Section: Orthopaedics

Original Research Article

A COMPARATIVE PROSPECTIVE STUDY ON VARIOUS METHODS OF MANAGEMENT OF DISTAL TIBIAL FRACTURES IN A TERTIARY CARE HOSPITAL

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Abstract

Background: Road traffic accidents, twisting injuries, fall from height, and other high energy injuries frequently result in fractures of the distal Tibia meta diaphyseal area, which account for 10% of all fractures at the distal end of the Tibia. Distal tibia fractures are unique in a few ways that render them susceptible to developing problems like, distal part of locomotive system, its inherent instability, bone is subcutaneous in whole extent with minimal soft tissue cover, often comminuted, blood supply in distal fourth is poor, fracture is often associated with breech of soft tissue, salvage procedure have high failure rates. To evaluate the results of various methods of management of distal Tibial Fractures in terms of Operative time, Time required for fracture union, Rate of malunion, wound infection, Functional outcome, Full weight bearing time. **Materials and Methods:** Study Design: A prospective hospital based observational study. Study area: Department of Orthopaedics. Study Period: 1 year. Study population: Patients coming to Department of Orthopedics in with distal tibial fractures. Sample size: study consisted of 30 subjects. Sampling method: convenient sampling. Study tools and Data collection procedure: A careful history of the mechanism of injury, the likelihood of associated injuries, and the presence of underlying medical conditions that can affect treatment or healing is obtained. The mechanism of injury provides insight into the amount of energy imparted to the bone and soft tissue at the time of fracture, which is crucial for surgical planning and for advising the patient on prognosis. Details such as the height of a fall or the speed of a motor vehicle accident are therefore important. In open fractures, assessing the environment in which the injury occurred will guide antibiotic treatment. **Result:** Our study had shown rate of union as 21 + 1.92 in group A (plating) vs 24 + 1.63 in group C (Ilizarov), p = 0.002 which is statistically significant. Group A (plating) shown 1 soft tissue infection (which was treated with regular dressings and antibiotics) Vs no soft tissue infections in Group C (Ilizarov) but the number of secondary procedures in the form of debridement are more in group C (ilizarov) 3 out of 4 Vs 1 out of 15 in Group A (plating). Average duration between admission to surgery in our study in Group A (Plating) is 3.06 + 1.43 vs 7.75 + 2.62 days in Group C (Ilizarov), p= <0.00001 which is statistically significant. **Conclusion:** Finally, we consider that the minimally invasive plate osteosynthesis, locking intramedullary nail stabilization and ilizarov are all efficient and reliable methods for treating distal tibial fractures with good outcome. Fracture pattern, clinical circumstances and surgeon skills should be considered before deciding the treatment. Intramedullary locked nailing is considered as preferable surgical option whenever it is feasible i.e, even if one distal locking is possible.

INTRODUCTION

Road traffic accidents, twisting injuries, fall from height, and other high energy injuries frequently result in fractures of the distal Tibia meta diaphyseal area, which account for 10% of all fractures at the distal end of the Tibia. Distal tibia fractures are unique in a few ways that render them susceptible to developing problems like, distal part of locomotive system, its inherent instability, bone is subcutaneous

in whole extent with minimal soft tissue cover, often comminuted, blood supply in distal fourth is poor, fracture is often associated with breech of soft tissue, salvage procedure have high failure rates.

These fractures, which are frequently accompanied by severe soft tissue damage, necessitate surgical treatment, ideally with successful reduction and internal or external fixation. When compared to other long bones, the distal tibia experiences more open fractures because of its subcutaneous placement. Large soft tissue injury typically interrupts the vascularity of the fracture site, making distal tibia fracture management more complicated and increasing the risk of sequelae (infection, non-union or delayed union).

With as little harm to soft tissues as possible, treatment plans and fixation techniques work to reduce the fracture, repair the affected bones, and restore congruence to the articular surfaces. To lower the high rate of wound healing and infectious problems associated with open fractures, proper wound management is essential.

Available different modalities of treatments: Closed reduction and cast application: stable distal tibia fractures can be treated Nonoperatively, but non-union, affected leg shortening, malunion, decreased range of motion and early arthritic changes have been observed after treating these fractures.[1]

Intramedullary (IM) nailing: Intramedullary interlocking nailing for the management of tibial diaphyseal fractures is the Gold standard, but in distal tibia fractures it is not so clear, studies shown that there is a biomechanical disadvantage in fractures of the distal tibia managed with intramedullary interlocking nail when compared with plate fixation.[2] When fracture is very close to the ankle IM nail will give less intrinsic stability as a consequence of decreased contact between bone and implant. Distal to fracture site if the distance between the cortices is more, an excessive amount of mechanical load is carried by intramedullary nail and is transferred to distal screws which leads to bending of screws, failure. Malalignment and knee pain are more commonly seen with this technique.[3-5]

Plating: In past years open reduction and plate fixation has attained an agreeable degree of reduction and fixation but it often requires larger incision and soft tissue dissection which increases the chance of complications (infection, wound complications and implant prominence,[6-8] non-union, delayed union). To overcome these drawbacks minimally invasive plating has come into an existence

External fixation: In open tibia fractures with soft tissue damage where plating or nailing are not possible, external fixation may be useful. But it results in unacceptable reduction, increased rate of non-union (2-17.6%), malunion (5-25%) and infection of the pin tract sites (10-100%).[9,10]

Although previous studies have compared plates with intramedullary nails plates with external fixation and intramedullary nails with external fixation,[6,11-14] few data are available on the three methods above. The minimally invasive plate osteosynthesis (MIPO) technique has gained prevalence in recent years. This percutaneous plating technique uses indirect reduction methods and allows stabilization of distal tibial fractures while preserving the vascularity of the soft tissue envelope. As a result, the MIPO technique has gradually become the preferred option for some surgeons.[7,15]

Hence the present study was undertaken to evaluate the operative time, functional outcome, union time and complications of various modalities of treatment of distal tibial fractures.

Objectives: To evaluate the results of various methods of management of Distal Tibial Fractures in terms of Operative time, Time required for fracture union, Rate of malunion, wound infection, Functional outcome, Full weight bearing time.

MATERIALS AND METHODS

Study Design: A prospective hospital based observational study.

Study area: Department of Orthopaedics.

Study Period: 1 year.

Study population: Patients coming to Department of Orthopedics in with distal tibial fractures.

Sample size: study consisted of 30 subjects.

Sampling method: convenient sampling.

Inclusion Criteria

- Patients age between 18-60 years.
- Extra articular and intraarticular fracture of distal tibia Metadiaphyseal region.
- Closed tibial fractures or Gustilo grade 1 or grade 2 and grade 2 and grade 3 open fractures.
- Patient was able to walk without aid prior to the accident.

Exclusion Criteria

Pathological fractures, Patients with previous fractures of distal Metaphyseal tibia on the same side.

Ethical consideration: Institutional Ethical committee permission was taken prior to the commencement of the study.

Study tools and Data collection procedure:

Initial Evaluation and Management

A careful history of the mechanism of injury, the likelihood of associated injuries, and the presence of underlying medical conditions that can affect treatment or healing is obtained. The mechanism of injury provides insight into the amount of energy imparted to the bone and soft tissue at the time of fracture, which is crucial for surgical planning and for advising the patient on prognosis. Details such as the height of a fall or the speed of a motor vehicle accident are therefore important. In open fractures,

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assessing the environment in which the injury occurred will guide antibiotic treatment.

Parameter		Degree	Score
1.	Pain	None	25
		While walking on uneven surface	20
		While walking on even surface outdoors While walking indoors	10
		constant and severe	5
2.	Stiffness	None	10
		Stiffness	0
3.	Swelling	None	10
		Only in evenings	5
		Constant	0
4.	Stair-climbing	No problems	10
		Impaired	5
		Impossible	0
5.	Running	Possible	5
		Impossible	0
6.	Jumping	Possible	5
		Impossible	0
7.	Squatting	No problems	5
		Impossible	0
8.	Supports	None	10
		Taping, wrapping	5
		Stick or crutch	0
9.	Work, activities of daily life	Same as before injury	20
		Loss of tempo	15
		Change to simpler job	15
		Severely impaired work capacity	0

Rating According to OLERUD & MOLANDER SCORING SYSTEM

SCORE	RESULTS
100-80	Excellent
50-79	Good
25-49	Fair
< 25	Poor

Physical Examination

The patient is carefully examined for associated injuries. Once life-threatening injuries have been ruled out or adequately addressed, attention can be focused on the ankle injury. Deformity of the foot and ankle is often apparent on initial inspection. The neurological and vascular status of the foot must be evaluated. When pulses are absent, the ankle is realigned, and then the vascularity is reassessed. Splinting the ankle prevents further soft tissue trauma.

Open wounds are inspected to determine their extent and the amount of contamination. The condition of the skin is carefully examined, including the amount of swelling and the presence of fracture blisters. Tense soft tissue swelling is frequently present, and it is assessed by both inspection and palpation. The presence or absence of skin wrinkles has been recommended as one way to assess the degree of soft tissue swelling. The true extent of the soft tissue injury may not declare itself initially, so the ankle must be frequently reassessed.

Fracture blisters are common and can be divided into two types: clear fluid- filled and blood-filled blisters. Histologically, both types are separations at the dermal- epidermal junction, but blood-filled blisters are deeper and indicate more severe soft tissue injury. There have been more wound complications when incisions are made through blood-filled blisters. Local bruising and ecchymosis indicate a greater degree of deep soft tissue damage. Although compartment syndrome is unusual, it should be considered, and the tenseness of the muscle compartments of the leg and foot should be routinely examined.

Olerud & Molander Ankle scoring system16 was used in this study to assess the results.

Statistical Analysis

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Analysis of variance (ANOVA) was used for various continuous variables in different groups to find the statistical significance. P value <0.05 will be a statistically significant study.

RESULTS

A total of 30 patients with distal tibia fractures was taken in our study and divided into three groups.

Group - A (15 patients) treated with minimally invasive plating

Group - B (11 patients) treated with intramedullary interlocking nail

Group - C (4 patients) treated with Ilizarov ring fixator.

Group-A: Mean age of the patients is 46.8 years, 38.36 years in Group-B and 39.2 years in Group C. 21 patients (70%) were male (8cases are in Group-A, 9 were in Group- B and 4 in Group C) and the remaining 9 patients (30%) were female (7 cases are In Group-A, 2 were in Group-B and Group C has no females).

Right side more commonly involved than left side, 60% of cases in Group-A, 81% of cases in Group-B and 25% of cases Group C involved Right side. Most common mode of injury in all the groups is road traffic accidents 60% in Group-A (i.e. 9 cases), 91% in Group-B (i.e. 10 cases) and all 4 cases in Group C.

Table 1: Mean age of patients in Group A (Plating), B (Nailing) and C (Ilizarov)

	Number of patients	Mean (SD)	P value
Plating	15	46.8 (10.89)	0.2 (Not significant)
Nailing	11	38.36 (12.89)	
Ilizarov	4	39.25 (15.77)	
Total	30		

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Table 2: Number of males and females in each treatment group.

	Male	Female	Total
Plating	8	7	15
Nailing	9	2	11
Ilizarov	4	0	4

Showing male preponderance because of travelling and working in factories and fields.

Table 3: Duration between injury and surgery

	N	Average duration between injury and surgery (SD)	P value
Plating	15	3.06 (1.43)	<0.00001 (Significant)
Nailing	11	1.72 (1.19)	
Ilizarov	4	7.75 (2.62)	

Average duration of time between injury and surgery 3.06 days in group-A, 1.72 days in Group-B and 7.75 days in group C (p value <0.00001).

Table 4: Duration of surgery (in minutes)

	N	Average duration of surgery (SD)	P value
Plating	15	99 (7.12)	<0.00001 (Significant)
Nailing	11	80.45 (6.5)	
Ilizarov	4	132.5 (10.4)	

Average time taken for surgery in Group-A was 99 minutes, 80.45 minutes in Group-B and 132.5 minutes in group C, (p value <0.00001).

Table 5: Weight bearing time in weeks

	N	Weight bearing time in weeks (SD)	P value
Plating	15	13.86 (2.13)	<0.000001 (Significant)
Nailing	11	11.09 (1.57)	
Ilizarov	4	12 (0)	

Time taken to start full weight bearing in patients treated with Distal Tibia Locking Plate is 13.86 weeks, interlocking nail is 11.09 weeks and in Ilizarov 12 weeks.

Table 6: Duration of fracture union (in weeks)

	N	Mean duration of fracture union (in weeks) (SD)	P value
Plating	15	21 (1.92)	0.002 (Significant)
Nailing	11	19.36 (2.42)	
Ilizarov	4	24 (1.63)	

In Group- A average time taken for fracture union is 21 weeks, Group B 19.36 weeks and in Group-C 24 weeks p value 0.002.

Table 7: Functional outcome

	N	OMAS score mean (SD)	P value
Plating	15	85 (5.97)	0.59 (Not Significant)
Nailing	11	87.27 (5.17)	
Ilizarov	4	85 (7.07)	

12 patients belong to AO / OTA- A1 and 10 patients belongs to A2 and 7 patients belongs to A3 and 1 patient belongs to B2. In our study 19 patients has closed fractures, 4 patients have grade I compound fractures and 7 patients has grade II compound fractures.

Table 8: Follow up results

Characteristics	Plating	Nailing	Ilizarov	P value
Average duration of surgery	99	80.45	132.5	<0.0001 (Significant)
Full weight bearing	13.86	11.09	2	<0.00001 (Significant)
Fracture union	21	19.36	24	0.002 (Significant)
Non union	-	-	-	-
Delayed union	-	-	-	-
Malunion	-	-	-	-
Superficial skin infection		1	-	-
Deep infection	1	-	-	-
Stiffness	3	-	1	-
Implant failure	-	-	-	-

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Debridement	1	2	3	0.01 (Significant)
Functional Outcome (OMAS score)	85 (5.97)	87.27 (5.17)	85 (7.07)	0.59 (Not significant)
Excellent	2	2	0	-
Good	13	9	4	-
Fair	0	0	0	-
Poor	0	0	0	-

DISCUSSION

Our study revealed the average age of patients with such injuries to be 46.8 (+ 10.89) in plating, 38.36 (+ 12.89) in nailing and 39.25 (+ 15.77) in ilizarov group. It is comparable with a study on similar fractures conducted by Cory Collinge et al,[17] Heather A Vallier et al.[11] In our study, the male preponderance for such kind of injuries were high 70% compared to the study by Andrew Grose et al,[18] which was 67% possibly due to the fact that occupational exposure and along with associated injuries are more common in male than females. However, the study by Cory Collinge et al,[17] 46 were comparable in the fact that they had 77% male patients.

In our study there is a slight preponderance of high energy fractures (76.66%). Andrew Grose et al,[18] could attribute 58%, while of such injuries to be of high energy, while Heather A Vallier et al,[11] attributed 51% of fractures to high energy. Our present study shows more number of RTA's when compared with the study conducted by Heather A.Vallier et al,[11] Andrew Grose et al.[18] Cory Collinge et al,[17] included only high energy fractures in his study. Young-Mo Kim et al,[19] attributed only 7.4% of fractures to high energy this may be due to lesser number of RTAs, because of better road safety in Korea in compare to India. Heather A Vallier et al,[11] who contributed only 51% of high energy fractures.

Our study had 36.66% open injuries. This was comparable on the studies conducted by Heather A Vallier et al,[11] who has 30% open fractures, Hazarika et al,[15] who has 40% open fractures. Young-Mo Kim et al,[19] included only closed fractures in his study.

Study by Cory collinge et al,[17] showed 16% CI, 32% C2 and 24% C3. Andrew Grose et al,[18] also had fractures types 2% B1, 4% B2,12% B3, 6% C1, 12% C2, 64% C3. Heather A Vallier et al,[11] also had fractures 31% A, 21% B, 44% C. We had a higher percentage of type A fracture. In our study we had 40% of A1, 10% of A2, 23.33% of A3, 3.33% of B2.

The average surgical time was 99 + 7.12 minutes in Group A, 80.45 + 6.5 minutes in Group B and 132.5 + 10.4 minutes in Group C. It is comparable with the average of 97.9 minutes taken by J.J. Guo et al in their study.[20]

Aksekili et al,[21] in a study treating 35 distal and diaphyseal tibial fractures with the MIPO technique, suggested that MIPO is an effective treatment for tibial diaphysis and distal tibia fractures with low complication and high union rates. We observed a high frequency of anterior knee pain after intramedullary nailing, which is consistent with early studies.[14] A tendon-splitting approach was used in our study. Keating et al,[22] reported reduced pain problems using a paratendinous approach, whereas Toivanen et al,[23] in a prospective, randomised study failed to detect any differences between the two methods. A percutaneous approach aiming to avoid prepatellar scarring and injury to the infrapatellar nerve was described by Karladani and Styf 24 but any benefit from this method has not been demonstrated so far in any prospective randomised study. According to Keating et al,[22] the aetiology for anterior knee pain after intramedullary nailing is multifactorial, and proximal nail protrusion was not found to be an important factor.

In a study of an initial group of patients who underwent open reduction and internal fixation Ruedi and Allgower,[25] reported 74% overall good to excellent results in 84 patients. Unfortunately, the fractures were not classified regarding the severity of the skeletal or soft tissue injuries. However, in a second report, Ruedi and Allgower,[26] classified the fracture types regarding the skeletal injury severity and reported an 80% good result for all fractures as judged by the patient, and approximately 70% good results as judged by the surgeon.

Sirkin et al,[27] showed a reduced incidence of partial thickness wound necrosis of 8% when the reconstruction of the distal tibia was delayed for 14 days post-injury. There was one patient with a type IIIA open fracture who developed deep infection and ultimately had a below knee amputation. Patterson and Cole,[28] also reported good results with this two-staged protocol with 77% good or excellent results. Neither infections nor soft tissue complications were reported.

The Ilizarov circular external fixation system has the advantage of sparing the ankle joint to allow early motion. Tensioned wires are an effective way to fix a short bony segment. In achieving articular reconstruction, skin incisions can be limited and surgical dissection is also minimized. The current study yielded good results with this technique in treating AO type A extra-articular fractures. Fractures extending distally to within 4 - 5 cm of the ankle joint can be satisfactorily treated. There were no non-unions.

Guo JJ,[20] and others have done a study in 85 patients with distal metaphyseal tibia fractures treated with either plating or nailing and they have not found any significance difference in union time but time taken for surgery is significantly high in patients treated with MIPO than nailing (97.9 vs 81.2 minutes).

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Yong Li,[12] and others have done a study in 46 patients with distal tibia metaphyseal fractures and they found average operating time, full weight bearing and fracture union time is significantly high in patients treated with MIPO than locked nailing (90±20.3 vs 76±16.6 minutes; 11.1±1.7 vs 9.0±1.4 weeks; 23.1±3.6 vs 21.3±3.5 weeks respectively. Our study results can compare with above study, Average time taken for surgery in group A (plating) is 99 min where as in group B (nailing) is 80.45 min it suggests there is significant difference in both groups (p=<0.0001). There is a significant change seen in between two groups regarding weight bearing mobilization. In patients operated with nailing, full weight bearing mobilization started at an average 11.09 weeks where as in plating group full weight bearing mobilization started at 13.86 weeks.

Im and Tae,[6] done a comparative study regarding wound complications in patients treated with intramedullary nailing and plating and observed significantly higher rate of wound complications in plating group than nailing group (7 out of 30 patients in plating group versus 1 out of 34 in nailing group; p=0.03).

Our results are comparable with above study, Postoperative complications are more seen in patients treated with plating, three ankle stiffness and one deep infection and only superficial skin infection seen in patients treated with intramedullary nailing all superficial skin infections are treated with regular dressing and antibiotics whereas for deep infections wound debridement was done.

Cheng et al,[29] done a comparative study between patients having distal tibia fractures treated with minimally invasive plate osteosynthesis and conventional open reduction with plate fixation and observed a significantly high rate of implant irritation complaints in patients operated with MIPO than open technique. In our study threepatients complained hardware irritation in plating group, this is may be due to subcutaneous location of the implant with minimal soft tissue coverage and implant thickness.

Guo et al,[20] done a prospective randomized control study in 85 patients with distal tibia fractures treated with either MIPO or intramedullary nailing (41 patients with plating and 44 patients with nailing) and observed that all are united without any significant difference in functional score. Our study shows no significant difference.

Our study had shown complications like 3 ankle stiffness out of 15 cases in group A (Plating) and 1 ankle stiffness out of 4 in group C (Ilizarov) while the functional outcome is same in both. (Group A (Plating) 85 + 5.97, Group C (Ilizarov) 85 + 7.07, p= 0.59 which is statistically not significant.). Average time taken for surgery in Group A (plating) 99 + 7.12 min whereas in group C (Ilizarov) is 132.5 + 10.4 min, p= <0.00001 which is highly significant. Our study had shown rate of union as 21 + 1.92 in group A (plating) vs 24 + 1.63 in group C (Ilizarov), p = 0.002 which is statistically significant. Group A (plating) shown 1 soft tissue infection (which was treated with regular dressings and antibiotics) Vs no soft tissue infections in Group C (Ilizarov) but the number of secondary procedures in the form of debridement are more in group C (ilizarov) 3 out of 4 Vs 1 out of 15 in Group A (plating). Average duration between admission to surgery in our study in Group A (Plating) is 3.06 + 1.43 vs 7.75 + 2.62 days in Group C (Ilizarov), p= <0.00001 which is statistically significant.

Yongchuan Li et al,[30] have done a study in 121 patients with displaced distal tibial metaphyseal fractures treated with nailing, plating and external fixator and they found operative time as 114.4 + 26.1 minutes (plating), 87.5 + 22.7 (nailing) and 85.8 + 21.3 (External Fixation). Time to union 15 + 3.4 weeks (plating), 15.6 + 3.2 (nailing) and 15.2 + 3.5 (external fixator). Soft tissue infection 7 (plating), 1 (nailing), 2 (external fixator). Deep infection 1 (plating), 2 (nailing), 6 pin tract infections (external fixator). Ankle function scores are in excellent/good range.

Our study results can be compared with the above study. Average time taken for surgery in group A(plating)= 99 minutes, group B(nailing)= 80.45 minutes and group C = 132.5 minutes. Time to union in group A(plating)= 21 + 1.92 weeks, group B(nailing) = 19.36+ 2.24 weeks, group C = 24+1.63. one superficial skin infection seen with nailing, one deep infection seen with plating which is treated with debridement and antibiotics and one pin tract infection is seen in group C (ilizarov). Functional score is good to excellent in all the groups which is statistically not significant.

CONCLUSION

Finally, we consider that the minimally invasive plate osteosynthesis, locking intramedullary nail stabilization and ilizarov are all efficient and reliable methods for treating distal tibial fractures with good outcome. Fracture pattern, clinical circumstances and surgeon skills should be considered before deciding the treatment. Intramedullary locked nailing is considered as preferable surgical option whenever it is feasible i.e, even if one distal locking is possible.

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