Multiplanar external osteosynthesis as compared to internal osteosynthesis for comminuted tibial plateau fractures

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Abstract:

Objectives:
We aim to compare Ilizarov versus internal fixation in the treatment of complex tibial plateau fracture as regards clinical, radiological results, and rate of complication.

Patients and methods:
In this study, we managed 40 cases with complex tibial plateau fracture Schatzker five and six (type 41c). Twenty cases were surgically managed by the Ilizarov technique and the other twenty cases were surgically managed by double internal fixation

Results:
while using the Knee society score, the results are the following Regarding the Ilizarov group the range of the knee society score is 31-90 with a Mean ± SD of 76.05±14.86 (11 excellent, 4 good, 3fair, 2 poor) while the group with internal fixation the range of knee society score is 44-93 with Mean ± SD 73.95±13.38 (8 excellent, 5 good, 3 fair, 4 poor). According to these results; the p-value is 0.641 with no significant difference between the two groups.

Conclusion:
There is no difference between Ilizarov and internal fixation in the treatment of complex tibial plateau fracture

Keywords:
Complex tibial plate fracture, Ilizarov, internal fixation

Introduction

Tibial plateau fracture remains a challenge to Orthopaedic surgeons with an incidence of 9.2% of all tibial fractures. The bicondylar type is the most challenging subgroup, with a varied rate of incidence ranging from 20–40% of all tibial plateau fractures [1].

Complex tibial plateau fractures are usually described as Schatzker Type V and VI or as 41 C type injury when using the AO classification. In recent years, the three-column fixation technique (according to the axial cut in the CT to detect the affected column that needs to be fixated) is being used to treat the multiplanar complex tibial plateau fractures [2].

Complex tibial plateau fractures (Schatzker V and VI) are characterized by significant articular depression; severe fracture comminution and displacement; significant associated injury to the soft tissue envelope of the proximal tibia; and in Schatzker VI fractures, dissociation of the tibial metaphysis from the diaphysis [3,4].

The target of management is an anatomic reconstruction of the joint surface, restoration of axial alignment, preservation of the soft tissue envelope of the proximal tibia, and rigid fixation to prevent secondary displacement and allow early active and passive movement to delay the progression to knee osteoarthritis [3].

Previously, the standard accepted treatment for such fractures was open reduction and internal fixation through an extensile incision. The combination of damage to the soft tissues resulting from the energy of the original injury and the extensive surgical dissection led to a high rate of complications, including skin slough, necrosis, and infection [5].

Several alternative methods of treatment, including percutaneous reduction and circular frame stabilization, minimally invasive techniques and implants, and temporary external fixation followed by delayed definitive surgery, have been popularized the advantages of circular frame fixation (with or without percutaneous lag screw fixation) include minimal soft-tissue dissection and ability to correct deformity in multiple planes [5].

This study aims to evaluate the efficacy, advantages, and disadvantages of external fixation in comparison to internal fixation in the management of complex tibial plateau fracture.

Patients and Methods:

It is a prospective randomized clinical study, where 40 patients will be conducted with tibial plateau fracture Schatzker V and VI. Ethical approval was obtained before the initiation of the study with informed consent taken from each patient to participate in the study. All operations were done in our institution hospitals by authors and followed up in the period between 2015 and 2018.

Patients were divided randomly into two groups Group (A) 20 Patients with an odd number were managed by internal fixation. Group (B) 20 Patients with an even number were managed by Ilizarov external fixation. Demographic data are shown in [Table 1].

The inclusion and exclusion criteria of patients added to the study are shown in [Table 2].

Table (1): Demographic data of patients included in the study:

Demographic data		**Group A**	**Group B**	**P-value**
Age (ys)		42.05±12.06	40.45±11.95	0.676
Sex	Male	17 (85.0%)	17 (85.0%)	1.000
	Female	3 (15.0%)	3 (15.0%)	
Shatzker classification	5	12 (60%)	10 (50.0%)	0.271
	6	8 (40%)	10 (50.0%)	

Table (2): Inclusion and exclusion criteria:

Inclusion criteria	exclusion criteria
1. Age group: adults older than 18 years. 2. Sex: both sexes. 3. Closed tibial plateau fracture types V and VI according to Schatzker classification. 4. Both external fixation and plate fixation can be used for the fixation of the fracture.	1. Associated vascular and nerve injury. 2. Skin loss. 3. Open fractures. 4. Patient with compartment syndrome. 5. Pathological fractures.

Surgical technique for internal fixation:

In this study, we carried out the internal fixation according to the three-column classification [2]; the affected column fixation will be carried out through different approaches. In cases of lateral and medial plating, the patient was placed supine on a radiolucent operating table. The table should provide the capability to flex the knee to 90 degrees, while in cases of posterior plating through a direct posterior approach; Patients were placed in the prone position on a radiolucent table. We used a universal anterior approach in two cases, a double approach in eight cases, a lateral approach in four cases, and a posterior approach in six cases [2].

Surgical technique for Ilizarov external fixation:

patient position is supine position After the fracture is distracted and aligned, the joint surface is assessed; if not well reduced; reduction should be done percutaneous or through a limited incision. After reduction of the articular surface, the reduction can be maintained by either olive wires or 6.5 mm cannulated screws, we did pre-assembly of the frame in the form of three rings, the first wire was applied parallel to the joint line as a reference wire then continue the frame in normal alignment with good stability.

All patients will be followed up post-operatively by plain radiograph (anteroposterior and lateral) every two weeks for the first two months then every month till fracture healing occurred and a CT scan is obtained to detect the accuracy of fracture healing and articular surface reduction.

Partial weight-bearing and exercises will be started after callus formation on the radiograph. Full weight-bearing will be started after the bone union. Functional assessment "subjective & objective" The Knee Society Clinical Rating System). In group B in case of the crossing knee joint (cases with ligament instability after frame application), the femoral pieces were removed after 6 weeks, and patients were encouraged to start knee exercises to gain full range of motion and the whole frame was removed after radiological healing was obtained.

Figure 1: a. bicondylar tibial plateau fracture anteroposterior view x-ray, b. lateral view x-ray, c. postoperative anteroposterior x-ray, d. lateral view x-ray, and e. clinical photo of patient knee flexion on follow-up.

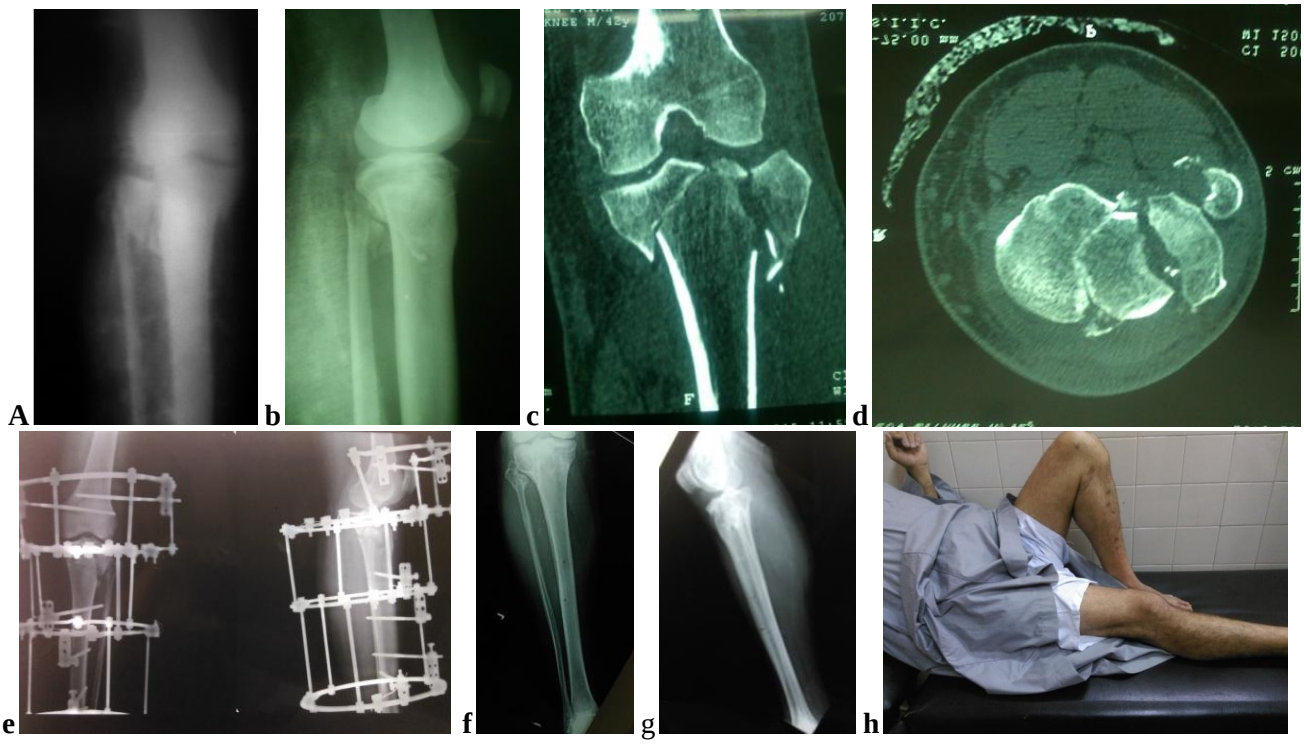

Figure 2: a. anteroposterior view x-ray of bicondylar tibial plateau fracture, lateral x-ray view, c,d. CT scan of the fracture, e. postoperative x-ray fixation by Ilizarov, f,g. after frame removal and h. clinical photo of knee flexion of the patient on follow-up

Results:

The range of motion of group A was 110.25±17.05° while in group B was 103.50±23.18° (P-value = 0.301) with no significant difference, the incidence of partial weight-bearing in group A was 9.60±1.67 weeks while in group B was 6.60±3.69 weeks (P-value = 0.002) with a significant difference. The incidence of full weight-bearing in group A was 17.65±3.66 weeks while in group B was 11.00±4.18 weeks (P-value <0.001) with a significant difference. Radiological healing was achieved in group A at 15.30 ± 3.20 weeks while in group B at 16.80±4.18 weeks (P-value = 0.210) with no significant difference. The mean score according to knee society score (KSS) [6] was 73.95±13.38 in group A while in group B was 76.05±14.86(P-value = 0.641) with no significant difference [Table 3]. Regarding complications in group A, we found 2 cases with the delayed union, 2 cases with superficial infection, 1 case with deep infection, and 2 cases with Varus malalignment. In group B there was 1 case with fixed equines, 7 cases with pin tract infection, 1 case with the delayed union, and one case with deep venous thrombosis (DVT) with (P- value=0.522) with no significant difference.

The mean follow-up period in our study was 18 months.

Table 3: clinical and radiological results:

		Group A	Group B	P-value
Range of motion		110.25±17.05	103.50±23.18	0.301
Partial weight-bearing		9.60±1.67 wk	6.60±3.69 wk	0.002
Full weight-bearing		17.65±3.66 wk	11.00±4.18 wk	<0.001
Fracture union		15.30±3.20 wk	16.80±4.18 wk	0.210
Knee society score		73.95±13.38	76.05±14.86	0.641
Follow up period				
Complications	Superficial infection	2 cases	7 cases	0.522
	Deep infection	1 case	No cases	
	Fixed equines	No case	1 case	
	Delayed union	2 case	1 case	
	DVT	No cases	1 case	
	Malalignment	2 case	No cases	

Discussion:

In this study, we provide a descriptive and comparative analysis of our experience with the utilization of Ilizarov external fixation in comparison with an internal fixation method in the management of complex tibial plateau fracture. In our comparison, we depended on different parameters (partial and full weight-bearing, range of motion of knee joint, radiological healing with fracture union, and knee society score) and complication rate to evaluate which method is better in the management of complex tibial plateau fracture.

1. Partial and full weight-bearing:

Comparing the two groups we found that patients managed with Ilizarov external fixation enjoyed earlier partial weight-bearing with a range of 2-16 weeks with Mean±SD (6.60±3.69) and full weight-bearing with 6-24 weeks with Mean±SD (11.00±4.18)

On the other hand, in patients with internal fixation, we found that regarding partial weight-bearing the range was 6-12 weeks with Mean±SD (9.60±1.67), and for full weight-bearing, the range was 14-24 weeks with Mean±SD (6-24).

Comparing the two groups regarding partial weight-bearing (p-value = 0.002) with a significant difference and full weight-bearing (p-value <0.001) with a highly significant difference.

In other studies; Eggli et al [7] performed dual plating on 14 patients and permitted immediate 10 kg of weight-bearing. All patients achieved union by 12 weeks, Ali AM et al [8] in their study of elderly patients with bicondylar plateau treated with an external ring fixator and early full weight-bearing; 10 of 11 patients achieved a good result.

2. Radiological healing:

In our study: the average time of fracture healing in group B was 12-28 weeks with Mean±SD (16.80±4.18 weeks) while in group A was 12-20 weeks with Mean±SD (15.30±3.20 weeks) with (p-value = 0.210) with no significant difference between two groups.

Zhong Fenglin [9] did a study on 759 cases with tibial plateau fractures the average time to union

in the external fixation group was 17.73 ± 4.87 weeks (range, 8.5–64.2 weeks) versus 15.64 ± 4.36 weeks (range, 6–60 weeks) with plating group. There was no difference between the groups concerning the mean time to union (P = 0.310) with results nearly like ours.
Conserva V, et al [10] The overall mean duration of healing was 16.8 weeks in the external fixation group and was 15.9 weeks (7.5– 32 weeks) while in the plating group was 17.2 weeks (9.1–45 weeks); no statistical difference between the two groups (p = 0.340) with results nearly like ours.

3. The total range of motion:

The total range of motion in the Ilizarov group is 40-125° with Mean±SD (103.50±23.18°) while in the internal fixation group range of motion is 80-125° with Mean±SD (110.25±17.05°) there is no significant difference (p value=0.301).
Zhong Fenglin [9] found that the average value of knee flexion was109.4±12.6 (range,0–170) in the external fixation group and 118.5 ± 11.2 (range, 60–150) in the plating group; no significant difference was demonstrated between the groups (P = 0.168) with results nearly like ours.

4. Knee society score

Regarding the Ilizarov group, the range of knee society score is 31-90 with Mean±SD 76.05±14.86 (11 excellent, 4 good, 3fair, 2 poor) while in the group with internal fixation the range of knee society score is 44-93 with Mean±SD 73.95±13.38 (8 excellent, 5 good, 3 fairs, 4 poor).
According to these results; the p-value is 0.641 with no significant difference between the two groups.
Regarding patients managed by Ilizarov external fixator, Chin et al [11] operated on 18 patients with a KSS mean of 65.9(6 excellent, 1 good, 3 fair, and 8 poor), El Barbary et al [12] operated on 29 patients and their result was KSS:(18 excellent, 7good, 1 fair and 2 poor), Babis et al [13] operated 18 patients and their results were (18 excellent, 10 good, 4 fair and 1 poor), Mikulak et al [14] operated 24 patients and their results were (9 excellent, 6 good, 4 fair and 5 poor), Stamer et al [15]operated 22 patients and their results were (13 excellent, 3 good, 1 fair and 6 poor), Subasi et al [16] operated 15 patients and their results were mean 77(3 excellent, 7 good 1 fair and 4 poor), Faldini et al [17] KSS: mean 89, (25 excellent 4 good, 2 fair and 1poor)
Regarding patients managed by open reduction and internal fixation Yu et al [18] operated on 54 patients with a knee society score = of 70.3 and Benirschke et al [19] operated on 13 patients with a mean KSS of 84.6.
Rohra et al [20] operated on 34 patients with KSS (24 excellent, 8 good,1 fair, and one poor).

5. Complications:

David Metcalf, Craig J. Hickson et al [21] found in their systematic review that the rates of superficial infection in the external fixation and ORIF groups, respectively, were 14.0 vs 4.7 % (P = 0.01). The rates of deep infection were 4.2 and 2.6 % (P = 0.700), respectively. Pooled results for any infection (deep or superficial) found that patients treated with external fixation had greater odds of this outcome (P = 0.01).
The rates of venous thromboembolism (VTE) were nine cases of deep vein thrombosis (3.8 %), with no statistically significant differences between the groups (P = 0.45), and no reported pulmonary emboli. Compartment syndrome was reported as a complication (81 fractures). It featured in 5.4 % of external fixation cases and 9.1 % of those undergoing ORIF (P = 0.56).

In our study:

In the Ilizarov group, we found pin tract infection in 7 cases that were managed by gradual dressing with saline and systematic antibiotics we needed to remove the infected pin in one case. The gradual dressing by saline declined the rate of pin tract infection compared with other previous studies.
Fixed equinus was found in one case due to bad patient compliance that needed open tendon Achilles lengthening after frame removal and application below-knee cast.
Deep venous thrombosis was presented in one case and after the failure of medical treatment by thrombolytic drugs intra-venous filter was applied. Delayed union was found in a single case that was managed by an iliac crest graft.
On the other hand, in the internal fixation group delayed union was found in two patients, where the union was found only in one cortex by x-ray and CT scan one of them was managed by iliac crest graft only
In the other patient, the lateral plate was done biologically due to severe comminution so there was a large butterfly that needed besides the iliac crest graft a lag screw to fix it well.
Superficial infection presented in two patients and after systematic antibiotics, one of them improved, the other had recurrent attacks of infections for six months then removal of the plate after union and debridement was done to eradicate the infection.

One patient was presented with a deep infection from the start and after repeated sessions of antibiotics the infection persisted, so we removed the plates and converted it to Ilizarov till union was achieved. Malalignment was presented in two cases they were managed by tibial osteotomy and correcting one of them by another plate and the other was by Ilizarov.

The drawbacks of our study are the relatively short follow-up period in some of the cases. Another limitation is the relatively small sampling included in this study which is mainly because we have excluded patients that required multiple procedures. On the other side, the point of strength of our study is that it is the first study to depend on multiple points of comparison (partial and full weight-bearing, knee ROM, KSS, radiological healing of the fracture and complications) to evaluate which is better in management of complex tibial plateau fracture

Conclusion:

From our study we conclude that Ilizarov and internal fixation are different tools for the management of complex tibial plateau fracture, none of them is superior in the treatment of complex tibial plateau fracture; the choice of the method is according to fracture personality and surgeon experience.

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