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Original Article

External Fixation versus Plate Osteosynthesis in the Management of Distal Tibia Fractures

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ABSTRACT

Background: Fracture of the tibia is the most critical type due to its subcutaneous position in the leg, and poor soft tissue around it. Fracture of the lower third of the tibia represents 6% of all fractures of the whole body. It can be treated surgically by plating or external fixation technique which provides immediate weight bearing and can be considered as a primary and a definitive fixation. The study aimed to compare the clinical results of both techniques for treating distal tibia fractures.

Methods: This is an interventional clinical study that was conducted on patients with either distal one third tibia fractures at the Orthopedic Surgery Department at Zagazig University Hospital. 24 cases were included as a comprehensive sample, 12 cases in each group.

Results: There was a statistically significant difference between external fixation and plate groups as regard lateral distal tibia mal alignment ($p<0.05$) being higher in external fixation group, and there was a statistically significant difference between external fixation and plate groups as regarding Osteoarthritis OARSI ($p<0.05$).

Conclusions: There was no significant difference between external fixation and plate groups as regards pain and functional outcome. Duration to radiologic union was longer in the external fixation group than in the plate group.

Keywords: External fixation; Plate osteosynthesis; Distal tibia fractures

INTRODUCTION

Throughout the history of orthopedic surgery, tibial fractures were of the most challenging one. Whatever the cause of the fracture is, high energy trauma and severe twisting injury even a mild one in a predisposed bone can cause the tibial bone to be fractured. Several classifications of the fractures were existed according to different considerations. Extension of the fracture line to involve the articular surface, presence of an open wound over the bone and the status of the soft tissue around the bone are mostly bases of different fracture classifications which will direct the surgeon toward the management Protocol. This management protocol could be conservative or operative. The management will start from the emergency room where the patient presented immediately after the injury, the operation room where he will be fixed by the surgeon and the post-operative period which has a very important impact on the healing process and rehabilitation of the patient [1].

Adults who sustain high energy trauma (such as car crashes, falls from great heights, or sports-related injuries) may fracture their lower third tibia, which results in axial rotational stresses on the lower limb [2].

In certain instances, conservative therapy may be used when fractures are stable and require little shortening. High frequency of issues like

as malunion, variation in limb length, and reduced following conservative treatment for these fractures, reports of early ankle osteoarthritis and range of motion have been made [2,3].

For the majority of distal tibia fractures, surgical fixation is an option that necessitates careful pre-operative planning. Locking plates, interlocking nails, and external fixators are methods for stabilizing fractures. The type of fracture, the quality of the bone, and the state of the soft tissues all influence the fixation techniques [2,4].

In general, open reduction internal fixation (ORIF) with dynamic compression plates (DCP) is still preferred over external fixation because of its wealth of experience and affordable therapy of these fractures. The anatomical reduction might be necessary, but it could also lead to significant soft tissue dissection, blood supply interruption, delayed union, nonunion, and wound problems [5].

Regarding external fixation, for example, Ilizarov technique, when treating distal metaphyseal tibia fractures, the Ilizarov approach allows for unrestricted weight-bearing and early final treatment, which can lead to a favorable outcome. Regardless of whether soft tissue was damaged, the fractures were treated right away after the injury. Low rates of complications arose from this procedure. Compliant patients are necessary [6].

Our hypothesis is that in severely comminuted distal tibia fractures or bad skin and soft tissue condition, external fixation is considered a better fixation technique than the plate osteosynthesis technique. On the other hand, the plate method is better in good skin and soft tissue condition and as a bridging technique in comminuted fracture with good soft tissue condition.

This study aimed to compare between the external fixation technique and the plate osteosynthesis technique regarding pain, functional outcome and alignment.

METHODS

This randomized control trial was conducted between August 2020 and August 2023 after the approval from ethical committee of Zagazig University Hospitals (IRB#9141-14-12-2021). Written informed consents of the patients were obtained. The sample size of the study was calculated to be 24 patients. Patients' demographic data were collected using case notes. There were 11 females and 13 males, their ages ranged from (18 years to 63 years) with an average of 39 years, and the mean follow-up period was one year. The maximum duration of follow-up was 3 years and the minimum was 2 years.

Inclusion criteria were patients with distal one-third tibia fractures, surgically fit patients, skeletally mature patients, and distal one-third tibia fractures, extra-articular & intra-articular except for type 43-c2, c3 according to American Orthopedic (AO) classification. The exclusion criteria were patients with insufficient or lost follow-up data, surgically unfit patients, pathological fractures, and comminuted distal tibia fractures (AO classification 43-c2, c3).

History and clinical assessment:

A detailed history was taken, including mechanism of injury, patient's complaint and history of any other associated injuries or underlying medical diseases. General examination: vital signs, head to toe examination for presence of any associated injuries and local examination for evaluation of the patient including observation, palpation and complete neurovascular examination. It is extremely important to assess skin and soft tissue status. Trauma sheet have to be fulfilled in all cases. Pre-operative radiographs of the affected distal tibia, all patients had standard AP and lateral radiographs. Computed Tomography "3D CT" was done to evaluate the intra-articular extension, degree of comminution. Immediate post-operative and serial follow-up radiographs were done for all patients.

Pre-Operative preparation:

Strict elevation of the injured part was done to minimize swelling and edema. Pre-operative antibiotics were administered 30 min before the operation.

Surgical Technique:

Anesthesia: Except for one, every patient had surgery while under spinal anesthesia; 2 cases underwent surgery under general anesthesia due to associated spine injury. Every patient was put in the supine posture.

Frame assembly:

Four rods connect two rings to form the proximal construct. The distal construct consists of one ring and 5/8 calceneal in 15 cases with sufficient bone of distal segment to be fixed with ilizarov k-wires. B- Only 5/8 calceneal ring in 9 cases with highly comminuted articular surface.

Distal tibial plating:

On a radiolucent operating table, twelve patients were placed supine with the contralateral iliac crest elevated. As a result,

rotation is possible, improving access to the medial side. The thigh was bandaged with a tourniquet. If the fibula shattered within 7 centimeters of the lateral malleolus' tip, it was repaired.

Open reduction of the fracture was done, then insertion of screws and closure of the wound. When closing subcutaneous tissue, care must be taken to ensure that the skin is not twisted and that the plate is adequately covered.

Post-operative management:

Patients were placed in the posterior slab, post-operative X-rays were taken right away, and the neurovascular condition was assessed. Two days of intravenous broad-spectrum antibiotics were administered and patients were discharged on oral antibiotics for five days. As regards DVT prophylaxis, subcutaneous clexane 40 IU was given every 24 hours postoperative to every patient up until their release. Guidelines for quadriceps muscle activity and range of motion for the knee and ankle, excluding those that come with a back slab and are not permitted to bear weight.

Follow-up program:

At 2 weeks, stitches were removed. At 6, 12, 24 weeks, patients attended the OPC for regular follow-up. On the side that was injured, weight bearing was limited, while the other side was supported by crutches. The patient follow-up procedure involved in the study was for 2 years minimally and 3 years maximally.

Evaluation:

The absence of pain at the fracture site and the appearance of bridging callus in three of the four cortices visible on the tibia's AP and lateral radiographs are indicators of fracture union. Time to union was recorded. Malalignment was defined as greater than 5° ante-/ recurvation, greater than 5° varus/valgus deformity, or greater than 15° rotation difference.

STATISTICAL ANALYSIS

Microsoft Excel is used to code, enter, and analyze historical data as well as basic clinical examination, laboratory tests, and outcome measurements. After that, the data were loaded into the statistical package for the social sciences (SPSS version 20.0) program in order to be analyzed. P-value of < 0.05 was considered statistically significant & <0.001 for highly significant results for two-tailed tests.

RESULTS

Table 1 showed that there was no statistically significant difference between external fixation and plate groups as regards time from injury to surgery and mechanism of injury ($p>0.05$).

Table 2 showed that there was no statistically significant difference between external fixation and plate groups as regards GA and Tscherne soft tissue injury grading ($p>0.05$).

Table 3 showed that there was highly statistically significant difference between both groups as regards method of fixation ($p<0.001$). There was no statistically significant difference between external fixation and plate groups as regards fibular and associated fracture ($p>0.05$).

Table 4 showed that there was no statistically significant difference between external fixation and plate groups as regards AOFAS Score, VAS and FADI scores ($p>0.05$).

Table 5 showed that there was a statistically significant increase in plate groups as regards Ankle ROM Plantarflexion, Subtalar ROM Inversion & Subtalar ROM Eversion ($p<0.05$).

Table 6 showed that there was no statistically significant difference between external fixation and plate groups as regards complications ($p>0.05$).

Table S1 showed that there was a statistically significant difference between external fixation and plate groups as regards lateral distal tibia malalignment ($p<0.05$). There was no statistically significant difference between external fixation and plate groups as regards Anterior distal tibia malalignment and RUST score ($p>0.05$).

Table S2 showed that there was a statistically significant difference between external fixation and plate groups as regards Osteoarthritis OARSI ($p<0.05$).

Table S3 showed that there was a highly statistically significant difference between external fixation and plate groups as regards duration to radiologic union ($p<0.001$), being longer in external fixation group. The Mean ± SD of duration in the frame in external fixation group was 20.8±7.5 weeks.

Case Presentation:

A male patient, 67 years old, presented after a road traffic accident. Clinical examination and imaging revealed that he had a left distal tibia fracture which was grade one on Tscherne classification. The patient is known to be hepatic and diabetic, controlled by insulin (Figure 1).

A female patient, 37 years old, presented with a fractured left distal tibia due to a fall to the ground. The soft tissue injury was headed as one according to Tscherene classification (Figure 2).

Table 1: Time from injury to surgery and mechanism of injury among the studied groups

Variable	External fixation group (N=12)		Plate group (N=12)		t-test	P-value
Time from injury to surgery (days):						
▪ ***Mean ± SD***	2.9 ± 2		3.4± 2.3		-0.564 (MW)	0.579
▪ ***Range***	0-7		0-8			
Variable	**N**	**%**	**N**	**%**	**χ 2**	**P-value**
Mechanism of injury:						
▪ ***FFH***	6	50	6	50	----	1
▪ ***RTA***	6	50	6	50		

MW: Mann Whitney test

Table 2: GA and Tscherne soft tissue injury grading among the studied groups

Variable	External fixation group (N=12)		Plate group (N=12)		χ 2	P-value
	N	**%**	**N**	**%**		
GA:						
▪ ***No wound***	8	66.7	10	83.3	2.3	0.53
▪ ***GA II***	2	16.7	2	16.9		
▪ ***GA III a***	1	8.3	0	0		
▪ ***GA III c***	1	8.3	0	0		
Tscherne soft tissue injury grading:						
▪ ***0***	5	41.7	0	0	7.3	0.064
▪ ***1***	3	25	8	66.7		
▪ ***2***	2	16.7	2	16.7		
▪ ***3***	2	16.7	2	16.7		

Table 3: Fibular, associated fracture & method of fixation data among the studied groups

Variable	External fixation group (N=12)		Plate group (N=12)		χ 2	P-value
	N	**%**	**N**	**%**		
Fibular:						
▪ ***Fracture***	9	75	11	91.7	1.2	0.590
▪ ***Intact***	3	25	1	8.3		
Associated fracture:						
▪ ***No***	6	50	9	75	9.2	0.294
▪ ***Fracture Lt humorous***	1	8.3	0	0		
▪ ***RT Fibula LT calcaneus***	1	8.3	0	0		
▪ ***Fracture distal radius***	1	8.3	0	0		
▪ ***Bilateral fracture distal***	1	8.3	0	0		
▪ ***Medial malleolus***	1	8.3	0	0		
▪ ***Lt jaw***	1	8.3	0	0		
▪ ***Rt Tibia fracture L3***	0	0	1	8.3		
▪ ***Medial malleolus***	0	0	2	16.7		
Method of fixation:						
▪ ***Ilizarov***	12	100	0	0	fisher	**0.000* (HS)**
▪ ***Plate***	0	0	12	100		

HS: Highly Significant

Table 4: Pain and Functional Outcome Scores among the studied groups

Variable	External fixation group (N=12)	Plate group (N=12)	t-test	P-value
AOFAS Score:				
▪ ***Mean ± SD***	72.8 ±17.3	79 ± 12.5	-0.99	0.333
▪ ***Range***	32-97	57-99		
VAS:				
▪ ***Mean ± SD***	5.4 ± 1.9	6.9 ± 1.7	-2.5	0.051
▪ ***Range***	2-8	3-9		
FADI:				
▪ ***Mean ± SD***	77 ± 10.4	83.1 ± 6.6	-1.7	0.101
▪ ***Range***	54-98	70-96		

Table 5: Ankle and Subtalar Range of Motion (ROM) values among the studied groups

Variable	External fixation group (N=12)	Plate group (N=12)	t-test	P-value
Ankle ROM Dorsiflexion (°):				
▪ ***Mean ± SD***	13.2 ± 2.1	15 ± 2.9	2.3	0.226
▪ ***Range***	10-20	10-20		
Ankle ROM Plantarflexion (°):				
▪ ***Mean ± SD***	38± 5.5	44 ± 4.5	2.9	**0.007* (S)**
▪ ***Range***	28-42	27-46		
Subtalar ROM Inversion (°)*:*				
▪ ***Mean ± SD***	14± 2.6	19 ± 1.4	5.7	**0.001* (HS)**
▪ ***Range***	7-19	11-22		
Subtalar ROM Eversion (°)*:*				
▪ ***Mean ± SD***	8.2± 1.2	10 ± 0.2	4.3	**0.003* (S)**
▪ ***Range***	4-12	4-14		

Table 6: Complications among the studied groups

Variable	External fixation group (N=12)		Plate group (N=12)		χ 2	P-value
	N	%	N	%		
Complications:						
▪ ***No***	3	25	8	66.7		
▪ ***Pin tract infections***	5	41.7	0	0		
▪ ***Mal-union***	2	16.7	1	8.3	10.6	0.101
▪ ***Delayed union***	1	8.3	1	8.3		
▪ ***Infection***	1	8.3	1	8.3		
▪ ***DVT***	0	0	1	8.3		

(A) **(B)**

(C)

Figure 1: Clinical examination and imaging revealed that he had left distal tibia fracture which was grade one on tscherne classification. A) Pre-operative. B) After 5 months showing nearly full union. C) After device removal

(A)

(B)

Figure 2: She was presented by fracture left distal tibia due to fall to ground. The soft tissue injury was headed as one according to Tscherene classification. A) Three months postoperative. B) Six months postoperative showing full union.

DISCUSSION

One of the most frequent fractures of long bones is still the distal tibial fracture. Two possible causes of this fracture are rotational and bending stresses. Open fractures and the risk of infection due to skin sloughing are more frequent in this kind of fracture because of the thin skin and reduced soft tissue coverage. There are various surgical management techniques that can be employed when conservative treatment is not acceptable [7].

Although open reduction internal fixation (ORIF) offers stability, it frequently necessitates significant dissection of soft tissues, additional devascularization of the fractured bone segments, which carries a higher risk of problems, and additional surgery. High rates of healing and low rates of soft-tissue problems were observed with

minimally invasive percutaneous plate osteosynthesis, or MIPPO [8]. When compared to Ilizarov external fixation, ORIF employing dynamic compression plates (DCP) is still preferred due to its extensive experience and affordable therapy of these fractures (IE) [9].

The objective of this study was improving outcomes of patients with distal tibia fractures and to compare the clinical and functional outcomes after external fixation versus plate osteosynthesis for distal tibia fractures.

This is an interventional clinical study that was conducted on patients with either distal one third tibia fractures at the Orthopedic Surgery Department at Zagazig University Hospital. 24 cases were included as a comprehensive sample, 12 cases in each group.

This study revealed that there was no statistically significant difference between external fixation and plate groups as regards AOFAS Score, VAS and FADI scores ($p>0.05$). The Mean of AOFAS Score was 72.8 ± 17.3 in external fixation group and 79 ± 12.5 in plate group.

Elgammal et al. aimed to evaluate Ilizarov's methods, outcomes, and drawbacks when treating distal tibial fractures with or without limited internal fixation. The AOFAS score, which ranged from 53 to 96, was described as good generally. Ten cases, or 66.67 percent of all patients, had satisfactory results, according to the report. Nine cases (44.44 percent of the intra-articular group) had satisfactory outcomes, two cases (22.22%) had bad results, and three cases (33.33%) had fair results. The intra-articular group obtained a fair AOFAS score of 73.29 (lowest score 53, maximum score 91). The total AOFAS score for the extra-articular group (n = 6) was good in one case, with all six cases (i.e., 100% of the extra-articular group) having satisfactory outcomes, and excellent in five cases (lowest score 88, maximum score 96) [9].

Sitnik et al. examined 84 distal tibia fractures treated with open reduction and internal fixation and found that 74% had excellent or satisfactory functional results. (1) Restoring fibular length; (2) Reducing articular surface; (3) Cancellous bone grafting of the metaphyseal defect; and (4) Stabilization with a medial buttress plate were the four principles they promoted [3].

While some writers reported the same favorable outcomes as Sitnik et al. [3], Rubio-Yanchuck et al. [10] and Song et al. [11] revealed a significant risk of complications along with less than ideal results.

Elgammal et al. discovered positive outcomes, with 76% of patients having good functional outcomes. No patient required an ankle arthrodesis, and there were no long-term fracture union issues [9].

There was no statistically significant difference between the plate groups and the external fixation groups in this investigation as regards GA and Tscherne soft tissue injury grading ($p>0.05$). 0 was 41.7% in the external fixation group, 1 was 25% in the external fixation group and 66.7% in the plate group, 2 was 16.7% in each group and grade 3 was 16.7% in each group.

According to our research, there was no statistically significant difference in side and AO classification between the external fixation and plate groups ($p>0.05$). 43 B2 AO classification was 33.3% in the external fixation group and 33.3% in the plate group.

Elgammal et al. [9] reported that their cases were all Rushdi et al.12] type III, but the majority of the cases in the earlier analysis were type I and II.

According to the current study, there is a significantly significant difference between external fixation and plate groups as regards duration to radiologic union ($p<0.001$), being longer in the external fixation group. The mean ± SD of duration in frame in the external fixation group was 20.8 ± 7.5 weeks.

While, Fadel et al. [1] who aimed to compare the effectiveness of dynamic compression plates (PO) and Ilizarov external fixation (IE) in the treatment of extra-articular distal tibial fractures. They stated that the radiological union time has arrived was 196.5 days in PO and 130 days in IE.

In the current study, there was no statistically significant difference between external

fixation and plate groups as regard Ankle and Subtalar Range of Motion (ROM) (p>0.05).

While that a study by Elgammal et al. [9] reported that, in 8 cases (53.33%), the ankle had the same range of motion as the contralateral side. Less than 25% of the cases (33.3%) had a restriction. There were just two situations (13.33%) where the limitation exceeded 25%. The ankle motion's total arc averaged 46.75 (with a range of 30-75). Plantar flexion averages 35 degrees (range 20–50 degrees), while dorsiflexion averages 6.4 (range 0-10).

There was no statistically significant difference in problems between the external fixation and plate groups in this investigation (p>0.05). Pin tract infections occurred in 41.7% in the external fixation group, malunion occurred in 16.7% in the external fixation group and 8.3% in the plate group, delayed union occurred in 8.3% in each group, infection occurred in 8.3% in each group, and DVT occurred in 8.3% in the plate group only.

Although we were treating such fractures, which were classified as intra-articular and extra-articular fractures, there were some differences in complications severity according to the fracture degree and extension of the fracture line to the articular surface.

Milenkovic et al.[13] examined the application of plates and external fixators in 59 patients with open fractures of the distal tibia of types II and III; significant osteomyelitis complicated 19% of the patients, and 11.5% suffered plate fixation failure, necessitating the use of an external fixator; in contrast, only one patient in the group using external fixators presented with osteomyelitis.

Our research revealed a statistically significant distinction between the exterior fixation and plate groups as regards lateral distal tibia malalignment (p<0.05) being higher in the external fixation group.

Our research revealed a statistically significant distinction between the exterior fixation and plate groups as regards Osteoarthritis OARSI (p<0.05).

A study was published in 2019 reported that operative treatment of fractures in this area by conventional ORIF is expected to cause further compromise to the soft tissue envelope. 11 cases developed deep infections with skin dehiscence and exposure to the hardware, and nine of them had preoperative diabetes mellitus [14].

Distal tibia fractures can be stabilized with plate fixation, although traditional methods require periosteal stripping and extensive dissection, which raises the possibility of soft tissue problems [15].

Bach and Hansen compared the use of plates and external fixators in 59 individuals with kinds II and III distal tibia open fractures. The external fixator group only reported one instance of osteomyelitis, and they suggested that the primary stabilization strategy for Grades II and III open tibial shaft fractures should involve the use of external fixators. Of the patients, 11.5% experienced plate fixation failure requiring the use of an external fixator, and 19% experienced sequelae from severe osteomyelitis [16].

Hosny and Fadel treated 34 open tibial fractures (GI, II, and III) using IE. There were 28 patients that received outstanding and good grades, 1 fair patient and 1 poor patient. For these types of fractures, they advised using IE as the first and only course of treatment [17].

The average duration to union for closed, unstable fractures was 19 weeks, and the infection rate was 7% in open fractures of grades I and II. The idea that external fixation should be used to treat more serious grades II and III fractures due to their high infection rates [17].

Othman et al. [18] reported in their study 100% union of 26 tibial fractures in 22 patients, mainly using the Ilizarov external fixator for treatment. It took an average of 25.6 weeks to unionize. 21 out of the results were rated as exceptional, four as good and one as fair. In a different series, 32 the Ilizarov external fixator was also used to treat open tibial fractures. Healing times were 21.9 weeks for individuals with a single trauma and 25.7 weeks for those with multiple traumas. These times are thought to be

comparable to the findings published by Fayed et al.[19].

Despite its low profile, internal fixation with the locked plate seems strong enough to withstand the forces acting on the distal tibia. As the shape of the plate matches with anatomical shape of the bone, this would allow for better angular and axial stability. If this is coupled with the very low incidence of infection, it might explain the fact that none of the cases in this group developed mechanical failure of the implant [20].

A study which was held by Elsherbiny et al [10] reported that eight antibiotics and local antiseptics were used to successfully treat the pin site local infection that the patients experienced. There is ongoing debate on the acceptable level of residual deformity. It is challenging to apply the postoperative radiological results as a prognostic factor by correlating them with the clinical outcome. There were two malunions in their study; one fracture had a 20° valgus malalignment; the patient eventually underwent ankle fusion after developing ankle arthritis. Following the removal of the Ilizarov frame, a second case of 5° valgus deformity developed. This patient received short cast leg treatment, and the clinical outcome was deemed satisfactory in the end. Based on the criteria outlined, the quality of reduction was deemed good in four patients, fair in six, and bad in two [21].

The limitations of the present study include the small sample size, the unfamiliarity of the patients with external fixator and its possible psychological trauma.

On the other hand, the results of the current paper support our hypothesis, which is that in severely comminuted distal tibia fractures or bad skin and soft tissue conditions, external fixation is considered a better fixation technique than the plate osteosynthesis technique. While, the plate method is better in good skin and soft tissue condition and as a bridging technique in comminuted fracture with good soft tissue condition.

CONCLUSIONS

We conclude from this investigation that there was no discernible difference between plate and external fixation groups as regards pain and functional outcome. Duration to radiologic union was longer in the external fixation group. However, external fixation is a preferable choice in cases with bad soft tissue conditions, and severe comminution and has the advantage of rapid weight bearing. On the other hand, plate osteosynthesis is preferred over external fixation in a good soft tissue condition and its advantage of less time to union.

Conflict of Interest: None

Financial Disclosures: None

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Table S1: Distal tibia and RUST score malalignment among the studied groups

Variable	External fixation group (N=12)	Plate group (N=12)	t-test	P-value
Lateral distal tibia mal alignment:				
▪ ***Mean ± SD***	2.3 ± 5.2	-1.5 ± 3.1	2.1 (MW)	0.047 (S)
▪ ***Median***	1	0		
▪ ***Range***	-4:15	-7:3		
Anterior distal tibia mal alignment:				
▪ ***Mean ± SD***	2.6 ± 11.9	2.1 ± 5.8	0.13 (MW)	0.898
▪ ***Median***	0	0		
▪ ***Range***	-13:37	-2:20		
RUST score:				
▪ ***Mean ± SD***	9.8± 2.1	10.6 ± 1.9	1	0.322
▪ ***Range***	5-12	6-12		

S: Significant

Table S2: Osteoarthritis OARSI among the studied groups

Variable	External fixation group (N=12)		Plate group (N=12)		χ 2	P-value
	N	%	N	%		
Osteoarthritis OARSI:						
▪ ***Grade 1***	5	41.7	5	41.7	8.3	0.04 (S)
▪ ***Grade 2***	0	0	5	41.7		
▪ ***Grade 3***	5	41.7	2	16.7		
▪ ***Grade 4***	2	16.7	0	0		

Table S3: Durations among the studied groups

Variable	External fixation group (N=12)	Plate group (N=12)	t-test	P-value
Duration in frame (weeks): ▪ ***Mean ± SD*** ▪ ***Range***	 20.8 ± 7.5 12-36	 ----- -----	----	**----**
Duration to radiologic union (weeks) ▪ ***Mean ± SD*** ▪ ***Median*** ▪ ***Range***	 19.3± 9.7 20 0-40	 6.7 ± 2.3 6 6-14	4.4 (MW)	0.000 (HS)

HS: Highly significant

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