goyal, Dr. Hari Kripal Singh Tanwar, Dr. Shubham Redhal, Dr. Gaurav Jain and Dr. Lalit Kumar

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Abstract
As surface of tibia is subcutaneous along most of its length and its vascular supply of tibia is perilous compared to any other bone surrounded by heavy muscles? These types of fracture are often associated with compartment syndrome or neuro-vascular injuries. As there is existence of a hinge joint at the knee and the ankle that permits no adjustment for rotational deformity after fracture, distinctive care is being required during reduction of these type of fractures to correct such deformity.
The problems associated with fixation of distal tibia fractures include local and deep infections, local implant irritation, knee pain, stiffness of ankle, transient peroneal nerve palsy, malalignment and subsequent malunion and non-union.
This study deals with the ability to maintain a mechanically stable reduction in extraarticular distal one-third tibia fractures managed with intramedullary nailing.
Materials and Methods: This was a hospital-based prospective study on the outcome in 20 patients of extra-articular distal one-third tibia fractures, who will be admitted in the Department of Orthopaedics of Muzaffarnagar Medical College, Muzaffarnagar over a period of 18 months.
Results: Mean age of patients was 39.05 years (18-80). Fracture union was seen radiologically within 3 to 6 months depending upon the pattern of fracture.
Conclusion: We conclude that fractures of extraarticular distal one-third tibia with or without associated fractures of fibula managed with closed intramedullary nailing had the least number of complications, allows early partial weight-bearing and 95% of the patients achieved union by the end of 6 months. Thorough planning and placement of the nail at the center of a wide metaphysis in anteroposterior and lateral view is essential to overcome varus, valgus and posterior tilt.

Keywords: Distal one-third tibia fracture, interlock nailing, extraarticular tibia fracture

Introduction
Tibial fractures are the most common fractures of a long bone, with the incidence of 492,000 fractures annually. As tibia is one of the chief load-bearing bones of the lower extremity, therefore, tibial fractures can lead to widespread disability, sustained morbidity unless the treatment is appropriate.
As the surface of the tibia is subcutaneous along most of its length and its vascular supply of tibia is perilous compared to any other bone surrounded by heavy muscles. These types of fractures are often associated with compartment syndrome or neuro-vascular injuries. As there is the existence of a hinge joint at the knee and the ankle that permits no adjustment for rotational deformity after fracture, distinctive care is being required during the reduction of these types of fractures to correct such deformity. The problems associated with fixation of distal tibia fractures include local and deep infections, local implant irritation, knee pain, stiffness of ankle, transient peroneal nerve palsy, malalignment and subsequent malunion and non-union [3, 4]. Various options in the management of distal fractures according to the pattern of fracture and the soft tissue damage around the fracture are closed reduction and cast, intramedullary nailing, plates and screws fixation and external fixation. Non-operative treatment of these fractures has become less popular due to inadequate reduction, stiffness of ankle, malalignment leading to subsequent malunion and problems of cast disease. The two most commonly practiced methods for management of distal tibial fractures are closed reduction and internal fixation, either with intramedullary (IM) nailing or plates and screws.

There is an ongoing debate regarding which one is superior over the other, especially in case of distal tibial fracture not involving the ankle joint. We assumed that better results might be obtained when distal meta-diaphyseal fractures are managed by intramedullary (IM) nailing. As the metaphyseal diameter is larger than the diameter of the nail, malalignment is a common problem encountered in distal third tibial fractures.[5] To encounter this problem, recent advances in intramedullary nailing have been made, which has permitted surgeons to stabilize distal tibial fractures using multiplanar locking options. The evaluation of the use of poller screws (blocking screws) and fibular plating as a addition to fixation along with statically locked IM nail of small diameter is also being done.

Looking at the encouraging results of this device in fractures of distal tibia as reported in literature, we planned to study the outcome in patients of extra-articular distal tibial fractures managed with interlocked intramedullary nails.

Advantages of the closed intramedullary nail over plating

1. In closed intramedullary nailing, the fracture hematoma is preserved, that is essential for the healing of fracture thereby increasing the chances of union.
2. The intramedullary nail is a load-sharing device, therefore early weight-bearing can be started as compared to plating that is a load-bearing device and weight-bearing is started after the union.
3. Better rotational stability as a result of proximal and distal locking screws.
4. The short duration of surgery, decreased soft tissue damage, decreased blood loss thereby decreasing chances of infection.
5. Reaming in nailing technique itself acts as a bone graft, thereby aids in the union.

Reamed intramedullary nails are being preferred in cases of closed fractures of distal one-third tibia as it allows the use of larger diameter nails and therefore promoting fracture stability and union [6, 7] with the solid nails (unreamed nails) are nowadays preferred over external fixator.

Evaluation of soft tissue is most critical in the management of tibia fractures as most of it is subcutaneous. A close look for presence of swelling, blisters is required and for subsequent planning for delay in surgery. Haemorrhagic blisters indicate skin necrosis which needs special attention.

The duration of surgery is determined by the condition of soft tissue. Simple fractures can be managed within 6-8 hours. For other cases, surgery can be delayed once the skin condition is good and swelling subsides. Elevation of the limb, drugs to relieve edema, Magnesium sulphate dressing can be used to relieve edema.

Materials and Methods

Cases are classified based on AO classification:

AO Classification

- Type A: Extra-articular fractures
- A 1: Simple metaphyseal fracture
- A2: Metaphyseal wedge fracture
- A3: Complex metaphyseal fracture

Source of data

This was a hospital-based prospective study on the outcome in 20 patients of distal one-third tibia fractures managed with interlocking nailing, who will be admitted in the Department of Orthopaedics of Muzaffarnagar Medical College, Muzaffarnagar over a period of 18 months.

Inclusion criteria

1. Extra-articular distal Tibia fractures.
2. Patients with age above 18 years.

Exclusion criteria

1. Fractures are located above the junction of proximal two-thirds and distal one-third.
2. Intra-articular extension of fractures.
3. All Pathological fractures.
4. Open distal tibial fractures.
5. Deformed tibia.
6. Previous history of infection in ipsilateral foot or lower limb.
7. Known case of osteomyelitis of the tibia.

Investigations

1. Haemogram
2. Renal profile
3. Coagulation profile
4. Urine routine
5. Viral markers (by rapid method)
6. Random Blood Sugar
7. Electrocardiogram (E.C.G)

Chest X-Ray P.A view, X-Ray Anterior Posterior (AP) and Lateral view of the knee with leg and ankle with the leg. Anesthesia team performed a preanesthetic evaluation.

Operative technique: Intramedullary nailing. Surgery was performed under spinal anesthesia with a tourniquet and under an image intensifier on a radiolucent fracture table. Surgical site prepared scrubbed, painted and draped. Surgery was done under a tourniquet to avail a bloodless operative field and to minimalize the blood loss.

- By traction and manipulation, reduction was attempted. A ball-tipped guide wire was then inserted down the medullary cavity through the entry point. In the presence of fluoroscopy guidance, the guided wire was advanced distally after reducing the fracture until it reached the subchondral bone above the ankle. The guide must be central in both Antero-posterior and lateral view.
- Reaming of the medullary canal was carried out with sharp cutting cannulated reamers, while keeping the knee in flexion while reaming, the assistant holds the reduction. After reaming, ball-tipped guide wire was replaced with a non-ball tipped one using an exchange tube. The position of reamers is checked with the help of a C-arm. Appropriate size of the nail was estimated with the help of calibrated scale. The nail was mounted over the insertion handle assembly and inserted through the entry portal into the medullary canal after manually manipulating the fracture, the nail was advanced through the fracture site. Insertion was supported by gentle blows using a slotted hammer.
- Proximal and distal interlocking is done by fixation with screws by free hand technique under image intensifier control.
- Polar screws or temporary k wires was very useful to direct the nail in a central position.
- Post-operative physiotherapy regime was started. Patients were encouraged to do active toe movements on the day of surgery. Mobilisation of the ankle and knee of the affected side was done on the first post-op day. Patients were encouraged to sit on 2nd post-op day with an operated limb hanging from the bedside and encouraged

to actively mobilise knee and ankle. Non-weight bearing toe touch ambulation was started as soon as the pain was bearable and patient could perform active SLR. Anti-biotics (I.V./Oral) were continued till the wound condition obliges. Intravenous antibiotics were administered for 72 hours post-surgery and oral antibiotics were sustained for 5 days. Suture removal was performed at 12th-14th post-operative day depending on situation of the wound and check x-rays were done.

- Patients were be followed up in the out patients department monthly for up to six months. On each visit, local site was looked for any signs of inflammation, infection, range of motion of ankle and knee was assessed, ambulatory status of the patient was documented and X-rays of the involved limb were taken.
- Results were assessed.

Observations and Results

The following observations were made from the data collected during study of the outcome of extra-articular distal tibia fractures managed with interlocking nails in the department of Orthopaedics, Muzaffarnagar Medical College. This study included 20 patients with age, ranging from 18 years to 80 years with a mean age of 39.05 (range, 18-80 years). It was observed that distal one-third fractures of the tibia were more common amongst young and middle-aged people, with greater occurrence observed in 3rd and 4th decade of life.

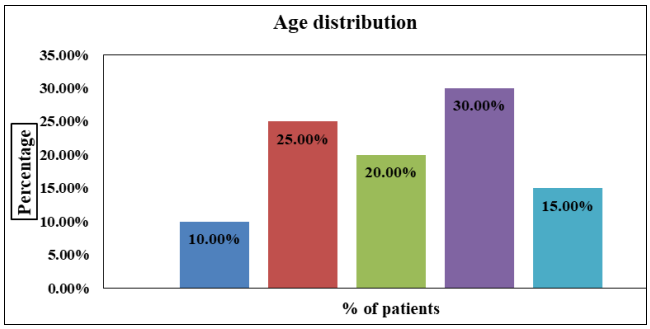


Fig 1: Age of patients

Avg. age (Mean ±SD) (years)	39.05 ± 15.57
Range (years)	18-80

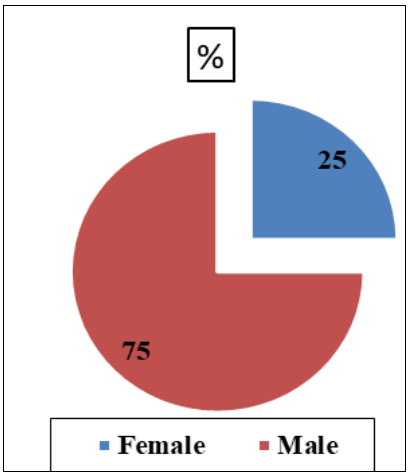


Fig 2: Distribution of patients according to gender

The ratio of Female to Male patients- 1:3

Out of 20 patients taking part in our study, 15 of our patients were males and 5 were females (male: female = 3:1). Therefore, there has been the greater occurrence of distal tibial fracture among males.

The most common cause of distal tibial fractures was as a result of roadside accidents. Of the 20 cases, in most cases (70% of 14 cases), it is the most common mode of injury resulting in distal tibial fractures. Other reasons were fall (20%, 4 patients) followed by assault (10%, 2 cases). Amongst the 5 female patients taking part in our study, two resulted in distal tibia fractures due to road traffic accidents and the remaining had a history of falls, most among them were trivial.

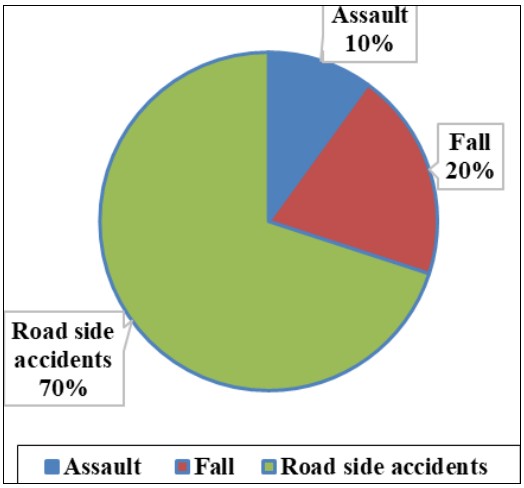


Fig 3: Distribution of patients as per the mode of injury

All of the distal tibia fractures were graded according to AO/OTA classification and more than half of these were type A2 fractures. A3 (1 patient, 5.00%) was the least common subtype.

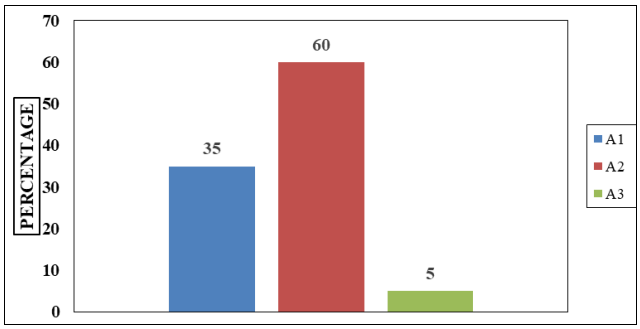


Fig 4: Distribution of patients according to the type of fracture

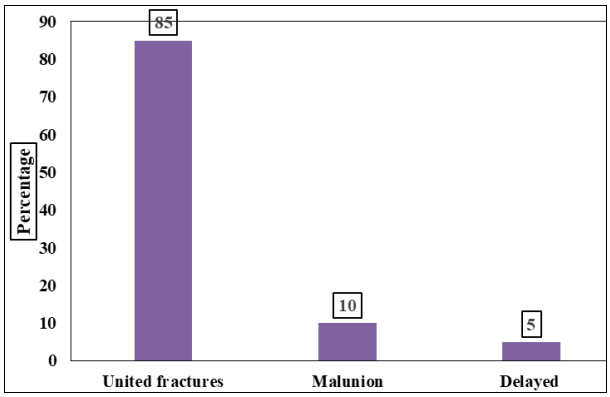


Fig 5: Distribution of patients having united fractures and non-union

The average time of full weight-bearing is 8.3 weeks. The decision to allow full weight was taken on the patient to

patient basis. It was started by 6 weeks in 5 patients, 8 weeks in 9 patients, and 10 weeks in 4 patients, by 12 weeks in 2 patients.

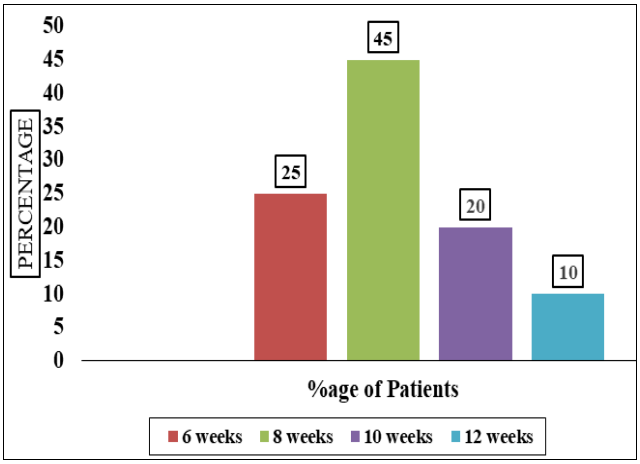


Fig 6: Distribution of patients according to full weight-bearing

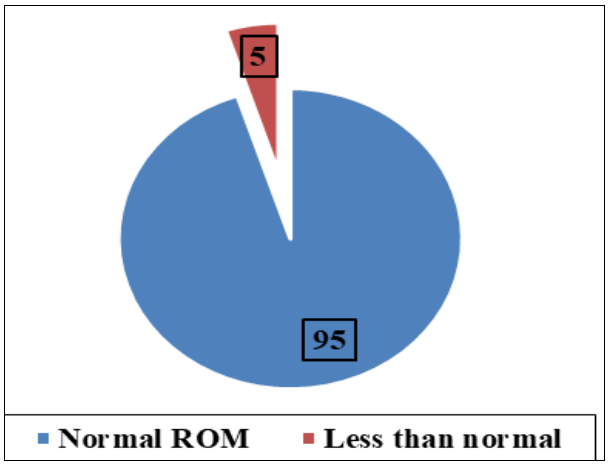


Fig 7: Distribution of patients according to restricted knee range of motion

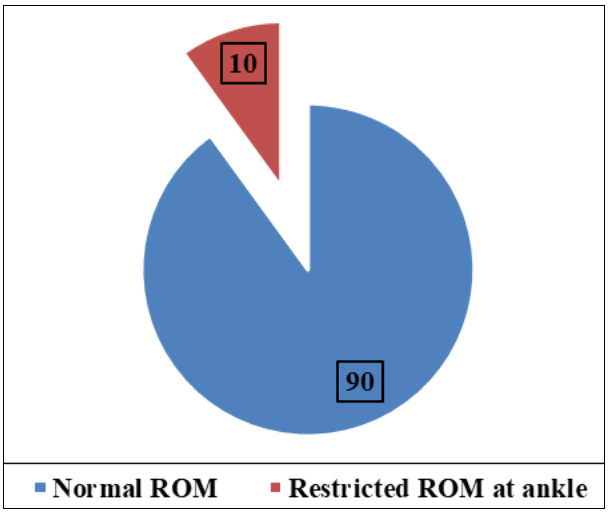


Fig 8: Distribution of patients having restricted Ankle Range of Motion (Planter Flexion, Dorsiflexion)

Out of 20 patients, infection was observed in one patient. This patient had a deep infection of the proximal locking site. Malunion was observed in two patients (10%). All two had valgus malalignment. Metalworks failure was reported in two patients. The first patient had a prominent interlocking bolt from the proximal interlocking site causing pain and the second patient had concomitant intramedullary k-wire fixation of fibula causing pain.

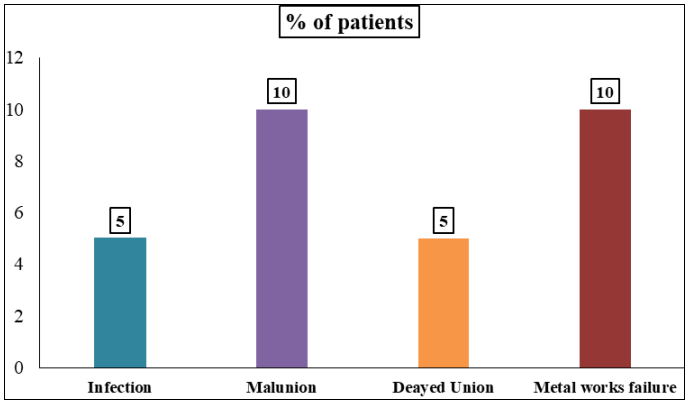


Fig 9: Distribution of complications

In our study, ankle pain (35%) was the most common complaint amongst the patients, trailed by swelling (15%), anterior knee pain (10%) and pain at the fracture site (5%). Furthermost, patients of angular malunion went to develop ankle pain in the future.

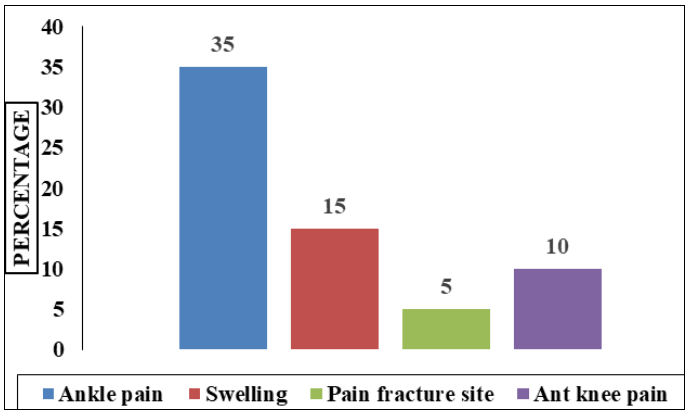
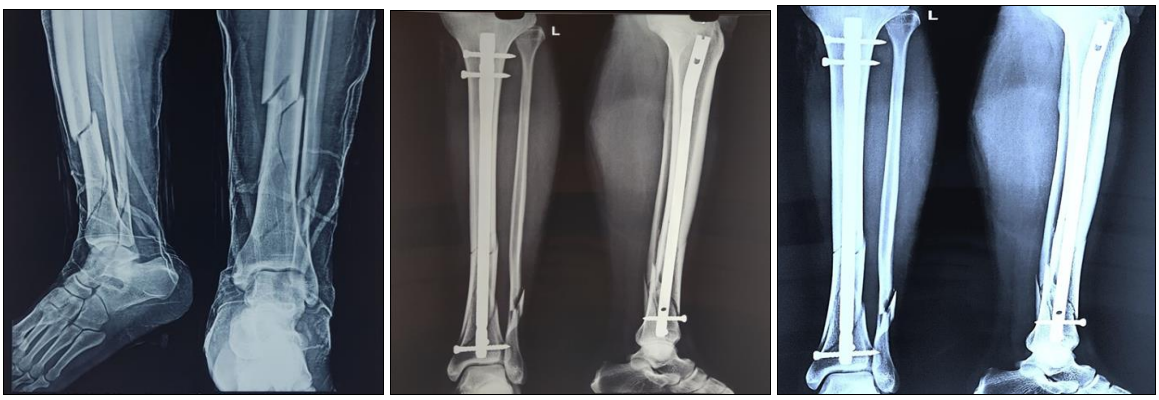


Fig 10: Distribution of complications among patients

Preoperative X-Ray Postoperative X-Ray

3rd month follow-up 6th month follow-up

Case 1



Preoperative X-Ray Postoperative X-Ray 3rd month follow-up

6th month follow-up

Knee ROM

Tibia nail

Dorsiflexion

Plantar flexion

Case 2

Discussion

The present study enrolled a total of twenty patients. One patient had isolated fractures of the distal third tibia and one patient had a segmental fracture of the fibula. The mean hospital stay was 11.2 days among the patients studied.

Age/Sex distribution: This study included twenty patients with age, ranging from eighteen years to eighty years with a mean age of 39.05 (range, 18-80) years. Out of these, 15 were males and 5 were females (Male: Female = 3: 1). The majority of comminuted fractures of distal third tibia were observed in young and middle-aged patients. Nine patients were treated for a right-sided fracture and eleven patients were treated for left-sided fractures.

The other studies of distal tibia fractures have also reported mean age of 38- 48.1 years with a male preponderance.

Vallier *et al*., (2011) [6] assessed plate versus intramedullary nail fixation in one hundred four patients sustaining extra-articular distal tibia shaft fractures with a mean age of 38 years (range, 18-95 years). Of these, eighty-five patients were males and nineteen were females. Hence, our study correlates with above-mentioned reports. We conclude that fractures of the distal end of the tibia are more common in young and middle-aged populations. The reason behind this being that these age groups are more often involved in outdoor activities making them more prone to injuries.

Mode of Injury

Out of twenty patients, more than two-thirds (70%, 14 patients) suffered distal tibia fractures as a result of road traffic accidents. Other causes were falls (20%, 4 patients) followed by assault (10%, 2 patients). Among the 5 female patients in our study, only 2 sustained injury due to road traffic accidents and rest had a history of fall, majority of which were trivial. Begkas *et al*. (2014) [7] evaluated forty two pateints with aseptic non-union of distal third tibia fractures. They observed that road traffic accidents (69%) caused the maximum number of tibia fractures in their study, followed by fall from height (19%).

Other authors have also observed that the majority of distal tibia fractures are a result of road traffic accidents followed by falls, this is a cause of concern especially in a developing country like India, given the high population density in large urban areas. The second factor contributing to it is a dramatic increase in vehicle ownership in our State of Uttar Pradesh in the last few years and poor traffic discipline has only made matters worse.

Fracture grading

Among the 20 patients enrolled in this study of distal tibial fractures, the fractures were graded according to AO/OTA classification. It was observed that out of 20 fractures, 7 were graded as Grade A1, 12 were graded as Grade A2, 1 was Grade A3.

Paraschou *et al.*, (2009) [8] evaluated the results of intramedullary nailing in the treatment of extra-articular distal tibial fractures and non-unions. Out of thirty five fractures, thirty one were closed and four were open. The fractures were classified according to AO/OTA classification. Twenty seven fractures were type A 1, 6 fractures were A2 and 2 fractures were A3.

As compared to above mentioned study. In our study, A3 was the least common type of fracture and A2 being the most common grade presenting among the population.

Full Weight Bearing

Full weight-bearing walking was started after clinical and radiological healing of the fracture. The average time of full weight-bearing was 7.9 weeks. The decision to allow full weight was taken on the patient to patient basis keeping in mind the associated injuries as well. It was started by 6 weeks in 5 patients, 8 weeks in 9 patients, 10 weeks in 4 patients, 12

weeks in 2 patients.

Guo J *et al.* (2010) [9] conducted a study on 85 patients with distal tibia fractures, out of which 44 were managed with interlocking nails. The authors allowed partial weight-bearing usually around 6 weeks after the operation, when there was radiological evidence of progress towards unions. A decision regarding full weight-bearing was made on an individual basis, depending on the progression of the union. The patients were followed up clinically and radiologically at intervals of six weeks until the bony union was achieved.

Fracture union/Non-union

Union had been defined radiologically as the presence of bridging callus in 3 or more cortices seen in biplane radio graphs without fracture site pain on full weight-bearing. Out of 20 fractures of distal tibia included our study, 19 fractures united and 1 in delayed union. The average time to union was 18.45 weeks. We observed delayed union in one pateint.

Vallier *et al.,* (2011) [6] reported a series of one hundred four patients with extra-articular distal tibial fractures, out of which 56 patients had been managed by interlocking nails. Mean follow-up time was 19.9 months. They reported a non-union in 4 patients (7.1%). All non-unions occurred after an open fracture. In our study, we considered only closed fractures. Intramedullary nailing with early partial weight-bearing resulted in the union in more than 90% of cases and one patient has delayed union.

Complications

Infection: One (5%) of patients in our study developed infections. This patient had a deep infection (proximal locking site) following a closed fracture for which the implant was removed and oral antibiotics were prescribed after the fracture had healed at 6 month follow-up. As of now, this patient has no discharge from the proximal interlocking site. Petrou *et al.* (2010) [10] conducted a study on 142 distal tibial fractures managed with reamed intramedullary nailing. They reported superficial infection in one case at the entry point of the nail.

Thus, we can infer from our study that only one case has been found proximal interlocking site infection, closed intramedullary nailing have the least chances of causing deep skin infection.

Metalworks failure: Metalworks failure was reported in two patients. The first patient had a prominent interlocking bolt from the proximal interlocking site causing pain and the second patient had concomitant intramedullary k-wire fixation of fibula causing pain. The symptomatic metal work was removed. No cases of breakage or proximal nail prominence have been observed in our study.

Vallier et al., (2008) [11] evaluated 111 patients with 113 extra –articular distal tibia fractures between 4 and 11 cm proximal to the plafond. 76 were treated with an intramedullary nail. Two patients had prominent interlocking bolt removal done for pain relief.

Malunion: Achieving and maintaining a good reduction is the most difficult aspect of nailing in distal tibial fractures. In mid-diaphyseal fractures, insertion of the intramedullary nail aids fracture reduction as the nail has a diameter only slightly smaller than the cavity in which it sits, ensuring coronal and sagittal alignment. However, in distal tibia fractures, the flare of the metaphysis, allows a "windscreen wiper" action of the distal fragment and prevents interference fit of the nail in the bone, making reduction difficult. Other factors contributing to malunion are small distal segments and technical errors occurring during surgery.

Our criteria for malunion were the radiographic alignment of more than 5° in any plane. In our case series, malunion was observed in two patients (10%). Both patients had questionable compliance as they started weight-bearing against advice. In our study, all the malunion were valgus. Both patients having malunion eventually developed ankle pain.

Zelle *et al.,* (2006) [12] reviewed 1125 fractures of distal without articular involvement. Out of these, 489 patients were managed with intramedullary nailing. The authors reported a malunion rate of 16.2% in patients undergoing nailing.

Associated/Secondary procedures

In our study, none of the patients underwent associated procedures during the primary management of the fracture of the tibia. The further secondary procedure was performed in one patient in an attempt to achieve fracture union or manage complications.

In two patients, concomitant stabilization of fracture ipsilateral fibula was done with plates and screws and in one with intramedullary k-wire.

Two patients got painful hardware (intramedullary wire and proximal locking bolt) removed.

In one patient, the nail was removed in view of infection at the proximal interlocking site. In one patient, dynamization was done 3 months post-operation.

Vallier *et al.,* (2011) [6] reported 14 secondary procedures in 10 patients managed with IM nails. Five of their patients underwent interlocking bolt removal, one patient underwent bone grafting for tibial defect, one patient underwent dynamization and fibula osteotomy, two patients underwent exchange nailing and one patient underwent exchange plating and bone grafting for non-unions.

Restricted ankle/knee range of motion

2 patients in our study had decreased range of motion (planterflexion and dorsiflexion) at the ankle. One of these patients has decreased ROM at ankle by approximately 30 degrees of planter flexion and 10 degrees of dorsi flexion. One patient had decreased ROM by approximately 5 to 10 degrees. One patient had decreased ROM at knee was suffering from osteoarthiritis bilateral knees. But the patient did not notice any difference in limitation in ROM and this did not affect their return to employment.

Paraschou *et al.,* (2009) [8] reported a limitation of ankle movements in a range of 5 to 10 degrees In 5 patients and no restriction in knee motion in their study consisting of 45 extra-articular distal tibial fractures and non-unions.

Ankle pain and knee pain

Out of 20 patients in our case series, seven patients complained of ankle pain and two patients complained of knee pain. Out of 7 patients, 2 patients had malunion at the fracture site. The intensity of both ankle and knee pain is mild to moderate and not limiting activity in most. However, one of the patients had persistent ankle pain and has angular malunion of more than 10 degrees.

3 out of these 7 patients are being prescribed NSAIDS regularly in view of pain. Most patients complained of pain on prolonged standing and associated ankle pain with prominent distal interlocking screws.

Causes of knee pain can be multifactorial. It can be caused by nail prominence, decreased quadriceps strength and injury to

patellar tendon while carrying out the surgery.

Paraschou *et al.*, (2009) [8] evaluated the results of interlocking intramedullary nailing in the treatment of extra-articular distal tibial fractures and non-unions. The authors reported knee pain in four patients due to the protrusion of the nail and it disappeared after the removal of the nail.

Conclusion

Finally, this can be concluded from the Study that closed fractures of distal one-third tibia with or without associated fractures of fibula managed with closed intramedullary nailing had least number of complications, allows early partial weight-bearing and 95% of the patients achieved union at the end of 6 months.

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