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Management of Distal Tibial Fractures by Ilizarov Fixator With or without Minimal Internal Fixation

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ABSTRACT

Background: Ilizarov fixator has more advantages in some types of distal tibial fractures as open, type C3according to AO classification and give satisfactory results more than plates and screws fixation because it minimizes complications.
Aim of the work: To estimate the techniques, results and complications of Ilizarov in management of distal tibial fractures with using minimal internal fixation or not.
Patients and Methods: During the period from August 2020 through June 2021, a prospective study was conducted on fifteen patients with fifteen tibial plafond fractures treated with Ilizarov fixator. The study consisted of 12 men and 3 women, with an average age of 40 years. The fractures classified according to the AO classification: A1 (6), B2 (2), C2 (2), C3 (5). There were 6 open fractures Treated by Ilizarov fixator with using minimal internal fixation when needed.
Result: The mean age was 40 ± 12.206 years, 80% of them were males and 20% were females the overall AOFAS score for the intra-articular group n= (9) was excellent in one case 95.40±5.61, good 84.30±7.24 in 3 cases, fair 73.1 ±13.08 in 3 cases and poor 61.34±6.81 in 2 cases. (44.44% of the intra-articular group) had satisfactory results. The overall AOFAS score for the extra-articular group (n=6) was excellent 95.40 ±6.31 (lowest score 88 while highest was 100) in five cases and good in one case where all six cases (100% of the extra-articular group) had satisfactory results.
Conclusion: Ilizarov fixator in distal tibial fractures minimize the complications

Keywords: *Ilizarov method; distal tibial fractures; External fixation.*

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INTRODUCTION

According to Heim's work and the frequently accepted AO classification, the distal tibia is described as an area inside a square whose lower part tracks the width of the distal tibia. The average length of the distal tibia is 57mm.[1]
Distal tibial fractures account for 3 percent to 10% of all tibial fractures and 1% of all lower extremity fractures. A fibular fracture is seen in 70 percent to 85 percent of instances, and it occurs in more complex injuries.[2]
Males are more likely than females to suffer from distal tibial fractures. They affect people of all ages, but they are less common among the elderly. The average age is from 35 to 40 years old. They are caused by axial and rotational stresses that cause a metaphyseal fracture, articular injury, and malleolar displacement in varying degrees.[3]
A distal tibial fracture is more of an injury pattern than a fracture. It comprises soft tissue damage as well as a fracture. Recognize the significance of the soft tissue component in the treatment of this injury. Failure to recognize the soft tissue condition will almost always exacerbate the injury, resulting in excruciating pathology. Infections wound dehiscence, or nonunion are all possible causes of nonunion.[4]
The goal of treating distal tibial fractures is to restore normal axial alignment and, if necessary, reduce articular displacement.[5] Treatment approaches have progressed from conservative methods to open reduction and internal fixation, as pioneered by Rüedi and Allgöwer, and subsequently to phased protocols and biologic plating. The external fixator, on the other hand, has always been a viable choice.[5]

Treatment for these fractures is difficult. Because of the wide range of clinical findings, determining the possible risk of surgical complications can be challenging. Even in patients who do not have articular involvement, the injury can be more significant than initially thought. One of the key reasons is the underestimating of soft-tissue injuries, which are not included in the fracture classification.[6]

Complications associated with distal tibial fractures tend to increase exponentially as the degree of the fracture increases. For the management of distal tibial fractures, an increasing degree of comminution, the proximal extension of the fracture, and soft tissue injury envelope are reasons for utilizing Ilizarov fixators.[12]

PATIENTS AND METHODS

This prospective study included fifteen patients having distal tibial fractures managed with Ilizarov fixator with using minimal internal fixation when needed at the Department of Orthopedic Surgery, during the period between August 2020 through June 2021. The period of follow-up of the cases was 8-12 months. All patients in this study were clinically assisted. Radiographic examinations including plain X-ray anteroposterior, lateral, and Mortis views of the distal tibia, knee, and CT scan in complex Multiplan fractures were done to determine the fracture type; any associated other fractures. Prophylactic preoperative I.V antibiotic (3rd generation cephalosporin gm) was used 30 minutes before surgery and using potent analgesic 24 hour after operation.

Patients who are admitted to our hospital will be treated with an Ilizarov external fixator technique and, if necessary, restricted internal fixation. The date of surgery for closed fractures was determined by the state of soft tissues and the likelihood of a restricted open reduction, which was typically determined by the degree of articular damage.

The Inclusion criteria in this study were as follows: patients aged 18–75 years, with displaced distal tibial fractures. We used AO classification to classify the fractures,[8] and used Rüedi and Allgöwer[7] for plafond fractures and Gustilo classification for open fractures, [9,10] the soft- tissue damage was graded according to the Tscherne classification[11] for closed fractures.

The operations were performed without a tourniquet and any traction table. We used biplane fluoroscopy during operation. We fixed all the 11 fibular fractures (73.3% of the whole fibulae where the rest were intact), were 4 cases fixed with one-third tubular plate and 7 cases by intramedullary 3 mm Kirschner wire from the distal tip toward proximal. Pinning of the fibula was done in a closed manner under image intensifier guidance in 7 cases while 4 cases required a limited small lateral incision for the plate. Traction and physical external pressure were used to reduce the fractures. If this did not result in a satisfactory anatomical position, the joint surfaces were restored using percutaneously inserted elevators, reduction forceps, and/or olive-tipped wires. The proximal ring was put at the fibular head's level. Extra wires parallel to the articular surface with posts attached to the distal ring provided further support. Olive wires placed to the ring on the lateral or medial side could be used to stabilize the syndesmosis and malleolar fragments. Additional rings were inserted in the tibia to improve system stability and enable unrestricted weight-bearing. Steel rings were used in conjunction with steel rods There were no bone transplants employed.

Patients could begin full weight-bearing when he starts physiotherapy immediately postoperatively to keep knee and ankle motion.

After 2, 4, 8, and 12 weeks, the patients were evaluated clinically and radiographically. An independent physiotherapist evaluated the clinical one-year outcome, which included the ankle's range of motion.

Statistical analysis: The statistical program for social sciences, version 15, was used to examine the data. The mean and standard deviation were used to express quantitative data (SD). Frequency and percentage were used to express qualitative data. When comparing two means, an independent samples t-test of significance was utilized. To compare proportions between two qualitative factors, the Chi-square (x2) test of significance was applied. The confidence interval was set at 95%, while the acceptable margin of error was set at 5%. The p-value was deemed significant when it was less than 0.05.

RESULTS

Fifteen tibial plafond fractures in fifteen patients and ranged in age between 18 and 75 years. There were twelve males and three females. The ratio was 4:1. The tibial plafond fractures were classified using Ruedi and Allgower classification[7] into sex type I and two types II and seven types III fractures. There were eight closed and sex open fractures. All fractures were caused by high-energy trauma. Four patients had other fractures.

Ilizarov was done in all cases, in seven cases was associated with limited internal fixation using 4 mm cancellous screws. Cross ankle fixation was done in all cases with an average period of 15 weeks in Ilizarov. The average time to union and Ilizarov removal was 15 weeks.

Follow-up of all cases averages 15 weeks (range 3-6 months). All, patients were evaluated clinically as well as radio-graphically

The anatomical reduction was achieved in five cases of Ruedi and Allgower type I, one case was a good reduction, and in type II had a good reduction, in type III one case had a good reduction, two cases had a fair reduction, and four cases had a poor reduction.

Clinical outcome (AOFAS ankle Hindfoot score):

The overall AOFAS score for the intra-articular group n= (9) was excellent in one case 95.40±5.61, good 84.30±7.24 in 3 cases, fair 73.1 ±13.08 in 3 cases, and poor 61.34±6.81 in 2 cases. (44.44% of the intra-articular group) had satisfactory results. The overall AOFAS score for the extra-articular group (n=6) was excellent 95.40 ±6.31 (lowest score 88 while highest was 96) in five cases and good in one case where all six cases (100% of the extra-articular group) had satisfactory results. Table (1)

Bivariate analysis was conducted between the final clinical score and factors thought to affect it. There was no statistically significant relationship between final clinical score and demographic data like age and gender, personal habits like smoking and substance abuse, biological considerations like D.M and Vitamin D level, trauma event history like MOT and associated injuries, preoperative radiological findings like angulation in AP view, angulation in

lateral view, a diaphyseal extension of the fracture, metaphyseal diaphyseal junction nature, fibular fracture pattern and syndesmosis injury, Tscherne classification, operative details like delay till fixation, mode of reduction and fibular fixation, follow up details like complications, time to union and radiological score. However, Factors that were found statistically Significant were AO classification.

Soft Tissue Injury:

Patients with Tscherne grade 0-1 closed fractures had 100% excellent to good results in contrast to 66.6% for open fractures (Table 19). No patients with 0- 1 closed fracture had a fair result in contrast to 100% of patients with grade II-III closed fractures. One case (20%) of open fracture cases had a poor result, one case (20%) had excellent and three cases (60%) had good results. Table (3)

Minimally invasive osteosynthesis (MIO) using inter- fragmentary screws to compress large articular fracture fragments or large putter flay in extra-articular fractures were performed in 7 cases in our series (46.67%). Minimal internal fixation had also an impact on the time to fracture union and fixator removal. Cases with MIO had a shorter time frame (average 18 weeks) concerning cases without MIO (average 24 weeks) (Table 4).

Range of motion (ROM):

We measure it in comparison with the other side with a goniometer. It was used as objective criteria of the functional result. The ankle had equal ROM as the contralateral side in 8 cases (53.33%). In 5 cases (33.3%) was the limitation was less than 25%. In only 2 cases (13.33%) the limitation was more than 25%. The average total arc of ankle motion was 46.75 (range 30-75). Dorsiflexion averages 6.4(range0-10) whereas plantar flexion averages 35 degrees (range 20-50 degrees)

Result of fibular fixation:

We fixed all the 11 fibular fractures (73.3% of the whole fibulae where the rest were intact), were 4 cases fixed with one-third tubular plate and 7 cases by intramedullary 3 mm Kirschner wire from the distal tip toward proximal. Pinning of the fibula was done in a closed manner under image intensifier guidance in 7 cases while 4 cases required a limited small lateral incision for the plate. One case had fixed by plate give excellent, one give good and two give poor. Three cases fix by k wire give excellent, two give good and two give fairs. Two cases of intact fibula give excellent, one gives good and one fair. Table (5)

Results according to the quality of reduction:

According to AOFAS score, Among the sex Cases with tibial plafond fractures, in whom anatomical reduction has been achieved, five had excellent results and one had a good result. The functional result in three patients with good reduction was good in two and fair in one. Two patients with a fair reduction had an excellent outcome for one and one had a fair outcome, whereas the four patients who had a poor articular reduction, two had a poor, one had a fair functional result and one good result (Table 6). There was a significant difference in the functional score between patients with anatomical restoration and patients with the poor restoration of articular surfaces.

AO AOFAS	43A			43B			43C			Total
	A1	A2	A3	B1	B2	B3	C1	C2	C3	
Excellent			5						1	6(40%)
Good			1			1		1	1	4(26.67%)
Fair						1		1	1	3(20%)
Poor									2	2(13.67%)
Total	0	0	6	0		2		2	5	15

Table 1: Relation between AO classification and the AOFAS score at the end follow up.

	Mean	Std. Error	Std. Deviation
Age	44.000	3.23669	12.5356
D.Extention (mm)	72.1333	11.91113	46.13159
AFOS	83.2667	3.01025	11.65864
Union time(week)	15.0000	.54336	2.10442

Table 2: the means and Stan. Deviations of age, diaphyseal extension, AFOS and union time

	Closed 0-1	II-III	Open	Total
Excellent	1	4	1	**6(40%)**
Good		1	3	**4(26.67%)**
Fair		2	1	**3(20%)**
Poor		1	1	**2(13.67%)**
Total	**1(6.67%)**	**8(53.33%)**	**6(40%)**	**15(100%)**

Table 3: The relation between soft tissue injuries and final outcome

	MIO	NO MIO	Total
Excellent	3	3	**6(40%)**
Good	2	2	**4(26.67%)**
Fair	2	1	**3(20%)**
Poor		2	**2(13.67%)**
Total	**7(46.67%)**	**8(53.33%)**	**15**

Table 4: The effect of MIO in intra-articular fractures.

	Excellent	Good	Fair	Poor	Total
Plate	1	1	0	2	4
K wire	3	2	2	0	7
Intact fibula	2	1	1	0	4
Total	6	4	3	2	15

Table 5: clinical result of cases according to fibular fixation.

	Anatomical	Good	Fair	Poor	Total
Excellent	5		1		**6(40%)**
Good	1	2		1	**4(26.67%)**
Fair		1	1	1	**3(20%)**
Poor				2	**2(13.67%)**
Total	**6(40%)**	**3(20%)**	**2(13.33%)**	**4(26.67%)**	**15(100%)**

Table 6: Results of plafond fractures according to the quality of reduction.

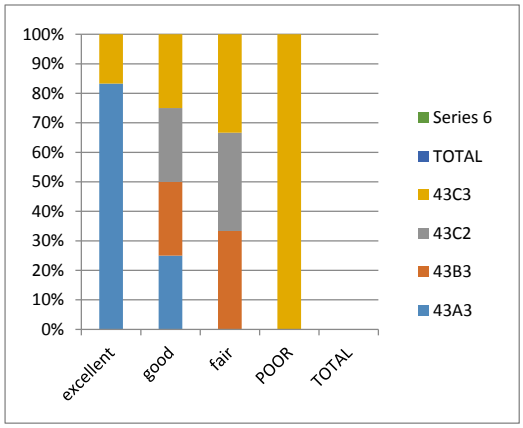

Fig. 1: Relation between AO classification and the AOFAS score at the end follow up.

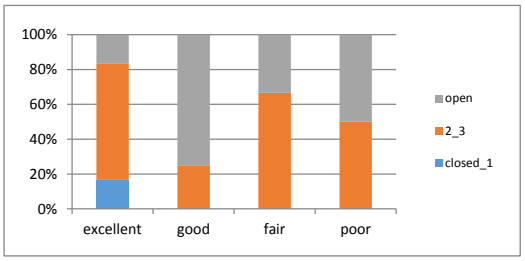

Fig. 2: The relation between soft tissue injuries and outcome.

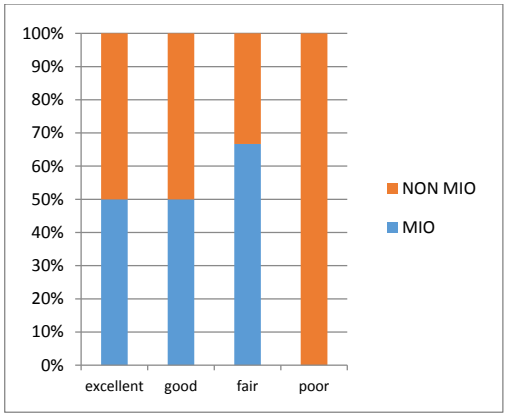

Fig. 3: The effect of MIO in intra-articular fracture of the final results.

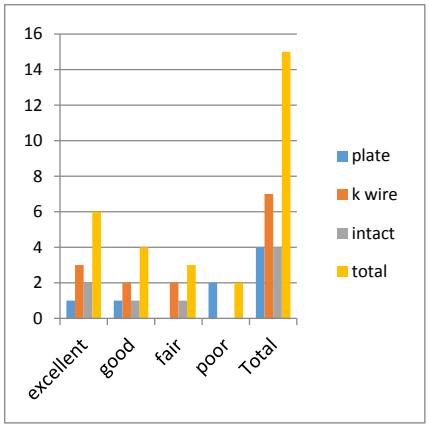

Fig. 4: Clinical result of cases according to fibular fixation.

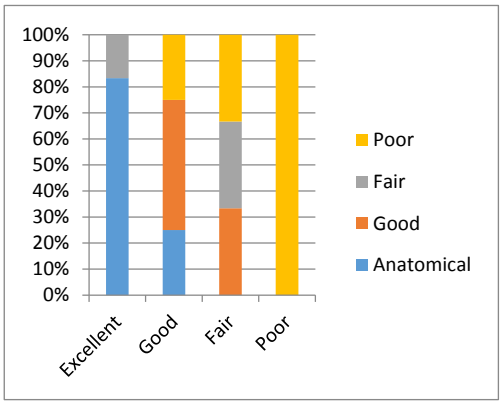

Fig. 5 : Results of plafond fractures according to the quality of reduction.

Complications:

One patient (6.67%) suffered from wound complications, all cases (100%) had some form of pin tract infections. fourteen cases required only local care and or oral antibiotics in the form of amoxicillin/clavulanic acid, 1gm bid for ten days. One case (6.67%) suffered from DVT long the course of follow-up. Three cases (20%) required more than six months for union to be complete on radiographs One case (6.67%) ended with malunion. had varus malunion of 10 degrees Only one case (6.67%) which had a flap coverage suffered later from chronic osteomyelitis which never flared up till

the end of follow-up One case (6.67%) ended with limb length discrepancy.

CASE PRESENTATION

Thirty-four-year-old, male, manual worker, smoker, non-diabetic sustained an FFH injury (15 meters) resulted in closed 43C3.3 intra-articular distal tibial fracture, Tsherne II with a diaphyseal extension of 57 mm

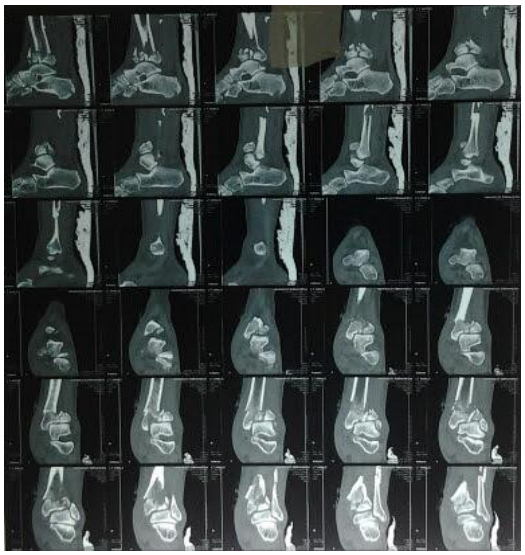

Fig. 6: CT cuts of intra-articular 43C3.3 case.

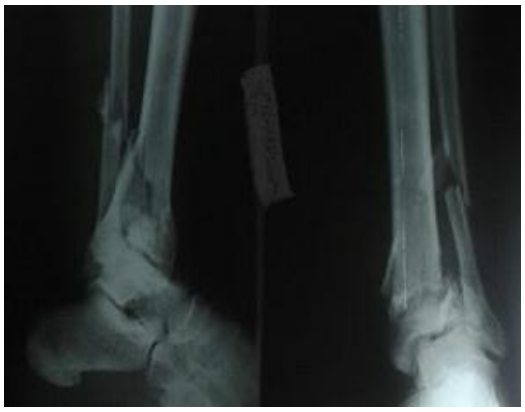

Fig. 7: Antroposterior and lateral preoperative x-ray.

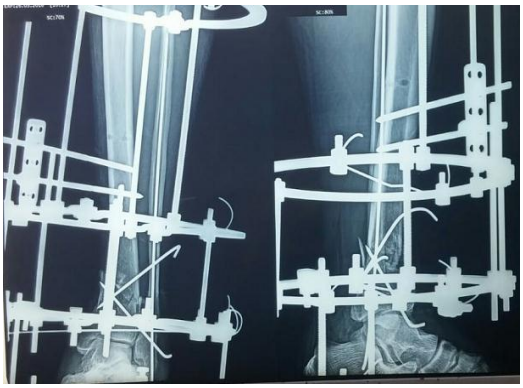

Fig. 8: A) Antroposterior B) lateral posteoperative x-rays of the sam case.

Fig. 9: AP and lateral follow up xrays of the same case after removal Ilizarov.

Fig. 10: AP and lateral follow up xrays of the same case ,four months after removal of the frame.Total time to union in that case was five months.

DISCUSSION

The goal of this research was to evaluate the clinical outcome of Ilizarov fixator with using minimal internal fixation when needed, as well as the factors that influence time to union utilizing that technique. To compare the results of this study fairly with those of other studies, it is necessary to ensure that the case-mix and technique of analyzing the results are comparable.

From a radiological standpoint, there are many types of fractures in the current study. Soft-tissue injuries, diaphyseal fracture extension, severe articular comminution, and high-energy trauma were found in virtually all the patients. To put it another way, many of the criteria that go into deciding on a treatment technique are difficult to assess.

The AOFAS, which is a validated clinician-based ankle-specific score and one of the most commonly utilized outcome measures in research reporting, was employed in this investigation. It is based on 100-point scores for each region, with 100 points being the best clinical state. The AOFAS gives the pain component 40 points, the function component 50 points (including 16 points for hindfoot motion), and the hindfoot alignment component 10 points. Mazur et al, on the other hand, give the pain component 54 points, the function component 26 points, and the range of motion 20 points (ROM). Despite being 100-point scores, these differences show that absolute values cannot be compared between researchers.[14]

The overall AOFAS score was good, at 83.318215.0977 (lowest score 53, highest 96), with ten cases (66.67 percent of all patients) having satisfactory outcomes. The intra-articular group (n=9) received a fair AOFAS score of 73.2941 13.0851 (lowest score 53, highest score 91), with 4 cases (44.44 percent of the intra-articular group) having satisfactory outcomes, two cases (22.22%) had poor results, while three (33.33%) had fair results. In five cases, the overall AOFAS score for the extra-articular group (n=6) was excellent (95.4000 6.3087) (lowest score 88, highest 96) and good in one case, where all six cases (100 percent of the extra-articular group) had satisfactory results.

El-Mowafi H, et al. (2015) employed the Ilizarov fixator for intra-articular cases, with an AOFAS score of 77.8 5.8 for the Ilizarov only group and 78.4 6.9 for the ankle arthroscopy group, indicating a fair result. This is substantially identical to our result in the intra-articular group, although the current study's cases are all Rüedi and Allgöwer type III, whereas the previous study's cases were primarily typed I and II.[13]

Ihab Badawy (2008) employed Ilizarov for 15 intra-articular cases, and Mazur et al's clinical ankle score varied from 36 to 83, with a mean of 74.2 16.18, indicating a fair success.[15]

Marsh et al found that in 49 plafond fractures treated with articulated external fixators, the average ankle score was 67 points.[16]

This approach produced outstanding outcomes in management of AO type A fractures in the current investigation. Fractures that extend distally to within 4-5 cm of the ankle joint can be treated successfully. There were no non-unions in the room. In most patients, early weight-bearing was also possible.

The Ilizarov fixator does not violate the soft tissues since it uses percutaneous tiny diameter wires, and it may gain good purchase in small distal fragments. The use of olive wires also helps us to minimize the large fracture fragments. This is an excellent technique, particularly in intra-articular comminuted tibial pilon fractures with uncertain soft tissue integrity.[12]

The most significant finding in this study was the Ilizarov method's overall good outcome and the lack of serious problems in a cohort with all of these unfavorable modifiers. It was allowed to operate on all patients immediately, regardless of soft tissue condition, distal fragment size, or intra-articular fracture lines, or whether a staged procedure should be utilized, employing the same protocol for both intra-articular and extra-articular fractures.

CONCLUSION

Using the Ilizarov fixator technique provides satisfactory results in cases of distal tibial fractures. However, it needs technical experience. Thus, to improve outcomes in such patients, it is recommended to Select patients carefully to be able to look after pin. Use limited internal fixation whenever possible. Improve the accuracy of articular reduction to improve overall results. Permit early ROM exercises to prevent joint stiffness and improve cartilage nutrition

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