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An Outcome of Ligamentotaxis and Stabilization by Ilizarov External Ring Fixator in Tibial Plateau Schatzker Type V Fracture

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Abstract **Original Research Article**

Introduction: The tibial plateau is a critical weight-bearing area located on the upper extremity of the tibia. Fractures of the plateau affect knee alignment, stability and motion. These fractures constitute approximately 1-2% of all fractures and typically occur in young individuals exposed to high-energy trauma caused by motor vehicle accidents or bumper strike injuries. The aim of our study was to evaluate the outcome of ligamentotaxis and stabilization by Iliazarov external ring fixator in tibial plateau Schatzker type V fracture. ***Methods:*** This prospective observational study was conducted at National Bangla nagar, Dhaka, Bangladesh in the period -e-Institute of Traumatology and Orthopaedic Rehabilittation (NITOR), Sher .from July to June 201725 *cases* with Schatzker type V tibial plateau fracture attending at emergency and outpatient department in NITORwere selected considering the inclusion and exclusion criteria. Ilizarov ring was used from local manufacturer and ring size is measured by ring templates. Follow up were done at OPD and also in Ilizarov clinic of NITOR at monthly interval up to complete fracture healing. Final evaluation was done according to Rasmussen Functional Grading Criteria. Data were collected with containing history, clinical examination, laboratory investigations, pre-operative, peri-operative, post -operative complications and postoperative follow-up findings. Data were compiled and tabulated according to key variables and functional assessment scoring. The analysis of different variable was done according to standard statistical analysis where the level of significance (P Value) was set at 0.05 by using SPSS version 22. Informed written consent was taken from the patient and patient's guardian after duly informing the procedure of treatment, anticipated result, possible advantages and disadvantages and complication considering all ethical issues. Protocol approved by ethical committee of National Institute of Traumatology & Orthopedic Rehabilitation Dhaka. ***Results*:** Mean±SD hospital stay 12±2.67 days, hospital stay range was between 7 to 16 days. All the patients were followed up for at least 6 months up to a maximum of 12 months with an average of 9.28 months. The mean±SD union time of fracture was 104.2±10.69 days. The lowest and highest union time were 82 and 120 days respectively. Pin tract infection noticed in 05(20%) of the patients and 02 (08%) patients had breakage of wire. Seven (07) patients had unacceptable range of motion of the affected knee joint (<90 º) and 04 patients had instability in extension <10º (according to Rasmussen Functional Grading Criteria). Out of 25 cases 21 cases (84%) showed presence of callus and invisible fracture line and 4 cases (16%) showed presence of callus but visible fracture line. Mean Rasmussen functional score was 23.84. 12 (48%) patients showed excellent, 09 patients (36%) showed good and 04 patients (16%) showed fair result. ***Conclusion:*** In this study, the results of tibial plateau fracture Schatzker type V by transosseous osteosynthesis technique with Ilizarov ring fixator has been found to be satisfactory. No case of nerve injury encountered. Pin tract infection is a potential problem despite the use of small wires. To avoid the disastrous complication of septic arthritis, we recommend placing wires at least 15 mm away from the joint line, monitoring the status of pin sites (especially at juxta-articular locations) and removing any pin revealing any features of infection.

Keywords: Ligamentotaxis, Iliazarov External Ring Fixator, Tibial Plateau, Schatzker Type V Fracture.

INTRODUCTION

The tibial plateau is a critical weight-bearing area located on the upper extremity of the tibia. Fractures of the plateau affect knee alignment, stability and motion. These fractures constitute approximately 1-2% of all fractures [1] and typically occur in young individuals exposed to high-energy trauma caused by motor vehicle accidents or bumper strike injuries; however, sports injuries, falls and other less violent

trauma frequently produce them, especially in elderly patients with osteopenia [2]. Tibial plateau fractures caused by high-energy mechanisms involve articular depression, condylar displacement, dissociation of comminuted metaphysis from diaphysis and open wounds or extensive closed degloving injuries [3]. These fractures may be associated with neurologic and vascular injury, deep vein thrombosis, compartment syndrome, contusion, crush injury to the soft tissues or open wounds [2]. The treatment goals are to anatomic reduction of the proximal tibial articular surface, restore limb axial alignment and fix metadiaphyseal comminution by stable fixation to allow early knee mobilization and weight bearing and minimize further morbidity to an already traumatized soft tissue envelope [4]. Over the years, many treatment modalities have been proposed for these complex fractures. All of them, from simple traction to demanding surgery, presented fair results but also serious complications. Traction, in terms of ligamentotaxis and casting, do not properly reduce the articular surface and lack the necessary stability, leading to unacceptable rate of Varus or valgus deformity, collapsed articular surface and post immobilization stiffness [5, 6]. Schatzker type V fractures involving both condyles routinely require repair. The plateau with the most severely involved articular surface should be stabilized and treated with minimal 'biological' fixation, using percutaneous implants, limited posteromedial incisions or an external fixator to minimize exposure and bone stripping. The advantages of circular frame fixation are almost no soft tissue exposure and blood loss with preservation of the periosteal and endosteal blood supply. This technique does not leave screws and plates when the fracture has healed. The fixator also allows for the adjustment of the alignment and for compression-distraction both during and after surgery and the ability to correct deformity in multiple planes. Another advantage when it comes to using the Ilizarov technique is that the fixation is stable enough to allow early weight-bearing and early knee joint motion which is the rationale for using the Ilizarov method in comminuted bicondylar high energy fractures and in addition, there is no need to use a staged protocol. Another important thing is that it is a cost effective procedure and it can easily be done in the centers with less available facilities which is very important to our country context. Patient treated with Ilizarov external ring fixator can return early to their job which is very important for their personal life and economic prospect. Bangladesh, the incidence of In tibial plateau fracture is also common like other fractures though there is no available data regarding this incidence. There was no analysis of results of Iizarov ring fixation inSchatzker type V tibial plateau fractures in Bangladesh though the procedure is well accepted in some centers of the world.

METHODS

This prospective observational study was conducted at National Institute of Traumatology and Bangla -e-Orthopaedic Rehabilittation (NITOR), Sher nagar, Dhaka, Bangladesh in the period from July to June 2017. Study population were all patients with Schatzker type V tibial plateau fracture attending at m emergency and outpatient department in NITOR fro which25 cases were selected considering the inclusion and exclusion criteria. Surgery was with detailed preoperative x- ray analysis and in some cases with analysis of CT scan with 3D reconstruction images. For every patient, a full length AP and Lateral view x-ray including knee and ankle was taken. Ilizarov ring was used from local manufacturer and ring size is measured by ring templates. All routine investigations (TC, DC, ESR, Hb%, RBS, Serum creatinine, Urine RME, ECG, Chest X-ray P/A view) were done for anaesthetic fitness. Follow up were done at OPD and also in Ilizarov clinic of NITOR at monthly interval up to complete fracture healing. Wound condition, pin tract infection, fracture alignment, bone infection, proximal and distal joint mobility were assessed and recorded. Final evaluation was done according to Rasmussen Functional Grading Criteria. Data were collected with containing history, clinical examination, laboratory investigations, pre-operative, peri-operative, post - operative complications and postoperative follow-up findings. Data sheet was formulated to evaluate the final outcome according Rasmussen Functional Grading Criteria for this study. Data were collected, compiled and tabulated according to key variables and functional assessment scoring. The analysis of different variable was done according to standard statistical analysis where the level of significance (P Value) was set at 0.05 by using SPSS version 22. Informed written consent was taken from the patient and patient's guardian after duly informing the procedure of treatment, anticipated result, possible advantages and disadvantages and complication considering all ethical issues. Protocol approved by ethical committee of National Institute of Traumatology & Orthopedic Rehabilitation Dhaka.

Inclusion Criteria

- .Schatzker type V tibial plateau fracture
- Closed fracture
- Both sex from 18 to 60 years old.
- Presented within two weeks of injury

Exclusion Criteria

- Others Schatzker type of tibial plateau .fracture
- Open fractures.
- .cal fracturePathologi
- .Fracture with neurovascular injuries
- Patients below 18 years and above 60 years of .age
- .Presented after two weeks of injury
- .Poly trauma patients
- Patient with other underlying uncontrolled co morbid conditions i.e. Diabetes mellitus, hypertension.

RESULTS

Of the total participants, 36% patients were in the age group 31-40 years and 36% were in between 41-50 years, 16% were in 21-30 years' group and 12% were in 51-60 years' age group; Mean± SD age of patients was 40.64±9.1 years with and the lowest and highest ages were 23 and 55 respectively. Sex distribution of the studied participants (Table-2) shows most (92%) of the patients were male and only 8% were female. Out of 25 patients, 23 patients (92%) were affected by road traffic accident (RTA) and 2 patients (08%) were affected by fall from height (Figure-1). Out of 25 patients, 10 patients (40%) were affected on left side and 15 patients (60%) were affected on right side (Figure-2). Mean±SD hospital stay 12±2.67 days, hospital stay range was between 7 to 16 days. All the patients were followed up for at least 6 months up to a maximum of 12 months with an average of 9.28 months. All patients were advised to attend to OPD at NITOR for follow up. Variables of interest noted and clinical assessment performed at each OPD visit, once monthly for 16 weeks after operation and then every 8 weeks' interval. The patients were followed up for at least 6 months up to a maximum of 12 months. Each patient was evaluated both clinically and radiologically. At final follow up, the results were graded as excellent, good, fair or poor according Rasmussen Functional Grading Criteria for evaluation of final results. The mean±SD union time of fracture was 104.2±10.69 days. The lowest and highest union time were 82 and 120 days respectively (Table-4). Figure-3 shows fixator related complications. In terms of fixator related complications, in 05(20%) of the patients pin tract infection noticed and 02 (08%) patients had breakage of wire. In final follow up, 07 patients had unacceptable range of motion of the affected knee joint ($<90^0$) and 04 patients had instability in extension $<10^0$ (according to Rasmussen Functional Grading Criteria). The individual cortical scores (anterior, posterior, medial and lateral) are added to provide an overall RUST value ranging from 4 to 12 for a set of radiographs. Out of 25 cases 21 cases (84%) showed presence of callus and invisible fracture line and 4 cases (16%) showed presence of callus but visible fracture line (Table-5). Malunion or nonunion was not found. Functional outcome according to Rasmussen Functional Grading Criteria (Table-7) shows Mean Rasmussen functional score was 23.84. Figure-4 shows out of 25 patients, 12 patients (48%) showed excellent, 09 patients (36%) showed good and 04 patients (16%) showed fair result. Rasmussen 1973 designated the excellent and good results as satisfactory outcome. The fair and poor results were designated as unsatisfactory. So, Satisfactory was (Excellent+ Good) 84%, Unsatisfactory (Fair+ Poor) was 16%.

Table-1: Age distribution of the patients (n=25)

Age (years)	Frequency	Percentage
21-30	4	16
31-40	9	36
41-50	9	36
51-60	3	12
Total	25	100
Mean± SD age	40.64±9.1 years	
Range	23-55 years	

Table-2: Sex distribution of the patients (n=25)

Sex	Number of patients	Percentage
Male	23	92
Female	02	08
Total	25	100

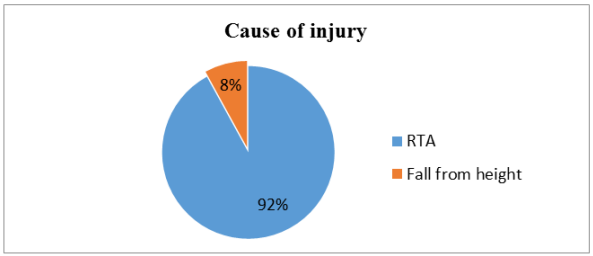

Fig-1: Pie chart showing cause of injury

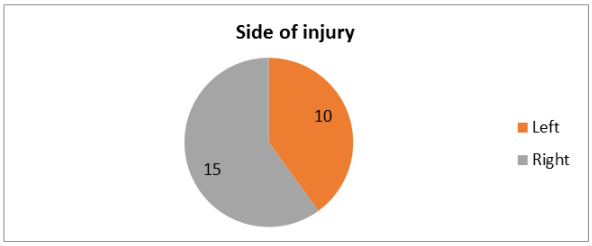

Fig-2: Pie chart showing side of injury

Table-3: Hospital stay of the patients (n=25)

Length of stay (week)	Number of patients	Percentage
< 1	3	12
< 2	18	72
< 3	4	16
Total	25	100
Mean±SD	12±2.67	
Range	7-16 days	

Table-4: Distribution of patients by union time (in days)

Union time(days)	Frequency	Percentage	Mean+SD
81-90	5	20	104.2+10.69
91-100	4	16	
101-110	10	40	
111-120	6	24	
Total	25	100	

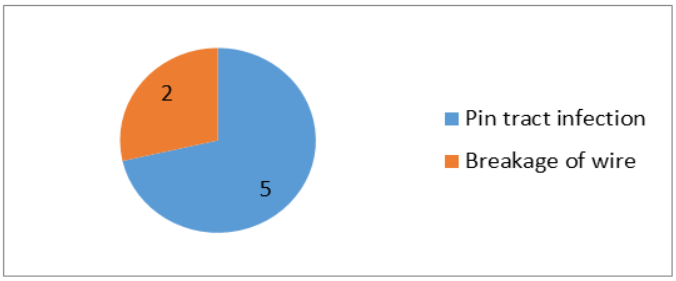

Fig-3: Pie chart showing fixator related complications

Table-5: Distribution of patients by radiographic criteria at final follow up (n=25)

Score per cortex	Frequency	Percentage
1	0	00
2	4	16
3	21	84
Total	25	100

Table-6: Distribution of patients by ROM of the affected knee at final follow up

ROM (degrees)	Frequency	Percentage
61-70	2	08
71-80	3	12
81-90	4	16
91-100	7	28
101-110	4	16
111-120	4	16
121-130	1	04
Total	25	100
Mean ROM	97.08º	
Range	65º to 125º	

Table-7: Functional outcome according to Rasmussen Functional Grading Criteria (n=25)

Patient Serial No.	Pain	Walking capacity	Extension	Total range of motion	Stability	Final score	Result
1	6	6	6	4	5	27	Excellent
2	6	6	6	4	5	27	Excellent
3	5	4	4	2	5	20	Good
4	5	4	6	4	5	24	Good
5	6	6	6	5	5	28	Excellent
6	2	4	4	2	4	16	Fair
7	6	6	6	4	5	27	Excellent
8	6	6	6	5	6	29	Excellent
9	5	4	6	4	5	24	Good
10	2	4	4	2	4	16	Fair
11	6	6	6	4	5	27	Excellent
12	4	4	4	2	4	18	Fair
13	6	6	6	4	5	27	Excellent
14	5	4	6	4	5	24	Good
15	6	6	6	4	5	27	Excellent
16	2	4	4	2	4	16	Fair
17	5	4	4	4	5	22	Good
18	5	4	4	4	5	22	Good
19	5	4	4	2	5	20	Good

20	6	6	6	4	5	27	Excellent
21	5	4	6	4	5	24	Good
22	6	6	6	5	6	29	Excellent
23	6	6	6	4	6	27	Excellent
24	5	4	4	2	5	20	Good
25	6	6	6	4	6	28	Excellent
Mean Rasmussen functional score				23.84			

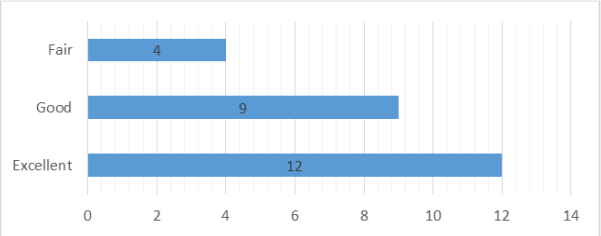

Fig-4: Bar chart showing final outcome

DISCUSSION

Tibial plateau Schatzker type V and VI fractures caused by high energy trauma, inflict extensive damage to the bone and more injury to the soft tissue. Early problems in the management of this high energy complex fracture include fracture instability. In our study, we had 25 (23 male and 02 female) patients. Mean age was 40.64 years; age range was 23-55 years. Majority of the patients were between 31-50 years. Kataria H.et al.[3] had study over 38 patients, age ranges were between 21 to 60 years (Mean 37 years) which is comparable with present study. The cause of the injury was road traffic accident in 92% and accidental fall from height in 08%. In our study, 84% patients stayed in hospital after admission less than 2 weeks. Mean hospital stay was 12+2.67 days. Kulkarni RM, & Kulkarni GS [7] treated 56 tibial plateau fractures (Schatzker Type IV, V & VI) with Ilizarov external fixator, where mean union time was recorded at 14 weeks (range 12-18 weeks). Dendrinos GK et al., [8] treated 24 patients with high energy tibial plateau fractures by Ilizarov external fixator. All the fractures united with an average time of union of 14.4 weeks. In our study the mean union time was 14.89 weeks with highest time 18 and lowest 12 weeks. Kataria H et al., [3] treated 16 Type-V and 22 type-VI tibial plateau fractures. Complications were 2 superficial infections, 3 pin site infections and 4 peroneal nerve palsies. In our study, complications included minor pin tract infections in five cases (case no.3, 6,12,19 and 24) and hardware problems in two cases (case no.10 and 16) which were managed by simple measures like administration of antibiotic and realignment. When surgery is performed early, anatomical reduction by ligamentotaxis are more easily achieved, with the extent of open surgery minimized. Small wire external fixation is the only viable option for early surgery whenever soft tissue injuries are present. In case of delay, patients must be maintained in calcaneal or distal tibial pin traction to avoid additional trauma and soft tissue compromise [3]. In a study conducted by El–Barbary et al., [9] which included 29 patients with Schatzker type 5 and 6 fractures a median knee ROM of 0 to 112 degrees was achieved and weight bearing was started after 6 weeks with no complications. Dendrinos et al., [10] conducted a similar study on 24 patients with high energy tibial plateau fractures. 90 % patients achieved a median ROM of 110 degrees. Weight bearing was started after 4 weeks. Zecher et al., in 21 patients with Schatzker type 5 and 6 tibial plateau fractures treated with circular ring fixator achieved greater than 90 degrees' knee ROM in all their patients. According to Ali et al., [11], flexion of less than 60º is incompatible with normal gait. In our study, partial weight bearing was started after 3 weeks. While full weight bearing was within the range from 6 to 8 weeks. The mean flexion of the affected knee was 97.08º at final follow up with a range from 65º to 125º. All the patients were able to walk and achieved functional knee flexion which allowed them to go back to their original occupation. Kataria et al., [3] treated 16 type-V and 22 type-VI tibial plateau fractures. The mean Rasmussen functional score was 26 (range 17-30) with excellent in 19, good in 17 and fair in 02 patients. In the final outcome, 94.3% cases were satisfactory. In our study, the mean Rasmussen functional score was 23.84 (range 16-29) with excellent in 12, good in 09 and fair in 04 patients. Regarding final outcome, satisfactory rate was 84% and it was quite acceptable. We enjoyed a short learning curve on the use of these frames. Results improved with experience, careful preoperative planning and thorough knowledge of neurovascular anatomy.

LIMITATIONS

This was a prospective observational study with small sample size which the main limitation of this study. Also, it was conducted in a very short period of time. Further studies with comparatively large sample size need to be conducted to observe the exact scenario.

CONCLUSION AND RECOMMENDATIONS

In this study, the results of tibial plateau fracture Schatzker type V by transosseous osteosynthesis technique with Ilizarov ring fixator has been found to be satisfactory. No case of nerve injury encountered. Pin tract infection is a potential problem despite the use of small wires. To avoid the disastrous complication of septic arthritis, we recommend placing wires at least 15 mm away from the joint line, monitoring the status of pin sites (especially at juxta-articular locations) and removing any pin revealing any features of infection. Adequacy of reduction is the most important factor to predict outcome. We have shown in

the present study that despite extensive articular comminution, satisfactory functional results can be achieved with the Ilizarov frame. Weight bearing is very important for callus formation during fracture healing. Weight bearing increases the formation of bone in fracture healing and lack of weight bearing decreases the amount of woven bone that is formed in healing of fractures. Though there were a few minor complications with the fixator, the ability of this stable frame provided good union without any second surgical procedure or bone grafting and prevented any malunion. Operations should be done using same technique by trained surgeons. Good intraoperative radiographs are needed to decrease the incidence of malreduction. Among the drawbacks of the Ilizarov technique are the risk of losing full range of movement of the knee joint and the visually less appealing and cumbersome ring external fixator. In addition, it is also a very demanding technique with a steep learning curve, requiring specialized training and experience.

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