

FUNCTIONAL AND RADIOLOGICAL OUTCOME OF ILIZAROV FOR SCHATZKER FRACTURE TYPE VI

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Abstract

Objective: The aim of this study was to assess the clinical and radiologic outcome of Ilizarov fixator in Schatzker's type VI fractures.

Settings: Orthopedics department of Ghurki Trust Teaching Hospital, Lahore.

Study design: Prospective observational study.

Study duration: The study period extended from 15th May 2024 to 15th November 2024.

Study methodology: During the study period consecutive sampling was applied and all the cases of open or close Schatzker's type VI fractures that were fixed with Ilizarov were studied. Outcome was assessed clinically as well as radiologically on 6-month follow-up. Clinical assessment was done by using American Knee Society score and radiologic assessment was done by Rasmussen's radiological scoring (RSS).

Results: A total of 68 patients were studied; where majority were males presenting following RTA and the mean age was 34.70 ± 8.14 . Final outcome in terms of postoperative range of motion, which was 90.8 ± 18.89 . Functional outcome in terms of AKSS was 69.63 ± 16.73 and the radiological outcome in term of Rasmussen's radiological scoring was 12.58 ± 3.05 . In terms of functional outcome, highest number of patients fall in the excellent outcome criteria i.e 46 patients. Whereas, in terms of radiological outcome highest number of individuals were in the good outcome category.

Conclusion: Ilizarov fixator is associated with excellent to good outcome in Schatzker's type VI fractures. The factors that affect the final outcome among these patients include use of proximal tibial C-ring and fracture patterns that don't need cannulated screws for fixation.

INTRODUCTION

Proximal tibia fracture are high energy fractures that are notorious because of the associated soft tissue injury as well as articular involvement.¹ Soft tissue injury can complicate and present as open fracture or

compartment syndrome.^{2,3} The high energy that is transmitted to the tibial condyles lead to comminution of the articular surface and its depression. Furthermore, neurovascular injuries

including peroneal nerve injury can further complicate the situation.³ This not only makes these fracture difficult to treat in the acute settings but also lower the functional outcome over the long term: leading to osteoarthritic changes in the joint at an early age. This is why the treatment principles in these fracture are different: demanding anatomic reduction while maintaining good soft tissue coverage.^{4,5} Alongside anatomic reconstruction, anatomic axis restoration as well as spanning fixation of metaphyseal comminution is the principle in proximal tibial fractures. Furthermore, soft tissue envelope restoration and maintenance is of prime importance.⁶ Schatzker in 1979, classified these fractures on anteroposterior (AP) X-ray of proximal tibia. Among the Schatzker's types, the most complex fracture is type VI. Schatzker's type VI is a fracture in which a horizontal or oblique fracture line separate the metaphysis from the shaft (diaphysis) and another fracture line extends into the tibial articular surface.⁷ This fracture pattern can only be produced with very high energy trauma and hence severe soft tissue complications are also expected. Both the fracture complexity and associated soft tissue injury make the management challenging in these scenarios.^{8,9} Hence, Ilizarov ring fixator is handy as it allows application of traction as well as multidimensional fixation of the fracture segments with wires and schanz screws. Furthermore all this can be done without incising the skin: hence, avoiding the wound complications that is a major threat in these injuries.⁹

In 2022, Pandey S et al. studied outcome of closed Ilizarov in proximal tibia fractures and inferred that the radiologic outcome of close ilizarov in schatzker's VI fractures as per Rasmussen's radiological scoring (RSS) was 13 ± 2.70 . They further elaborated that functional results were good and a mean score of 74.9 ± 7.26 was noted in their study group.¹⁰

The aim of this study was to assess the clinical and radiologic outcome of Ilizarov fixator in Schatzker's type VI fractures. Since no local research has been done on the subject; this study will play the pioneer role in development of local best practice guidelines for management of Schatzker's type VI fractures.

After taking an ethical approval from institutional review board of Ghurki Trust Teaching Hospital, Lahore: a prospective observational study was performed at the orthopedics ward of the aforementioned hospital. The study period extended from 15th May 2024 to 15th November 2024. During the study period consecutive sampling was applied and all the cases of open or close Schatzker type VI fractures that were fixed with Ilizarov were studied. Only the skeletally mature patients that signed the informed consent for inclusion in the study were included. WHO sample size calculator was utilized to calculate a sample size of 68, at 95% confidence interval, 8% margin of error and 13% population proportion.¹⁰ The patients with severe soft tissue injury including open wounds were first managed for wound related issues including primary wound wash and debridement alongside antibiotic coverage. All these cases underwent AP and Lateral X-rays of proximal tibia before surgery. In cases with severe articular comminution a temporary distal femoral ring was applied for a period of 3 weeks. All the cases were fixed under C-arm (image intensifier) guidance. On first postoperative day patients were encouraged to mobilize with weight bearing to toleration on the affected limb. Postoperative rehabilitation was supervised by a well-equipped physiotherapy department in concordance with the operating surgeon's advice.

Outcome was assessed clinically as well as radiologically on 6 month follow-up. Clinical assessment was done by using American Knee Society score and radiologic assessment was done by Rasmussen's radiological scoring (RSS) - **figure 1**. The American knee score is a physician calculated score that assesses pain (maximum of 50 points), stability (maximum of 25 points) and range of motion - ROM (maximum of 25 points). Furthermore, deductions are done from the overall calculated score in cases of extension lag, flexion contracture or malalignment. The final score is used to categorize the clinical state of the knee as excellent (85 or above), good (75-84), fair (60-74) or poor (<60). The Rasmussen score assesses articular depression, intercondylar widening and meta-diaphyseal angulation: marking each from 0 to 6. A total score of 18 is considered excellent, 12-17 is good, 6-11 is fair and <6 is poor.

Study methodology

Points	
A. Articular depression	
Not present	6
<5 mm	4
6-10 mm	2
>10 mm	0
B. Condylar widening	
Not present	6
<5 mm	4
6-10 mm	2
>10 mm	0
C. Angulation (varus/valgus)	
Not present	6
<10°	4
10°-20°	2
>20°	0

Figure 1: Rasmussen's radiological scoring (RSS)

Statistical analysis: Statistical analysis was performed with Statistical Package for Social Sciences (SPSS 23). Measures of central tendencies and proportions were used to present quantitative and categorical variables, respectively. Post-stratification t-test and Pearson's correlational analysis was performed to depict statistically significant relations (where $p < 0.05$ was considered significant).

Results

A total of 68 patients were studied; where majority were males presenting following RTA and the mean age was 34.70 ± 8.14 . This alongside the rest of the descriptive statistics is illustrated in the **table 1**. The **table 1** also depicts the final outcome in terms of postoperative range of motion, which was 90.8 ± 18.89 . Functional outcome in terms of AKSS was 69.63 ± 16.73 and the radiological outcome in term of Rasmussen's radiological scoring was 12.58 ± 3.05 . The postoperative outcome has been stratified as per the aforementioned criteria in excellent, good, fair and poor and presented in **figure 2**. From the figure it is

noteworthy that in terms of functional outcome, highest number of patient fall in the excellent outcome criteria i.e 46 patients. Whereas, in terms of radiological outcome highest number of individuals were in the good outcome category.

Inferential analysis to determine the factors affected final functional outcome is summarized in **table 2**. As is obvious from the figures written in the **table 2**, the patients in which percutaneous screw was not required to fix the fracture had better AKSS functional score i.e 71.75 ± 16.43 ; in comparison to those in which C screw wasn't required. Similarly the patients in which proximal ring was a C-ring showed better functional outcome with an AKSS score of 2.09 ± 15.41 ; in comparison to 59.23 ± 18.69 when full ring was used at the proximal tibia. Similar analysis to depict the association of various factors with Rasmussen's radiological outcome score is summarized in **table 3**. The only factor that affected the final radiological outcome was use of a C-ring as the most proximal ring in the ilizarov assembly.

Table 1: Descriptive statistics of the study group

Variable	Frequency (percentage %)	Mean± SD
Gender (male: female)	58(85.3%): 10(14.7%)	
Age (yrs.)		34.70±8.14

Mechanism of injury (RTA: fall: other)	51(75%): 16(23.5%): 1(1.5%)	
Compartment syndrome (developed: didn't develop)	8(11.8%): 60(88.2%)	
Pre-op CT (performed: not performed)	42(61.8%): 26(38.2%)	
Initial uni-planar ex-fix (applied: not applied)	10(14.7%): 58(85.3%)	
Percutaneous C-screws (used: not used)	11(16.2%): 57(83.8%)	
Proximal ilizarov ring (C-ring: full ring)	55(80.9%): 13(19.1%)	
Fracture type (close: open)	32(47.1%): 36(52.9%)	
Tscherne type (close grade 0: close grade 1: close grade 2: close grade 3: open grade 1: open grade 2: open grade 3: open grade 4)	7(10.3%): 8(11.8%): 6(8.8%): 11(16.2%): 6(8.8%): 14(20.6%): 13(19.1%): 2(4.4%)	
Postop ROM		90.8±18.89
American knee society score		69.63±16.73
Rasmussen's radiological score		12.58±3.05

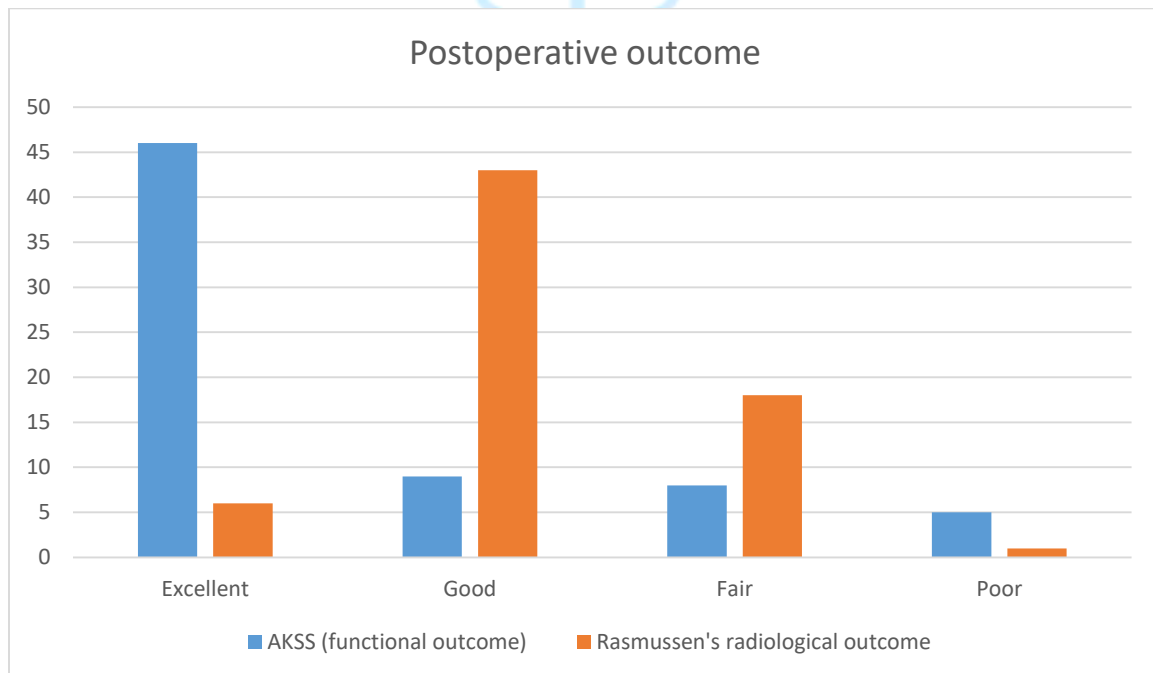


Figure 2: Illustrates outcome of Ilizarov in Schatzker's type VI fracture (Blue: Functional outcome in terms of American Knee Society Score: AKSS, Orange: Radiological outcome in terms of Rasmussen's radiological score category)

Table 2: Factors affecting functional outcome (AKSS)

	AKSS	t-value (*Pearson's correlation co- efficient)	p-value
Age (yrs.)		-0.19*	0.10
Gender (male: female)	69.42±16.9: 70.5±16.57	-0.17	0.86
Mechanism of injury (RTA: fall: others)	68.43±16.77: 73.43±17.09: 70.00±0.0	0.53	0.58
Compartment syndrome (developed: didn't developed)	76.25±12.46: 68.75±17.11	1.19	0.23
Pre-op CT (done: not done)	72.61±17.18: 64.80±15.06	1.90	0.06
Initial uniplanar ex-fix (applied: not applied)	72.50±15.85: 69.13±16.96	0.58	0.56
Percutaneous C screws (used: not used)	58.63±14.33: 71.75±16.43	-2.46	0.01
Proximal ring type (C-ring: full ring)	72.09±15.41: 59.23±18.69	2.59	0.01
Fracture type (close: open)	75.31±15.44: 64.58±16.40	2.76	0.07

AKSS: American Knee Society Score. Statistically significant p-values are in **BOLD**

Table 3: Factors affecting Rasmussen's radiological outcome

	Rasmussen's radiological outcome score	t-value (*Pearson's correlation co- efficient)	p-value
Age (yrs.)		-0.03*	0.79
Gender (male: female)	12.82±3.11: 11.20±2.34	1.57	0.12
Mechanism of injury (RTA: fall: others)	12.39±3.07: 13.1±3.09: 14.00±0.0	0.45	0.63
Compartment syndrome (developed: didn't developed)	14.00±2.82: 12.4±3.05	1.40	0.16
Preop CT (done: not done)	12.71±3.11: 12.38±2.99	0.43	0.66
Initial uniplanar ex-fix (applied: not applied)	13.20±2.85: 12.48±3.09	0.68	0.49
Percutaneous C screws (used: not used)	12.00±3.09: 12.70±3.05	-0.69	0.48
Proximal ring type (C-ring: full ring)	13.05±2.71: 10.61±3.68	2.71	0.009
Fracture type (close: open)	13.00±3.40: 12.22±2.69	1.04	0.29

Statistically significant p-values are in **BOLD**

Discussion

Early post-operative knee motion is crucial to prevent arthritis. Traditionally, ORIF with plating was the preferred treatment for proximal tibia complex fractures but had high complication rates due to soft tissue related complications.⁸ Jiang reported a 4.7%

infection rate with two plates and 7.3% with LISS.¹¹ To avoid these complications, mono-lateral or linear external fixators were tried but were not favored due to fracture reduction loss. However, ring fixators like the Ilizarov system offer excellent fracture reduction and stability, with minimal complications. Watson found Ilizarov wires and lag screws more stable than



dual plates, allowing early knee mobility with fewer complications.¹² Studies show ring fixators result in minimal complications and excellent knee motion, with no major issues reported by Kataria et al. and Chin et al.^{13,14} Furthermore, as Schatzker's type VI is a high energy trauma it is almost always associated with soft tissue injury that makes external fixation the preferred treatment modality.

In this study 35 (51.47%) had open wound and among the rest of the 33 patients, 26 had Tscherne grade 1 or higher closed soft tissue injury. Debnath et al. also studied outcome of ring fixator in Schatzker's type VI fractures; in their study almost similar proportion of patients had soft tissue injury. They inferred that 60% had open soft tissue injury while the rest of the 40% had some grade of closed soft tissue injury.³ The Ilizarov frame provides effective healing for soft tissue injuries, particularly ligamentous injuries. Despite severe articular damage, joint spanning with the fixator allowed rest to the soft tissue and satisfactory functional outcomes. Maintaining articular congruity ensures proper healing, with intra-operative imaging aiding in reduction.⁵ Knee instability post-fracture is often due to ligamentous laxity or bone deformity, though opinions on ligament repair during fracture fixation vary. In this series, ligament injuries were not primarily assessed.⁴

Open reduction and internal fixation (ORIF) is not recommended for cases with fracture blisters or extensive bruising due to high infection rates (23-80%).⁷ Morandi et al. found that external fixation reduces complications.¹⁵ Using percutaneous wires helps preserve blood supply to the bone. Olive wires act like lag screws: stabilizing fragments and maintaining a stable joint surface.⁸ Small tension wires support small fragments. The mechanical axis of the lower limb can be adjusted and monitored with the frame, which also prevents wire migration into the knee joint. This whole assembly allows early range of motion as well as weight bearing that not only stimulates bone healing but also strengthens the musculo-ligamentous structures around the knee.⁷ This leads to good radiological as well as functional result. The Ilizarov frame allowed early movement and weight-bearing, with no patients experiencing instability. This was also evident in our study group: where the final outcome in terms of postoperative

range of motion was 90.8 ± 18.89 and the functional outcome in terms of AKSS was 69.63 ± 16.73 . Furthermore, the radiological outcome in term of Rasmussen's radiological scoring was 12.58 ± 3.05 . This postoperative outcome was stratified as per the aforementioned criteria in excellent, good, fair and poor. In terms of functional outcome, highest number of patient fell in the excellent outcome criteria i.e 46 patients. Whereas, in terms of radiological outcome highest number of individuals were in the good outcome category. Similarly, in previous studies the functional outcomes of tibial plateau fractures treated with the Ilizarov fixator has been rated as excellent to good in 76–89% of cases.^{6,8} In the study performed by Debnath et al., 96.7% of patients achieved excellent to good functional outcomes. Knee stiffness, defined as flexion less than 100 degrees and an extension deficit less than 5 degrees was a common postoperative complaint noted by the Debnath et al. following Schatzker's VI fractures treated with Ilizarov. They inferred that the ring fixators yielded excellent to good results, and their results were in concordance to ours as well as the previously published data.³

Among the study limitations were the limited sample size and uni-centric data collection. These factors decreases the generalization of our inferences. However, uniformity of the operative technique and rehabilitation protocols at a single center decreases the bias that emerges because of variety in the surgical technique and rehabilitation process.

Conclusion

Ilizarov fixator is associated with excellent to good outcome in Schatzker's type VI fractures. The factors that affect the final outcome among these patients include use of proximal tibial C-ring and fracture patterns that don't need cannulated screws for fixation.

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