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Plating versus Ilizarov Technique for Complex Tibial Plateau Fractures: A Comparative Study on Functional Outcome and Patient Satisfaction

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Abstract

Objective

To compare clinical and functional outcomes and complications of open reduction internal fixation (ORIF) by plating and Ilizarov technique in complex tibial plateau fractures.

Methods

This study is a randomized clinical trial accompanying 56 patients having Schatzker type V and VI tibial plateau fractures. We divided patients into two groups for management. Group I; open reduction internal fixation and Group II; ilizarov technique. We conducted study at the orthopedics department, Jinnah Post-Graduate Medical Center, Karachi, from April-2018 to Oct-2020. The endpoint was to assess patients' satisfaction and clinical and functional outcomes up to an 18-month follow-up.

Results

The etiology of tibial fracture was mainly road traffic accident (RTA); 17 (70.9%) in ORIF versus 23 (71.8%) in the Ilizarov group. According to clinical outcomes, excellent extension lag was achieved in 100% of patients in both groups. Most patients had excellent knee flexion, thigh atrophy and instability outcomes (54.1% vs 59.37%, 87.5% vs 81.2% and 83.3% vs. 87.5%). The functional outcome assessment was done and recorded for 18 months of follow-up. There was no significant difference in normal walking, stair climbing, squatting, jumping and duck walking between the groups. The overall rate of complications was similar; 11 (45.8%) in ORIF versus 17 (53.12%) in the illizarov group (p=0.78).

Conclusion

Our study concludes that there is an excellent clinical and functional outcome found in both procedures as both are safe and effective procedures with fewer complications

Keywords

Complex Tibial Plateau Fractures, ORIF, Ilizarov Technique

Introduction

Complex tibial plateau fractures are extraordinary injuries that harm the articular and soft tissues in weight-bearing joints. The severity of the damage depends on the soft tissue injury[1]. The Schatzker's classification system is widely used for categorizing tibial plateau fractures based on the mechanism of injury, fracture pattern, and severity. The classification includes six types, ranging from type 1 to type 6. Low-energy fractures are seen in elderly patients with underlying bone diseases, while high-energy fractures are typically seen in younger patients with traumatic injuries. The severity of the fracture increases from type 1 to type 6, with type 6 being the most severe and associated with the highest risk of complications. The types include split fracture of the lateral tibial plateau (type 1), split with depression in the lateral tibial plateau (type 2), central depression in the lateral tibial plateau (type 3), medial condyle fracture (type 4), combined medial and lateral condyle fracture (type 5), and tibial plateau fracture with dissociation from tibial meta-diaphysis (type 6). Understanding the type of fracture and its severity is essential for proper diagnosis and treatment to achieve the best possible outcome. The tibial plateau fracture prevalence is 1% of all fractures[2]. The incidence rate is 1.3 people for every 10000 people per year. The suffering age is 52.6 years (males at >50 years/females>70 years)[3]. The procedural treatment is reflected as a surgical challenge because of the fracture pattern and its related nerve damage. Articular congruity and ligamentous instability cause a decrease in postoperative results in the long term[4]. Non-surgical methods of complex tibial plateau fractures give poor outcomes. Regular treatment is open reduction and internal fixing (ORIF) using screws and plates.

The surgical management depends on the quality of the bone, severity of bone damage and functional grade of the tibia[5]. Still, there is controversy regarding the selection of surgical procedures. Fixation has drawbacks of skin necrosis, deep or superficial infection, and wound breakdown. A single incision can operate condylar tibial plateau fracture, but there is a high risk of mal-alignment[6-7]. Complications may be reduced by using dual incision plating[8]. Bicondylar tibial plateau fracture surgeries are highly demanding despite long-term peri-operative complications[9]. Ultimately, lateral compression fracture transmits the low energy force to valgus-flexion[10-11]. One more attractive treatment technique is ilizarov external fixation. The

benefit of ilizarov is to treat the closed or open fracture with minimal chance of wound difficulties and functional weight-bearing and quick joint motion. In the long term, it is easy to undergo knee replacement if required. In Pakistan, many surgeons do not prefer to apply illizarov, and the patients are reluctant to undergo illizarov surgery due to its external appearance.

The purpose of the current study is to compare the patients' satisfaction with functional outcomes and complications post-surgery of ORIF with plating and ilizarov in complex tibial plateau fractures. The results will help us make the best surgical choice and convince Pakistani patients of the illizarov application despite its external appearance.

Methodology

This study is a single institutional non-randomized clinical trial undergoing complex tibial plateau fractures (ORIF or Ilizarov) at the Department of orthopedics, Jinnah Post-Graduate Medical Centre, Karachi. The study was conducted from April-2018 to Oct-2020. Fifty-six patients were included in total by non-probability consecutive sampling; 24 underwent ORIF, while 32 underwent Ilizarov fixation. The institutional research wing approved the current study. All patients were informed about the risk and benefits of ORIF or ilizarov operations, and written, and informed consent was taken from all patients before including them in the study.
The inclusion criteria were all adult patients with Schatzker type V and VI tibial plateau fractures admitted to our institute. The exclusion criteria included those patients who did not come for post-surgery follow-up for 18 months, ipsilateral fracture of femur and tibia, head and neck trauma, stroke and obstructive lung disease.

The study endpoint was to assess patients' satisfaction and clinical and functional outcomes. The clinical and functional outcomes were assessed using the Honkonen-Jarvinen (HJ) Criteria[12]. The HJ criteria are based upon four parameters: subjective, clinical assessment, functional evaluation, and radiological scoring. The subjective assessment consists of the frequency of symptoms experienced by the patient: daily, weekly, fortnightly, monthly, or never. The clinical evaluation

was based on extension lag, flexion range, and thigh atrophy. The functional assessment comprises the ability to walk, climb stairs, jump, squat, and duck walk. The radiological evaluation includes the degree of varus/valgus, tilting of the plateau, articular step-off, condylar widening in millimeters, and the relative joint space narrowing indicates degenerative changes after the plateau fracture. The stiffness, pain score, and physical Function with knee osteoarthritis were measured through WOMAC (Western Ontario and McMaster Universities Arthritis Index)[13]. WOMAC index score is recorded for assessing pain, stiffness and physical functions of hip and knee osteoarthritis; the range of the WOMAC score is 0 (best) to 96 (worst). The scores for every scale summed up, the Pain score range from 0-20, for Stiffness 0-8, and Physical Function, the range will be 0-68. High range scores on the WOMAC indicate worse pain, stiffness, and functional limitations[13].

Data analysis was performed by SPSS v23.0 (IBM corp., USA). Quantitative variables were calculated as Mean±S.D, and categorical variables were calculated as frequency and percentage. Study outcomes were compared using the chi-square test. P-value ≤0.05 indicated as statistically significant.

Results

The mean age was 45.66±15.46 in ORIF versus 36.37±14.22 years in the ilizarov group. The male/female ratio was 40 /16 (71.4% / 28.6%). There were 11 (45.8%) patients of Schatzker V and 13 (54.2%) patients of Schatzker VI in the ORIF group. However, 9 (28.12%) and 23(71.8) patients of Schatzker V and VI were in the Ilizarov group. The etiology of tibial fracture mainly by road traffic accident (RTA) of 17 (70.9%) in ORIF, 23 (71.8%) in the ilizarov group, remaining patients got fractures due to falls. The average degree of knee flexion at 18 months was 121.64° ± 15.42 ° in ORIF and 126° ± 13.65° in Ilizarov (Table-1).

Table-1 Pre-operative characteristics of participants		
Characteristic	**ORIF (n = 24)**	**Illizarov (n = 32)**
Age (years)	45.66±15.46	36.37±14.22
Male/female	16 (66.3%)/ 8 (33.7%)	24 (75%)/ 8 (25%)
Etiology		
Knee flexion (degree)	121.64 ± 15.42	126 ± 13.65
RTA n (%)	17 (70.9%)	23 (71.8%)
Fall n (%)	7 (29.1%)	9 (28.1%)
Side		
Right leg fracture n (%)	9 (37.5%)	14 (43.75%)
Left leg fracture n (%)	15 (62.5%)	18 (56.25%)
Type		
Schatzker V n (%)	11 (44.83%)	9 (28.1%)
Schatzker VI n (%)	13 (54.16%)	23 (71.8%)

According to clinical outcomes, excellent extension lag was achieved in 100% of patients in both groups. Most patients had excellent knee flexion, thigh atrophy and instability outcomes (54.1% vs. 59.37%, 87.5% vs. 81.2% and 83.3% vs. 87.5%). 8.3% of patients had fair thigh atrophy in the ilizarov group; there was 4.1% of the patient had clinical instability due to pain in the ORIF group. There was no statistical difference in the p-value. (Table-2). The mean WOMAC score was 8.6 in ORIF and 7.9 in the Ilizarov group.

Table-2 Clinical outcomes of participants				
Criteria		**ORIF (n =24)**	**Ilizarov (n=32)**	**P-value**
Extension lag n (%)	Excellent	24(100%)	32(100%)	1
	Good	-	-	-
	Fair	-	-	-
	Poor	-	-	-
Knee flexion n (%)	Excellent	13(54.1%)	19(59.37%)	0.90
	Good	9(37.5 %)	10(31.2%)	0.83
	Fair	2 (8.3%)	3(9.3%)	0.73
	Poor	-	-	-
Thigh atrophy n (%)	Excellent	21(87.5%)	26(81.2%)	0.78
	Good	3 (12.5 %)	4(12.5%)	0.68
	Fair	0	2(6.25%)	0.60
	Poor	-	-	-
Instability n (%)	Excellent	20(83.3%)	28(87.5%)	0.95
	Good	3 (12.5%)	4(12.5%)	0.68
	Fair	1 (4.1%)	0	0.89
	Poor	-	-	-

According to Honkonen-Jarvinen Criteria, the functional outcome assessment was done and recorded for 18 months follow-up. The criteria were normal walking, stair climbing, squatting, jumping and duck-walking. The comparison in both groups was similar in postoperative functional outcome. All the criteria had p-values ≥0.05, which indicates statistical insignificance (Table-3).

Table-3 Functional outcomes of participants

Criteria		ORIF (n =24)	Ilizarov (n=32)	P-value
Normal walking n (%)	Excellent	24(100%)	31(96.8%)	0.90
	Good	0	1(3.2%)	0.90
	Fair	-	-	-
	Poor	-	-	-
Stair climbing n (%)	Excellent	23(95.83%)	28(87.5%)	0.54
	Good	1(4.17 %)	4(12.5%)	0.54
	Fair	_	_	-
	Poor	-	-	-
Squatting n (%)	Excellent	15(62.5%)	24(75.0%)	0.47
	Good	9 (37.5%)	7(21.8%)	0.32
	Fair	0	1(3.25%)	0.90
	Poor	-	-	-
Jumping n (%)	Excellent	13(54.16%)	18(56.2%)	0.90
	Good	7(29.1%)	7(21.8%)	0.75

	Fair	3(12.5%)	3(9.3%)	0.95
	Poor	1(4.16%)	4(12.5%)	0.54
Duck-walking n (%)	Excellent	14(58.3%)	17(53.1%)	0.54
	Good	6 (18.7%)	7(21.8%)	0.96
	Fair	3(9.3%)	5(15.6%)	0.76
	Poor	1(4.17)%	4(12.5%)	0.54

There were fewer complications found during the postoperative follow-up. In the ORIF group, 3 (12.5%) patients developed infected non-union and redo surgery was done, while the incidence was 0% in the illizarov group (p=0.14). Redo surgery using bone grafts due to non-union was needed in 2 (4.8%) cases in ORIF versus 0 patients in the Ilizarov group (p=0.34). The frequency of SSI that resolved with antibiotics was 8 (30.0%) in ORIF versus no patient in the illizarov group (p=0.001). The overall rate of complications was similar; 11 (45.8%) in ORIF versus 17 (53.12%) in the illizarov group (p=0.78) as shown in Table 4.

Table-4 Complications of surgeries			
Complication	ORIF (n=24)	Ilizarov (n=32)	P-value
Decrease in range of motion n (%)	0	6 (18.7%)	0.07
Infected non-union, redo surgery at 6 months with Ilizarov n (%)	3 (12.5%)	0	0.14
Non-union, redo surgery with bone graft n (%)	2 (4.8%)	0	0.34
Pin tract infection n (%)	0	4 (12.5%)	0.20
Pin tract infections plus pin breakage n (%)	0	7 (21.8%)	0.04
Surgical site infection that resolved with antibiotics n (%)	8 (30%)	0	0.001
No complications n (%)	11 (45.8%)	17 (53.12%)	0.78

Discussion

RTA is the leading cause of complex tibial plateau fractures in the world and Pakistan. Complex tibial plateau fracture treatment is challenging to an orthopedic surgeon because of its complexity in stabilizing fragment fixation, articular surface congruity, soft tissue handling and precise reconstruction of the articular surface. Reconstructing a stable, painless, mobile knee is a challenging task. It needs a lot of technical knowledge and experience. There are different techniques and methods to fix the tibial plateau fractures, such as the dual plate technique (midline incision/ M. Benz incision), Ilizarov ring fixation and hybrid external fixation. Limited publications are comparing the ORIF and ilizarov fixation techniques.

Osteosynthesis and association for the study of internal fixation for treating complex tibial plateau fractures recommend using the double incision double plating technique rather than the Ilizarov technique[14]. There was a study conducted by Young and Barrack[15], Mallik et al.[9] on the internal fixation with plates in complex tibial plateau fractures. Their study concludes a high rate of deep wound infections. In another study, Uhl et al.[16] concluded that treating with dual plates may cause skin infection and osteomyelitis in complex tibial plateau fractures.

A randomized controlled study conducted by the Canadian orthopedic trauma society[17] and Hall et al.[18] on comparing ORIF and Ilizarov technique did not find any functional difference in both groups and mentioned multiple health deficits were found with residual limb injury in two years of follow-up. A meta-analysis conducted by Metcalfe et al.[19] compared ORIF and Ilizarov external fixation revealed that ORIF and Ilizarov both techniques are proper treatments, and there is no difference in both groups regarding the outcomes. Another meta-analysis conducted in china by Zhao et al.[20] in their conclusion reported that there is an advantage of Ilizarov fixation over ORIF, and both techniques were suitable in complex tibial plateau management.

A recent Cochrane review by McNamara et al. evaluating four randomized and two quasi-randomized trials, comparing ORIF with Ilizarov, did not find enough evidence to ascertain the best fixation method. Current evidence does not contradict the idea of the best results obtained

when using limited exposures to treat this fractures[21]. Using the Ilizarov technique, Catagni et al.[22] did not observe any deep infections in 59 patients with Schatzker V-VI fractures.

Our present study results and complications have maximum similarity to the Canadian orthopedic trauma society[17] and Hall et al.[18] studies about the functional outcome of complex tibial plateau fractures treatment with ORIF or Ilizarov technique in Schatzker V and VI. They concluded that both of these techniques are equally effective. We found the same as in our study. There was a non-significant difference in functional outcomes of the ORIF and Ilizarov groups ($p>0.05$). The complication rate between ORIF (47.3%) and Ilizarov (53.0%) ($p=0.87$). The average degree of knee flexion at 18 months post-op was 121.64° ± 15.42 ° in ORIF and 126°± 13.65° in ilizarov. The current study will help decide the best surgical option for the patient and increase surgeons' as well as patients' confidence to opt for the illizarov technique, which has the same outcome as ORIF with minimal complications.

Limitations

This is an 18-month post-operative Honkonen Jarvinen Criteria follow-up study for the clinical and functional outcome; we did not follow patients for a longer period. The study sample was small, needs to conduct a large study at a larger center where the patient flow is more for fine results.

Conclusion

Complex tibial plateau fractures treatment with ORIF (plating) or Ilizarov technique in Schatzker V and VI are safe and effective procedures with less incidence of complication. Our study concludes that there is an excellent clinical and functional outcome found in both procedures.

Authors Contribution

Ghori FS: Conception, design, drafting, analyze and critical/final revisions.

Khalil A: Data acquisition and critical revision.

Khan KM: Conception, design and final approval.

Declaration of Interest

None.

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None.

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