Original paper

Plate Versus Nail Fixation in Treatment of Distal Tibia Fractures

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Abstract

Background: Fractures of the distal third of the tibia are the major cause of morbidity in patients with lower extremity injuries. Most fractures are sustained in adults during high velocity injuries.
Aim: To compare the radiographic and clinical results of patients with extra- articular unilateral closed or type I (Gustillo and Anderson) open fractures of the distal third of the tibia shaft, treated with ORIF with those treated with closed reduction and IM nailing.
Patients and Method: This is prospective study on Fourteen patients treated with ORIF were matched to fourteen patients treated with IM nailing. RESULT: There were no significant differences in regard to: time of surgical procedures, non-union, hardware failure or deep infections between plate fixation and intramedullary nailing.
Conclusion: From this study we can conclude that, no much difference in regard to the time for union, nonunion, hardware failure and deep infections between ORIF and IM nailing. For optimal alignment we are considering the use of ORIF for closed and type I open extra articular fractures in the distal third of the tibia
keywords: Distal tibial fractures, Intramedullary nail, Plate, prospective study, Union complication.

Introduction

Fractures of the shaft of the tibia are among the most common fractures encountered in orthopedic practice. The tibia is a strong and large bone and about one third of its surface is subcutaneous. So, it is liable for fractures and the majority are of high energy may be associated with multiple system injuries [1]. Because the tibia is one of the principal load-bearing bones in the lower extremity, fractures can cause prolonged morbidity and extensive disability unless treatment is appropriate. The tibia is the large weight-bearing medial bone of the leg, it articulates with the condyles of the femur and the head of the fibula above and with the talus and the distal end of the fibula below figure (1) [2].

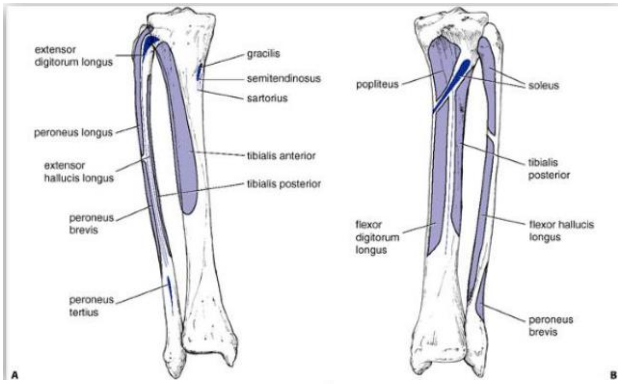

Figure 1. The anterior (A) and posterior (B) anatomy of the leg bones From.; Charles M., Rockwood & Green's Fractures in Adults, 6th edition, chapter 47, 2006. [2] .

The blood supply to the tibia is more precarious than that of bones enclosed by heavy muscles. Figure (2) [3].

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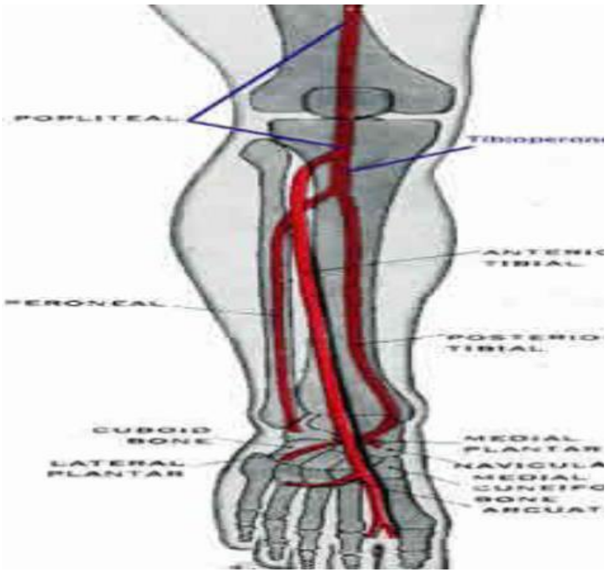


Figure 2. main blood supply of tibia C.R. Wheeless. Wheeless' Textbook of Orthopedics. e book. 1996. [3].

Several techniques are now available for their treatment, and the orthopedic surgeon must be aware of the advantages, disadvantages, and limitations of each to select the proper treatment for each patient. The type and location of the fracture, the degree of comminution, degree of soft tissue injury, the age of the patient, the patient's social and economic demands, and other factors may influence the method of treatment. [1, 4].

Many modalities of treatment are invented, including casting, external fixators and internal fixations including plate and screws and intramedullary nailing. [1]. Tibia fractures have been treated successfully in the past conservatively by casting. [1]. Many displaced fractures are unstable and they need more rigid fixation. For years there were so many discussions between closed reduction and external fixation and open reduction and internal fixation. Tibia being subcutaneous increase the risk of infection and nonunion. [4]. Fractures in which closed treatment is inappropriate can be treated with plate and screw fixation, intramedullary fixation (interlocking intramedullary nails), and external fixation. Locked intramedullary nailing currently is the preferred treatment for most tibial shaft fractures requiring operative fixation. Plating is used primarily for fractures at or proximal to the metaphyseal-diaphyseal junction. [4].

As with all fractures, tibial diaphyseal fractures can be classified in a number of ways. [5]. The most comprehensive classification of tibial diaphyseal fractures is the Orthopedic Trauma Association (OTA) classification initially described by the AO group figure(3). [5].

Patients and methods

This is prospective study done to Fourteen patients treated with open reduction and internal fixation were matched to fourteen patients treated with Intramedullary nailing on the basis of gender, age decade, and the Association orthopedic classification of the fracture.

Eventually, fourteen matched pairs of patients were assessed from November 2010 to January 2013 (Table 1)

All patients but two had a fracture of the tibia and the fibula. In each group 1 patient had an isolated fracture of the tibial shaft. All fibula fractures were left unfixed. Pneumatic tourniquet used adjusted at 300mmg pressure and 90 minutes maximum time.

In all patients managed with closed reduction and IM nailing the nail was inserted after reaming.

In all patients the static locking mode was used, with 2 proximal and 2 distal locking screws.

All 14 patients managed with ORIF were treated with a dynamic compression plate and screws.

The size and shape of the plate depended on the comminution and classification of the fracture. In most patients, one or more lag screws were used to optimize contact between the fracture parts.

In general, patients were seen 2 weeks after the operation and every 6 weeks thereafter. Radiographs were used to determine the time to union of the fractures. Radiographic union was defined as the presence of bridging callus in 3 of the 4 cortices as seen on anteroposterior and lateral radiographs. Delayed union was defined as radiographic union after>24 weeks. Alignment was determined radio graphically.

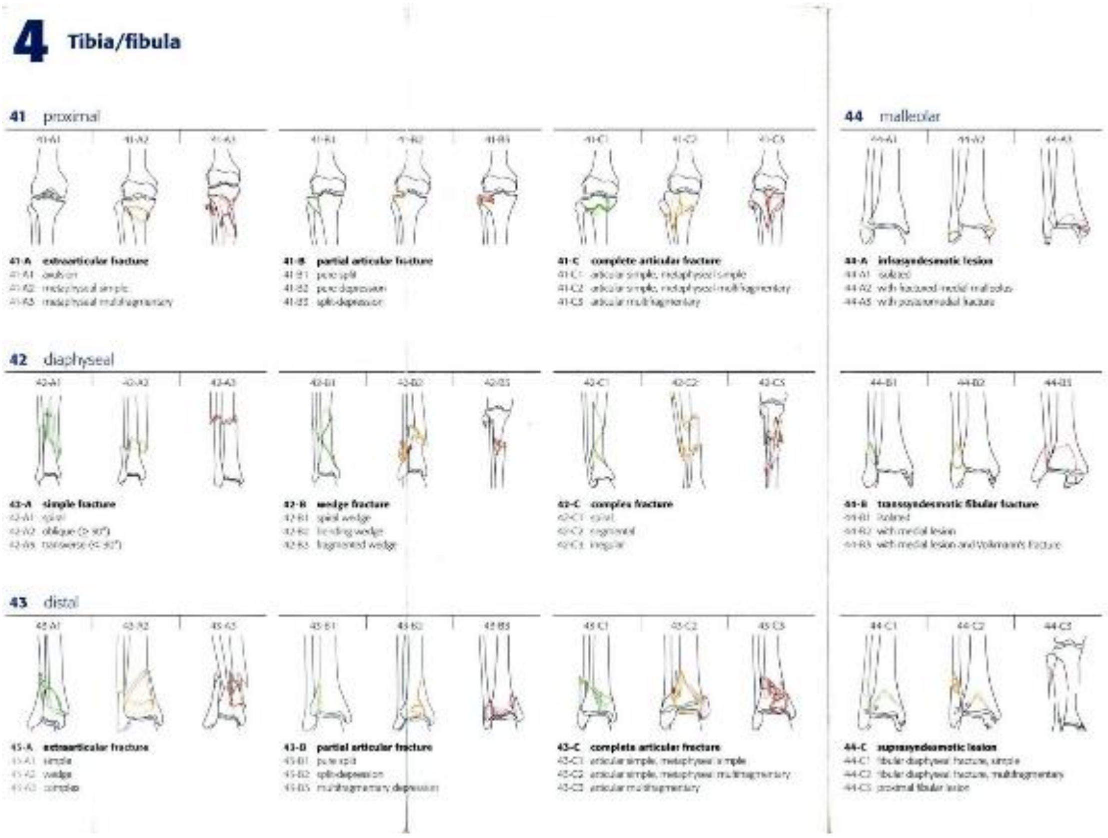


Figure 3. The Orthopaedic Trauma Association (OTA) AO classification of tibial diaphyseal fractures from Müller AO classification of Fractures –long bones……… Leaflet 2010 by Ao Trauma

Table 1. Characteristics of the 14 matched pairs of patients open reduction internal fixation and intramedullary nail

Open reduction and internal fixation				Intramedullary nailing			
Case	Gender/age (years)	AO class 42 A/B/C	Follow-up (years)	Case	Gender/age (years)	AO class 42 A/B/C	Follow-up (years)
1A	Female, 64	A2	2	1B	Female, 61	A2	1.5
2A	Female, 58	A1	2	2B	Female, 52	A1	3
3A	Female, 53	A1	1.5	3B	Female, 47	A1	1.5
4A	Female, 42	A1	2	4B	Female, 42	A2	3
5A	Female, 39	A3	3	5B	Female, 39	A2	2
6A	Female, 35	B2	3	6B	Female, 36	B2	3
7A	Female, 38	A1	2	7B	Female, 37	A2	2
8A	Male, 34	A1	2	8B	Male, 36	A1	3
9A	Male, 25	A3	1.5	9B	Male, 31	A3	2
10A	Male, 39	A3	3	10B	Male, 25	A3	2
11A	Male, 37	A1	3	11B	Male, 38	A2	3
12A	Male, 36	A1	2	12B	Male, 21	A1	3
13A	Male, 35	B2	2	13B	Male, 22	A3	2
14A	Male, 35	B2	2	14B	Male, 24	A3	2

figure 4. Reduction of fracture with guide rod. Campbell's Operative Orthopedics,12th edition,2012. (6)

Active range of motion of the ankle and the knee were assessed clinically.

Rotational alignment was assessed clinically by recording the position of the patient's feet . Patients were asked to sit on the examining table with their patellae pointing forward and to relax their feet. Then a model (a disc for marking the position of the feet) was placed under their feet to record the rotation difference.

For alignment measurement anteroposterior and lateral radiographs were made for both legs.

The length of the tibia was defined as the distance between the anterior intercondylar area and the inferior articular surface of the tibia. Shortening was defined as a left/right difference in the length of the tibia of >1 cm. Malalignment was defined as >5° procurvation/ recurvation, >5° varus/valgus deformity or >15° rotation difference.

First, the angle between the distal part and the proximal part of the contralateral tibia was determined by measuring the angle between the line through the centre of the tibial plateau down the middle of the proximal shaft, and the line from the center of the ankle up the middle of the distal shaft. Thereafter, the angle between the distal part and the proximal part of the consolidated tibia was measured. This was done in two directions, on anteroposterior and lateral radiographs. (figure 5 and figure 6).

Figure 5. varus/valgus deformity case(5)

Figure 6. procurvatum-recurvation deformity. case (1)

Patients with a clinical rotation difference of >15° and a clear rotation difference as assessed on the radiographs were considered to have rotational malalignment. (figure 7).

Preoperative planning for all patient includes:

1. General assessment.
2. Understanding of the mechanism of injury.
3. Good quality radiographic imaging.
4. Haematology investigation.
5. Prepare matched blood.

All fractures were treated by IM nailing reduced closely under fluoroscopic control, Pneumatic tourniquet done with 300mmg pressure and 90 minutes maximum time, A 5-cm incision along the medial border of the patellar tendon, a curved awl is used to access the medullary canal through the standard entry point. A guide wire is introduced and followed with fluoroscopy to ensure passing the fracture site and centered in the distal segment, reaming of the canal and choosing the appropriate nail size and insert it. Fix the nail with reamed intramedullary nail with proximal guided and distal free hand locking screws with no application of tourniquet and traction table was used.

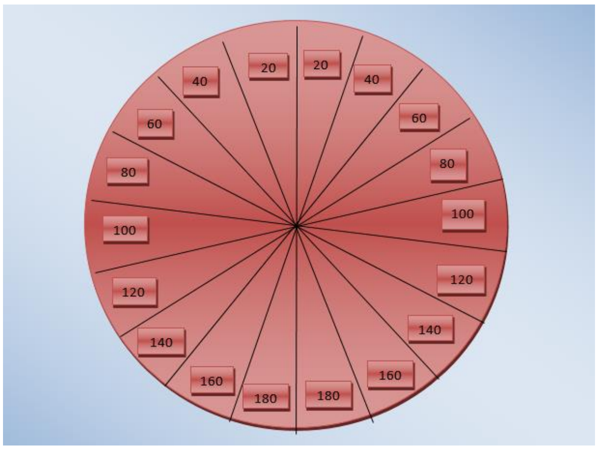


Figure 7. Rotational Malalignment

All fractures were treated by ORIF, a longitudinal incision 1 cm lateral to the tibial crest, expose the fracture, and retract the muscles laterally. No stripping of the periosteum circumferentially; subperiosteally elevation only necessary tissue for accurate fracture reduction. Determination of the length of the plate, using bending instruments to contour the plate to the tibia surface. For tibial shaft fractures in which plate fixation can be used, more commonly employed 3.5-mm implants has been used to decrease hardware prominence. Position the plate over the fracture site, and temporarily hold it in place with a standard plate-holding forceps. Use the 2.5-mm drill and guide for an eccentric (compression) or neutral (buttress) insertion of cortex screws.no blood transfusion was given intra operatively.

Inclusion criteria:

1. Aged at least 18 years at the time of diagnosis.
2. Having a closed or type I open fracture of the distal third of the tibial diaphysis.
3. With or without fracture of the ipsilateral fibula.
4. Unacceptable alignment.

Exclusion criteria:

1. Skeletally immature bone. (Open proximal or distal physes).
2. Multiply injured patients.
3. pervious fractures of the tibial shaft on the same side.
4. Patient with peripheral vascular disease.
5. Patient with medical illnesses like diabetes, uremia, cerebral vascular accident, metabolic disease.
6. Distal intra-articular fractures of the tibia(plafond).
7. Compound fracture.

Results

This is comparative study in which the first group treated with IM nailing was assessed at a mean time of 2.0 years (range 1.5–3 years) versus the second group treated with ORIF at a mean time of 2 years (range 1.5–3 years). Pre-operative and postoperative X rays demonstrate using an_anatomic plate and screws. (figure 8)

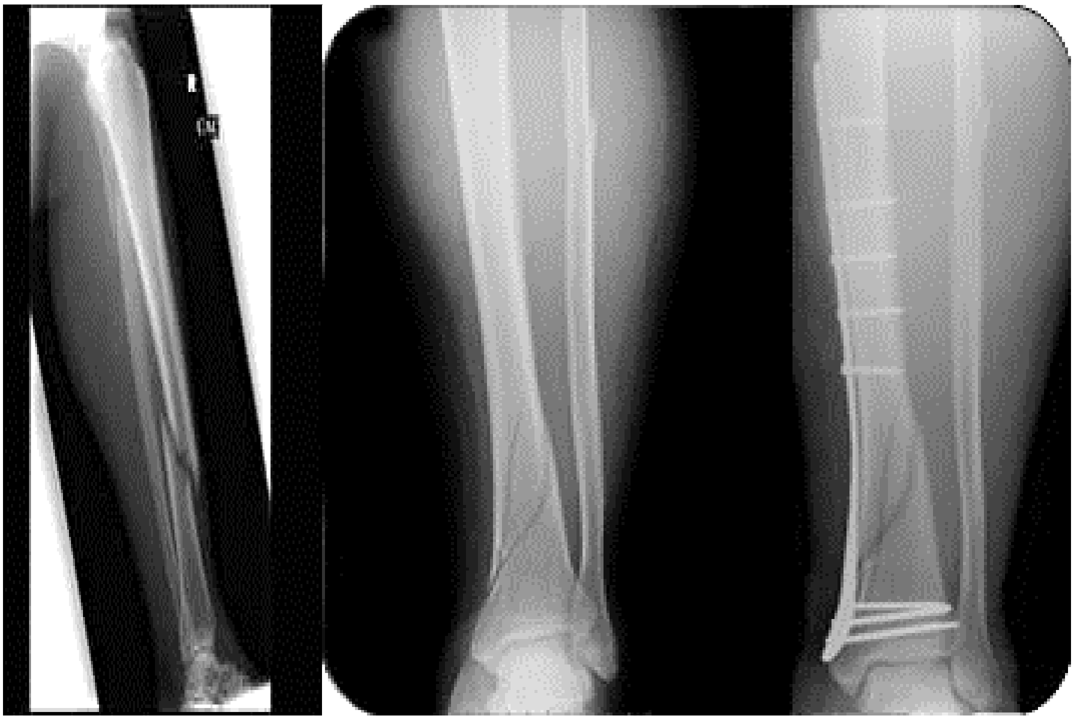


Figure 8. Pre-operative and postoperative Xrays demonstrate using an anatomic plate and screws. Case(1)

Patients stayed in the hospital for an average of 5 days (mean: ORIF 6 days (range 5–7), IM nailing 4 days (range 3 to 5)).

Mean total operation time (including anesthesia) of Operative management of a distal tibial fracture with ORIF was 107 min (range 60–195) and for operative management with IM nailing the mean time was 123 min (range 75–195).

The mean time to radiographic union was 19 weeks (range 14–32 weeks) for the ORIF group versus 21 weeks (range 13–28 weeks) for the IM nailing group.

Delayed union occurred in 2 patients managed with ORIF and in 3 patients with IM nailing.

(ORIF 14 versus IM nailing 13 weeks). Each group returned to work after a mean time of 24 weeks (ORIF 21versus IM nailing26 weeks;).

There were 6 smokers in each group.

Anterior Knee Pain was significantly higher after IM nailing than after ORIF.

None of the patients in the ORIF group and 1 patient in the IM nailing group had a knee limitation difference of >10°.Three patients in each group had an ankle limitation difference of >10°.

There were no patient in either group who had shortening of >1 cm.

None of the patients had varus/valgus malalignment of >5° after ORIF versus 2 after IM nailing and none had procurvatum/recurvatum malalignment of >5° after ORIF versus 2 after IM nailing.

No patients in either group had >10° varus/valgus or procurvatum /recurvatum malalignment.

Three patients had rotational malalignment of >15° after ORIF versus 4 after IM nailing.

The results are presented in (Table 2).

There were one complications in the ORIF group. One patient developed a superficial wound infection which was successfully treated with antibiotics.

In the IM nailing group there were two complications:

One patient had an interposition of the flexor hallucis longus tendon in the fracture, which necessitated a second operation to resolve the impingement.

In another patients an extra fracture fragment developed during the introduction of the nail (iatrogenic comminution) it was still possible to achieve acceptable alignment of the tibia.

This patient developed a low-grade infection around a locking screw that was treated with antibiotics and healed successfully. Figure (9)

Table 2. Comparison of the main results for the 14 matched pairs of patients. R >15° rotation, VV >5° varus/valgus, AR >5° procurvation-/recurvation

Open reduction and internal fixation				intramedullary Nailing			
Patients	Time to union (weeks)	Malalignment (°)	Anterior knee pain	Case	Time to union (weeks)	Malalignment (°)	Anterior knee pain
1A	15			1B	14	Rotation	
2A	14			2B	19	Rotation	Present
3A	14	Rotation		3B	23		Present
4A	16		present	4B	13		Present
5A	32			5B	23	Varus and valgus	
6A	17			6B	22	Anterior recuravation	
7A	18			7B	28	Varus and valgus;anterior recuravation	present
8A	25			8B	22		present
9A	21			9B	25		present
10A	21		present	10B	20		
11A	18	Rotation		11B	21		
12A	21			12B	27	Rotation	present
13A	15			13B	22		
14A	15	Rotation		14B	22	Rotation	present

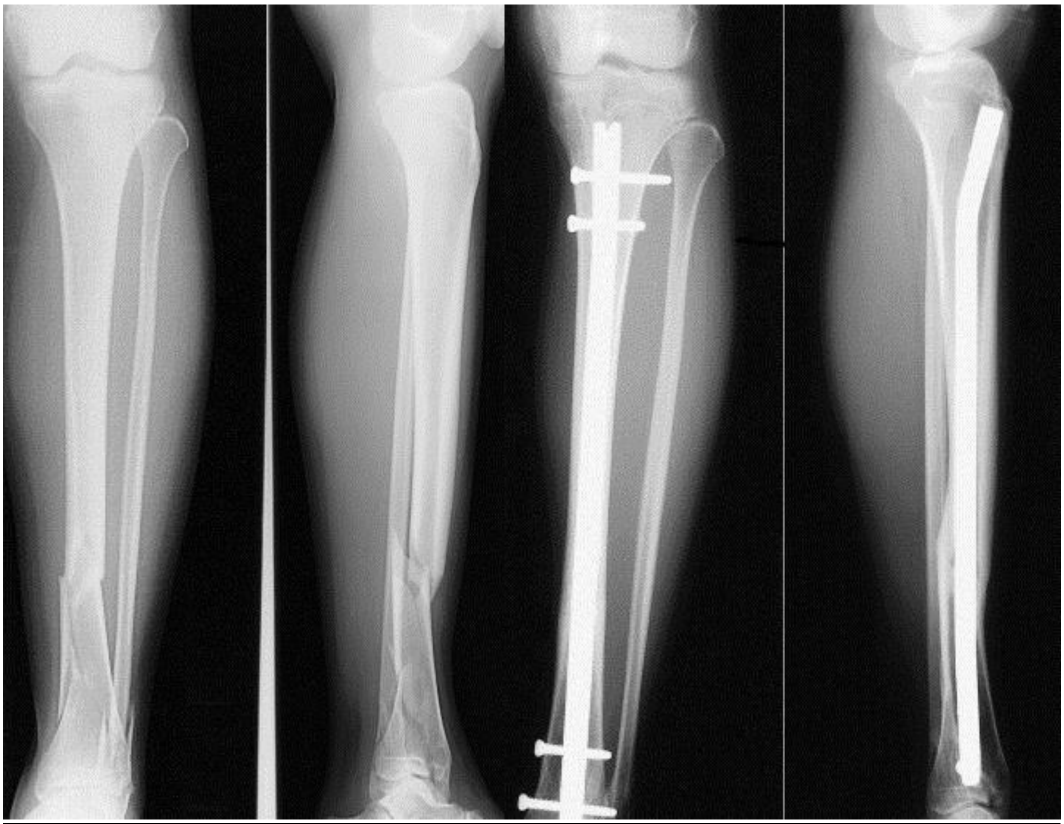
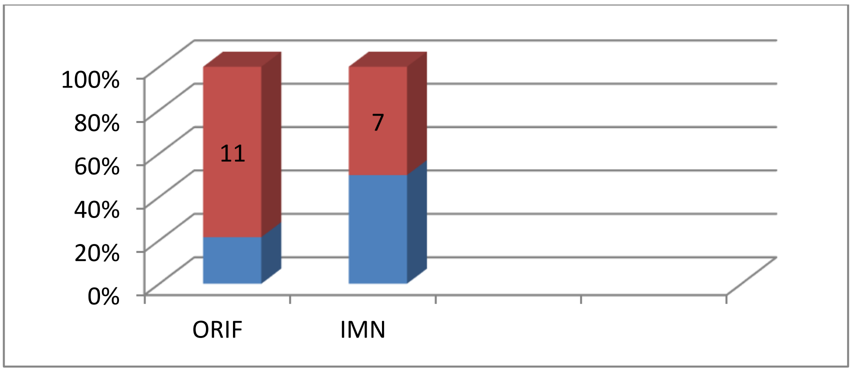


Figure 9. preoperative and postoperative radiograph internal fixation with IM nail. case (3)



GRAPH 1. Comparison of the main results for the 14 matched pairs

Discussion

The prospective design of this study has some limitations. Selection bias is introduced by the fact that the surgeon decided which operative modality is to be performed. Some of the bias was eliminated by the matching of patients. To maintain a sufficient number of patients, matching only included gender, age decade, and AO classification of the fracture.

There is malalignment in 3 of the 14 patients (21%) treated with ORIF and in 7 of the 14 patients (50%) treated with IM nailing (p=0.1).

There is a higher percentage of malalignment after IM nailing than after ORIF. Duda et al. (6, 7) they confirmed that biomechanical conditions in unreamed IM nailing of distal tibial fractures are unfavorable, because of a large axial to shear strain ratio between the bone fragments. The use of locking screws is reported to prevent angular instability and/or malunion in these distal fractures. (8).

In a prospective randomised trial Im et al. concluded recently that

Possibly, Im et al. would have found a larger angulation difference if ORIF can restore alignment better than IM nailing(9).They treated 64 consecutive distal tibial fractures with ORIF or IM nailing. They found an average angulation of 0.9° after ORIF versus 2.8° after IM nailing (p=0.01).Im et al. did not assess rotational malalignment, although malrotation may cause functional deficits. (10).Assessment of rotational malalignment in this study clinically and radiographically had been done. To minimise measurement bias we defined malalignment as a >15° clinically measured rotation difference. It remains difficult to assess rotational alignment clinically as well as radiographically.In the literature computer tomography (CT) is mentioned as the method of choice for determining rotational malalignment, because of its supposed reliability and reproducibility. (11) .Unlike the clinical or radiographic evaluation for malalignment, the position of the patient does not influence the accuracy of CT measurement of malalignment. Nevertheless, Jaarsma et al. showed that even CT measurement of malalignment, after IM nailing of femoral fractures, is inaccurate. (12) Malalignment can lead to complaints from the patient with regard to walking, practicing sports and so forth. Puno et al. evaluated 27 patients with 28 tibial fractures at an average of 8.2 years(range 6.0–12.3 years).They found a correlation between joint malalignment and clinical outcome for fractures of the tibia. Analysis showed that a greater degree of ankle malalignment produces poorer clinical results (13).

In this study a higher percentage of anterior knee pain after IM nailing than after ORIF Compared with 40% reported in Karladini and 76 % in that of Toivanin (14).

Delayed union was reported 20 % in the study of Kurland with average union time of 16.4 weeks with 3.8% non union rate (15). And 0 % delayed union with average union time of 12 weeks with 0% non union rate in that of Toivanin (16)., while average union time was 19 weeks with 1.8% non union rate in the study of Bone (17).

Although this study is limited by the small number of patients and the prospective design, our results suggest that especially in the distal third of the tibia, control of alignment directions is difficult with a nail alone.In view of this, it is interesting to note that some authors advise performing an open reduction and plate stabilisation of the fibula to increase the rotational control.(18)

Conclusions

From this study we can conclude that, no much difference in regard to the time for union, nonunion, hardware failure and deep infections between ORIF and IM nailing.
For optimal alignment we are considering the use of ORIF for closed and type I open extra articular fractures in the distal third of the tibia.

Recommendations

I hope that our respectful consultants or our colleagues will do a wide range of studies on this subject with larger number of patients to reach for the best methods for treatment of this type of distal third tibial fractures.
More research is needed to assess the long-term effects of malalignment.

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