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Research Article

Role of Ilizarov in Management of Comminuted Tibial Plateau Fracture (Prospective Study)

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Abstract

Background: Using Ilizarov in management of comminuted Tibial plateau fractures is not a new method but it is increasing nowadays.

Purpose: Evaluate the outcomes of using Ilizarov external fixator in management of high energy tibial plateau fractures type V and VI according to Schatzker's classification.

Study Design: Prospective study.

Methods: We selected patients with type V and VI Schatzker's classification, explained to them the open reduction and internal fixation (ORIF) and Ilizarov external fixator (IEF) as a management techniques. Patients between 19 and 57 years old had been selected and managed with IEF as their choice. All cases were evaluated clinically and radiologically. The femoral frame was removed after a mean of 5 (range 4 - 7) weeks and the tibial frame was removed after healing of the tibia.

Results: They were 33 patients diagnosed as tibial plateau fractures, twenty eight males and 5 females with a mean age of 39.5 (19 - 57) years old. Twenty-five patients had Left (Lt) tibia fractures while 8 patients had Right (Rt) tibia fractures. Twenty nine patients had closed fractures and 4 had open fractures. Twenty cases were type V and 13 cases were type VI and all fractures united at a mean of 19.6 (range 16 - 36) weeks. All patients were followed up for 2 years for pain, stability, range of motion, limping, patient satisfaction, radiographs, and ability to return to pre injury activity level. All patients returned to work except one case. According to Lysholm score; 2 cases were excellent, 2 cases were poor and the remaining were good results. Complications occurred in the form of skin infection, skin loss, compartment syndrome and unhappiness with the device.

Conclusion: We recommend using Ilizarov external fixation for stabilization of closed or open high energy tibial plateau fractures type V and VI Schatzker's classification.

Keywords: *High Energy Tibial Plateau; Ilizarov External Fixator*

Introduction

Tibial plateau fracture results from direct axial compression usually with a valgus (more common) or varus (less common) moment, and indirect shear forces [7]. The anterior aspect of the femoral condyles is wedge-shaped; with the knee in full extension, the force generated by the injury drives the condyle into the tibial plateau. The direction, magnitude and location of the force as well as the position of the knee at impact determine the fracture pattern, location and degree of displacement [7].

When a single compartment is involved in tibial plateau fracture, it is usually the lateral plateau [3]. This involvement is due to the anatomic axis at the knee joint, normally 7 degrees of valgus, as well as to the predominance of injuries causing a lateral- to medial-directed force [7].

Patient factors such as age and bone quality also influence the fracture pattern. Older patients with osteopenic bone are more likely to sustain depression-type fractures [8] because their subchondral bone is less likely to resist axially directed loads. In contrast, younger patients with denser subchondral bone are more likely to sustain split-type fractures and have an associated ligamentous disruption [5,13].

Standard open reduction and internal fixation techniques have been successful in restoring osseous alignment for bicondylar tibial plateau fractures; however surgical morbidity, especially soft-tissue infection and wound necrosis has been reported frequently. For this reason, several investigators have proposed minimally invasive methods of fracture reduction followed by circular external fixation as an alternative approach [6].

Complex tibial plateau fractures are most commonly caused by high-energy trauma and they are often associated with severe soft tissue injuries that can frequently result in severe complications. Ilizarov external circular fixation is an ideal method of treatment for high-energy fractures of the tibial plateau when extensive soft tissue dissection and internal fixation are contraindicated [9].

Our purpose is to Evaluate the outcomes of using Ilizarov external fixator in management of high energy tibial plateau fractures type V and VI according to Schatzker's classification.

Classification

There are numerous classification systems that have been proposed to describe tibial plateau fractures [12]. The majority of these systems are very similar, and each one recognizes wedge, compression, and bicondylar types. The Hohl classification was the first widely accepted description of tibial plateau fractures [12] classifying these fractures into displaced and undisplaced types. Under the displaced category, he recognized local compression, split compression, total condyle depression, and comminuted fractures.

Schatzker's classification of tibial plateau fractures is currently the most widely used and was the first to make the distinction between medial and lateral plateau fractures (Figure 1) [14]. Type I (split fracture) is a pure cleavage fracture of the lateral tibial plateau. Type II (split-depression) is a cleavage fracture of the lateral tibial plateau in which the remaining articular surface is depressed into the metaphysis. Type III is a pure central depression fracture with an intact osseous rim. Type IV involves the medial tibial plateau and is divided into two subtypes: Type A, which is a split fracture and Type B, a depression fracture. Either type may be combined with a tibial spine fracture. Type V is a bicondylar fracture in which the fracture line often forms an inverted Y shaped, the metaphysis and diaphysis remain intact. Type VI is a tibial plateau fracture in which there is dissociation between the metaphysis and the diaphysis [14]. Honkonen and Jarvinen have recently modified Schatzker's classification to take residual limb alignment into account. They divide Type VI fractures into two types; those that are medially and laterally tilted to take into account functional results in treated fractures with residual angulation [13].

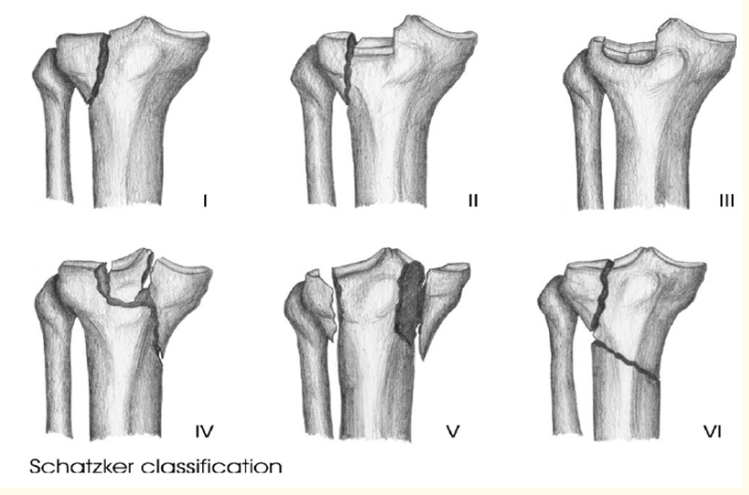

Figure 1: *Schatzker classification.*

In the Orthopaedic Trauma Association (OTA) classification, which is based on the Association for the Study of Internal Fixation (AO/ASIF) classification, the proximal Tibia is denoted as segment 41 and is divided into three main categories. Type A fractures are extra-articular. Type B fractures are partial articular and are subdivided into three main categories: B1 are pure splits, B2 are pure depression, and B3 are split-depression. Type C fractures are complete articular fractures and are also subdivided into three subtypes: Type 1 is articular and metaphyseal simple, Type 2 is articular simple and metaphyseal multifragmentary, and Type 3 is articular multifragmentary (Figure 2) [12].

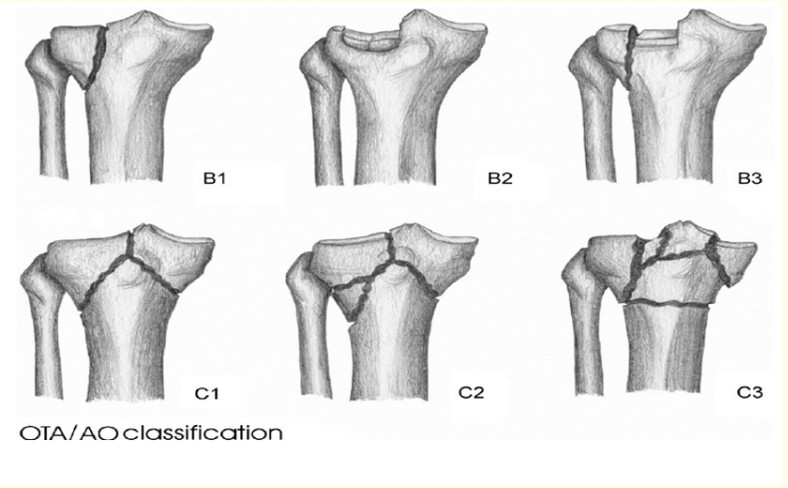

Figure 2: *AO/TA classification.*

Material and Methods

Between March 2011 and January 2016 we treated 33 patients with tibial plateau fractures with the Ilizarov technique. They were assessed clinically and radiologically (plain X-rays and CT).

We selected patients with type V and VI Schatzker's classification, explained to them the open reduction and internal fixation (ORIF) and Ilizarov external fixator (IEF) as a management options. Patients between 19 and 57 years old had been selected and managed with IEF. All cases were evaluated clinically and radiologically, CT was done for all cases to determine the posteromedial, anterolateral fragments and the amount of depression.

Our aim was to reduce the articular surface, elevate any depression if found and to restore the alignment especially the metaphyseo-diaphyseal axis.

We applied one and 5/8 ring in the distal femur and three rings of equal sizes (commonly 160 mm) for the tibia, a temporary first subchondral wire was used as a reference wire 10 mm distal to the knee articular surface so the device had to be parallel to the knee joint. The fibular head and the lateral malleulus had been transfixed by wires as a rule of fixation. After fixation of the distal 2 rings of the tibial construct, the temporary wire was removed and we started closed indirect reduction which was accomplished through ligamentotaxis and fragment manipulation with percutaneously inserted elevators or reduction forceps, limited open reduction was performed in 7 cases to elevate the depression (bone graft had been used in 5 cases).

After acceptable reduction, two opposite olive wires were used to compress the posteromedial and anterolateral fragments to get accurate anatomical reduction.

Open fractures were treated with immediate irrigation and debridement followed by fixation with the Ilizarov device. Hemarthrosis was aspirated in the cases to whom we did not do limited open reduction.

Early full standing and walking as early as the patient tolerated, encouraged post-operative day one.

We allowed knee mobilization after removing of the distal femoral construct at an average of 5 weeks, and the tibial frame was removed after fracture healing.

Results

Thirty three patients was diagnosed as tibial plateau fracture, all fractures were due to motor car accident, 28 males and 5 females with a mean age of 39.5 (range 19 - 57) years old. Twenty five patients had left (Lt) tibia fractures while 8 patients had right (Rt) tibia fractures, Twenty nine patients had closed fractures and 4 had open fractures (3 cases were type II and 1 case was type III according to Gustilo & Anderson classification), twenty cases were type V and 13 cases were type VI according to Schatzker's classification. All patients were followed up for 2 years for pain, stability, range of motion, limping, patient satisfaction, radiographs, and the ability to return to pre-injury activity levels.

We removed the femoral construct at a mean of 5 (range 4 to 7) weeks and the tibial frame after fracture healing. All fractures united at a mean of 19.6 (range 16 - 36) weeks.

All patients returned to work except one case. According to Lysholm score; 2 cases were excellent, 2 cases were poor and the remaining were good results. Five patients showed unhappiness with the device in the last one month.

MRI had been done after fracture healing for the patients who had continued complaining of knee instability which was estimated clinically. Injury to the collateral ligaments has been reported in 6 cases (18.1%) of cases, rupture of the anterior cruciate ligament reported in 5 cases (15.1%) and Meniscal injuries has been reported in 15 cases (45.4%) of the cases and after bone healing we transferred the patients to sport medicine center for further management.

Complications: Two cases had some limitation of the knee joint. One case had skin and subcutaneous tissue infection and needed debridement, one case developed skin loss and skin graft was done and one case developed compartment syndrome and fasciotomy was done. Pin or wire site infection was found in the majority of the cases and was treated with antibiotics and pin site care. We used Lysholm score for the evaluation of the outcome [16].

Lysholm score (points)	Pain	Swelling	Limping	Instability	Stair climbing	Use crutch	Locking	Squatting
	25	10	5	25	10	5	15	5

Table 1

Score outcome

Excellent	Good	Fair	Poor
> 90	84 - 90	65 - 83	< 65

Table 2

Our results according to Lysholm score (number of patients)

Excellent	Good	Fair	Poor
2	29	--	2

Table 3

Case 1: Pre op.

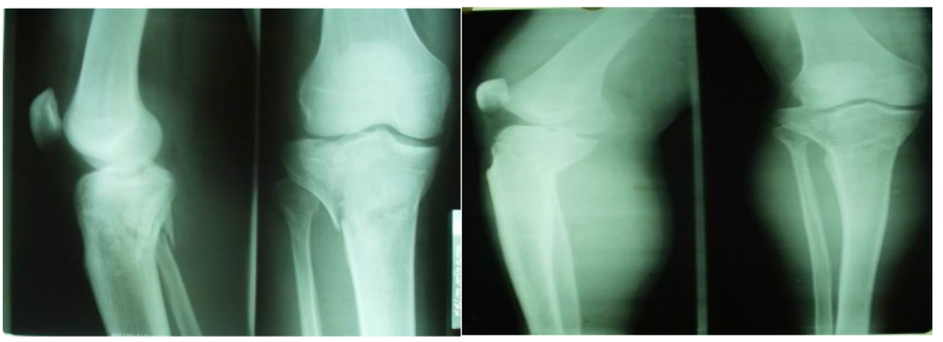

Figure 3

Post op.

Figure 4

After removal of the device

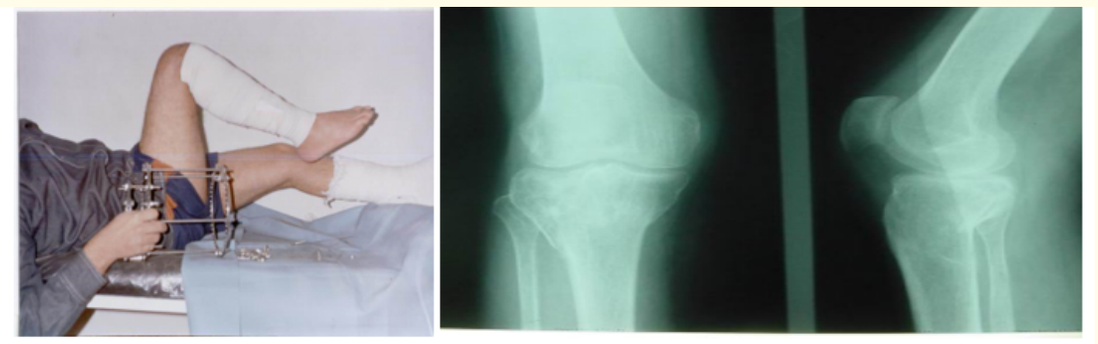

Figure 5

Case 2: Pre op.

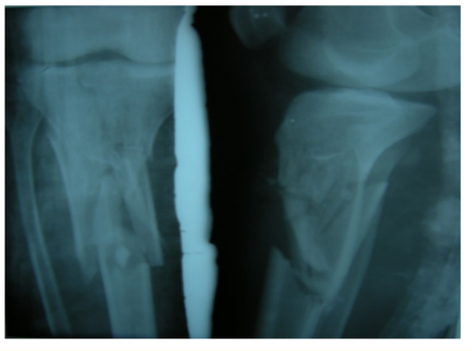

Figure 6

Post op.

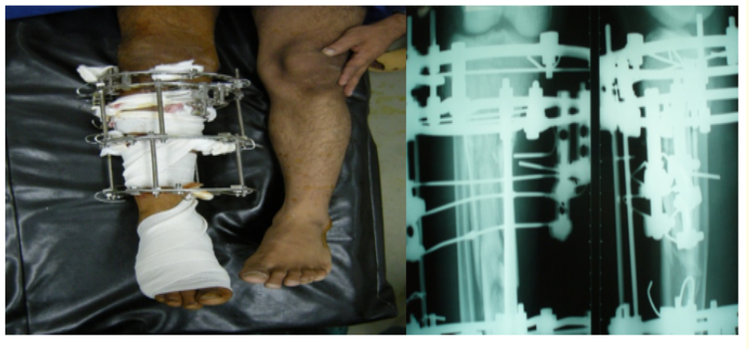

Figure 7

One month and 2 months post op.

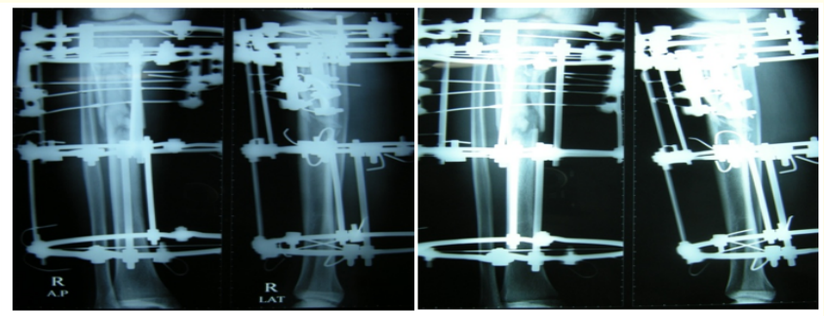

Figure 8

After removal of the device

Figure 9

Case 3

Figure 10

Discussion

The ideal management of bicondylar fractures of the tibial plateau remains controversial [18].

Treatment goals include satisfactory restoration of mechanical alignment, anatomic reduction of the articular surface, and stable fixation that allows an early range of motion of the knee; however attaining these goals may not be directly correlated with improved patient outcomes. Specifically, several reports have suggested that residual articular incongruity of the tibial plateau does not compromise long-term functional outcomes [10]. Additionally, open reduction and internal fixation, particularly through the compromised soft-tissue envelope, has been associated with major wound complications. Alternate methods of treatment for these serious injuries have therefore been suggested [15].

David., *et al.* reported that medial and lateral plate stabilization of comminuted bicondylar tibial plateau fractures through medial and lateral surgical approaches is a useful treatment method; however residual dysfunction is common. Accurate articular reduction was possible in about half of the patients [2].

Jeremy A Hall., *et al*. reported that patients in the circular fixator group had less intraoperative blood loss than those in the open reduction and internal fixation group (213 mL and 544 mL, respectively; p = 0.006) and spent less time in the hospital (9.9 days and 23.4 days, respectively; p = 0.024). There was a trend for patients in the circular fixator group to have superior early outcome in terms of hospital speciality surgery (HSS) scores at six months (p = 0.064) and the ability to return to pre injury activities at six months (p = 0.031) and twelve months (p = 0.024). These outcomes were not significantly different at two years [6].

Both ORIF and IEF provide a satisfactory quality of fracture reduction, but percutaneous reduction and application of a circular fixator results in a shorter hospital stay, a marginally faster return of function and similar clinical outcomes while the number and severity of complications are much higher with open reduction and internal fixation [6].

We believe that circular external fixation is an attractive option for these difficult-to-treat fractures, as reduction can be obtained through minimally invasive technique and ligamentotaxis. It allows early movement, early weight-bearing and early Rehabilitation. Also it has low infection rate and less hospitalization time.

In our study we used the Ilizarov device in all cases to avoid complications of ORIF, While limited open incision in 7 cases to elevate the depression and we used bone graft in 5 cases, we did not use any type of internal fixation. The incidence of the pin site infection was high but it did not cause deep infection or affect the result.

In our study 2 cases among the 4 cases with open fractures were poor results (50%), this means that the open fracture negatively affect the overall outcomes.

We used Lysholm knee score as it has many advantages; for example, Oxford Knee Score (OKS) is only applicable for functional evaluation in knee osteoarthritis, International Knee Documentation Committee Subjective Knee Form (IKDC) and Tegner Activity Scale are only used to evaluate knee ligament. Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Knee Injury and Osteoarthritis Outcome (KOOS) have 24 and 42 items respectively and the average time to complete the questionnaires ranges from 5 to 10 minutes which is considered lengthy in the realm of knee questionnaires. The Lysholm knee score on the other hand, has broad applicability and has only eight items that can be completed by patients in a short period of time [17].

Conclusion

Ilizarov techniques provide valuable results in management of high-energy tibial plateau fractures especially type V and VI. It allows closed reduction or minimally invasive reduction, early movement, early weight-bearing and early Rehabilitation. Also, it has low infection rate if compared to open reduction and internal fixation, Bone graft can be added through limited approach and this study has long term follow up reaches to 5 years.

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