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MANAGEMENT OF HIGH VELOCITY TIBIAL PLATEAU FRACTURES BY LIGAMENTOTAXIS USING ILIZAROV EXTERNAL FIXATOR

Orthopaedics

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ABSTRACT

Background: Tibial plateau fractures resulting from high energy trauma, typically Schatzker type IV, V and VI pattern fractures are difficult to deal with due to poor overlying soft tissue cover. Ligamentotaxis with ilizarov ring fixator can be a suitable definitive treatment option for such injuries with fewer associated complications as compared to internal fixation.
Patients and Methods: 30 patients within the age group of 18-80 years with Schatzker type IV, V and VI pattern injuries were included in the study. A four ring ilizarov assembly was used with knee spanning with a proximal femoral ring. The patients were followed for 12 months and evaluation was analyzed as per Rasmussen clinical and radiological criteria.
Results: The mean age of patients in our study was 39.76 years. Twenty cases were Schatzker type VI, 7 cases were Schatzker type IV (with extensive soft tissue swelling following high velocity trauma) and only 3 cases were type V. The mean duration of surgery was 47±12 mins without bone grafting and 72±14 mins with bone grafting. The mean interval from injury to surgery was 2.36 days (range 1-5 days). Rasmussen total anatomical outcome was excellent in 14 patients(46.66%) and good in 16 patients(53.33%). Rasmussen total functional outcome was excellent in 21 patients(70%) and good in 9 patients(30%). Final Outcome was excellent in 22 patients(73.33%) and good in 8 patient(26.66%).
Discussion: High velocity tibial plateau fractures, when treated with internal fixation and plating, carry a higher risk of associated complications ranging from deep infections to even compartment syndrome. The rate of re-operation following internal fixation in such injuries has been high with most of the re-surgeries being required within one year of primary fixation which adds to the morbidity of the patient. Ligamentotaxis with ilizarov ring fixation as definitive treatment in such cases can be a fruitful operation with lesser complications and early return to previous level of activity.

KEYWORDS

tibial plateau, high velocity, ligamentotaxis, Ilizarov fixator

INTRODUCTION

Fractures of the proximal tibia constitute around 1% of all the fractures in general. There is a wide spectrum of fracture patterns in proximal tibia ranging from un-displaced low energy fractures to high velocity fractures with severe comminution. The management of high velocity tibial plateau fractures mainly Schatzker type IV, V and VI has been an issue of discussion for quite a long time. Various modes of treatment can be found in literature for such high-grade fractures. With the continuing advancement in implant design technology, newer variety of pre-contoured fracture fixation plates come in the market with each passing day. But all such advancements have their own learning curve and set of complications. (1)

High velocity tibial plateau fractures are difficult cases to manage as the overlying soft tissue condition is poor most of the times and the fracture pattern itself is a unique surgical challenge when it comes to achieving a congruent joint line and restoring limb alignment.

The main focus of treatment for such injuries should be restoration of normal mechanical axis, adequate restoration of joint range of motion and minimizing the chances of osteoarthritis due to a compromised fracture reduction. But at the same time, equal importance should be given to the overlying soft tissue envelope. Off late, internal fixation with single or multiple pre-contoured plates has been the method in vogue. But in poorly selected cases or with excessive soft tissue handling these can be associated with multiple complications like infection, wound dehiscence, osteomyelitis requiring several surgeries and even leading up to amputation in some cases. (2)

Ring fixator application with ligamentotaxis can be a fruitful treatment option in such fractures as it offers early joint mobilisation along with easy management of overlying soft tissue wounds. We evaluated clinical and radiological results of ligamentotaxis using Ilizarov ring fixator in management of high energy tibial plateau fractures.

METHODS

Thirty patients in the age group of 18-80 years with high energy tibial plateau fractures presenting in the emergency were included in the study with a follow-up period of 12 months. Schatzker type IV, V and VI fracture patterns were included and those cases with loss of soft tissue cover warranting a plastic surgery intervention and vascular injuries were excluded from the study.

A thorough clinical and radiological assessment was done for each patient. Standard AP(Anteroposterior), oblique and lateral views of knee were taken. CT scan with 3D reconstruction was done in every patient preoperatively to learn about the fracture pattern and assess the areas of comminution in detail.

The fractured limb was placed in a preassembled 4 ring Ilizarov frame and fine wires of 1.8mm were placed through safe tissue corrider.1st ring was fixed at femoral condyles (at level of superior pole of patella).2nd ring was placed in tibia just proximal to the ankle joint.3rd ring was placed distal to fracture site. Ligamentotaxis was given between 1st ring and 3rd ring by distracting the connecting rods. If articular depression was not reduced by ligamentotaxis, the depressed articular fragment was lifted using k wires as joy stick or elevated through a small metaphyseal window with punch to restore the articular congruency. Metaphyseal defect created in the window was filled with autogenous cortico-cancellous bone grafts obtained from the iliac crest. Bone grafting was done in 8 out of 30 cases.

After reduction, compression was achieved using olive wires of 1.8 mm with 4 mm beads passed through the condyles coming from opposite sides and tensioned over 4th ring to achieve interfragmentary compression of condylar surface.

Post operatively, the femoral ring was removed after 3 weeks and the knee joint was mobilized. Partial weight bearing was started after 3 weeks and gradually increased as signs of healing were noted on radiographs. Serial radiographs were taken every 6 weeks. As radiological union was achieved, Ilizarov fixator was dynamized for 2 to 3 weeks. As soon as the patient was comfortable in walking full weight bearing, the fixator was removed. Radiological signs of healing were determined by disappearance of fracture lines on anteroposterior and lateral radiographs of knee and leg.

The patients were followed for 12 months and evaluation was analyzed as per Rasmussen clinical and radiological criteria. (3)

RESULTS

The mean age of patients in our study was 39.76 years. 27 patients were male and 3 patients were female. The predominant cause of injury was road traffic accident in 23 cases followed by fall from height in 7 cases. 20 cases were Schatzker type VI, 7 cases were Schatzker type IV (with

extensive soft tissue swelling following high velocity trauma) and only 3 cases were type V. Knee spanning with the use of femoral ring was done in type V and type VI cases. Right limb was affected in 17 cases and left limb was involved in 13 cases.

The mean duration of surgery was 47±12 mins without bone grafting and 72±14 mins with bone grafting. The mean interval from injury to surgery was 2.36 days (range 1-5 days). Mean time for full weight bearing was 22.56 days and the mean time for complete fixator removal was 14.48 weeks. We did not encounter any case of refracture following fixator removal. No additional surgery was required to achieve union in any of the cases. The average range of motion at 12 months of follow-up was 110.33 degrees.

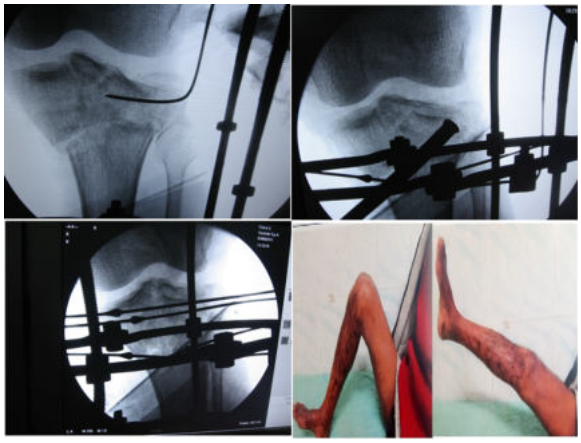

Figure showing intra-operative reduction of fracture fragments and adequate post-operative range of motion.

Rasmussen total anatomical outcome was excellent in 14 patients (46.66%) and good in 16 patients(53.33%). Rasmussen total functional outcome was excellent in 21 patients(70%) and good in 9 patients(30%). Final Outcome was excellent in 22 patients(73.33%) and good in 8 patient(26.66%).

Table No 1 (Rasmussen Score)

Rasmussen Anatomical Outcome	Total No. of Patients and their Schatzker Classification
(a) Good outcome (score 7-12)	16 Schatzker Type IV- 4 Type V- 0 Type VI- 12
(b) Excellent outcome (score 13-18)	14 Schatzker Type IV- 3 Type V - 3 Type VI- 8
Rasmussen Functional outcome	
(a) Good outcome (score 11-20)	9 Schatzker Type IV- 3 Type V- 1 Type VI- 5
(b) Excellent outcome (score 21-27)	21 Schatzker Type IV- 4 Type V- 2 Type VI- 15
Final Outcome score	
(a) Good (score 17-32)	8 Schatzker Type IV- 3 Type V- 0 Type VI- 5
(b) Excellent (score 33-48)	22 Schatzker Type IV- 4 Type V- 3 Type VI- 15

DISCUSSION

There is an increase in the incidence of complex fracture patterns in proximal tibia due to the rise in motor vehicle accidents and such injuries are usually as a result of high energy trauma. These complex fracture patterns with high grade comminution make it difficult for a surgeon to treat these fractures. Osteoporosis in old age patients predisposes them for depression type of tibial plateau fractures and as the available bone stock in such patients is also poor for fracture fixation, bone grafting is usually needed in such cases. (4,5)

Simple tibial plateau fractures that occur in low energy injuries can be fixed easily with internal fixation strategies with anatomical plating, but with high energy fractures, typically Schatzkar type V and VI, the associated complication with such techniques have been dreadful. (6) Many a times, surgeon encounters too many fracture fragments near the joint line and all such fragments are not amenable to plate and screw fixation, but can be easily taken care of by Ilizarov wire fixation. (7) Such cases are ideal for ligamentotaxis and ring fixator application and also complex fracture patterns with associated soft tissue compromise (e.g. compartment syndrome, degloving injuries with soft tissue loss, open fractures requiring daily dressings) are indications for Ilizarov fixation. (8)

Barbary H et al reported excellent outcome in 17 and good outcome in 11 of their cases as per Rasmussen radiological criteria using Ilizarov fixation of tibial plateau fractures with an average range of motion of 112.5 degrees. In our study, 22 patients had excellent outcome and 8 patients had good outcome and the mean range of motion was 110.33 degrees at 1 year of follow up. (18) (this also compares with most other series of tibial plateau fractures treated by ilizarov fixation ; add reference. There were no repeat surgeries required in our series apart from fixator removal which was done as an out patient procedure. There were three cases with superficial pin site fixation which healed with pin site dressings and antibiotics. Also mention that out of all cases nearly 75% were fixed in the 1st week. Average delay from presentation to surgery was 3 days.

Bicondylar fractures and fractures with meta-diaphyseal dissociation have extensive amount of haematoma considering the cancellous nature of the tibial plateau area and this underlying haematoma stretches the soft tissue cover to such extent that internal fixation in such cases carries additional risk of wound infection and hardware problems in the post-operative period. (9) However, Ilizarov fixation need not be delayed according to the skin condition and it can be done early compared to internal fixation and the valuable time to achieve accurate reduction of fracture fragments before they start to mal-unite, is not lost.

Closed reduction using ligamentotaxis or limited open reduction followed by Ilizarov fixator application avoids soft tissue stripping and preserves the vascularity of bone. Recent studies indicate that Ilizarov fixation has similar or better results and fewer complications compared with plating. Krupp et al reported a higher rate of complications with internal fixation as compared to external fixation in Schaztker type VI fracture pattern. (10) The advantage of Ilizarov over internal fixation is that it allows closed reduction, minimal soft tissue damage, early weight bearing and mobilization of the joint. Ilizarov fixator removal is a minor procedure unlike plate removal and can be done under sedation on an outpatient basis. (11)

Some surgeons reported re-surgery rate of 15.3% for all types of proximal tibial fractures treated with internal fixation (with in 1st year of primary surgery). Re-surgery include irrigation, incision and drainage, implant removal and even fasciotomy for compartment syndrome. (12) Other authors have even reported reoperation rates as high as 37% after internal fixation of type V and VI fractures. (12) Henry et al identified male sex, bicondylar fractures and open fractures as the major factors with increased rates of requirement for subsequent irrigation and debridement. With the use of external fixation and ligamentotaxis technique the increased morbidity from a second surgery can be avoided. (12) There are proponents in favour of two stage surgical fixation who like to span the fracture using external fixation and then later on go for plating. Some authors have used this two-stage technique in management of complications of dual plating in high energy tibial plateau fracture. (13) Also the infection associated with internal fixation is deep seated and the severity of repeat surgery is greater after internal fixation as compared to external fixation, where pin site infections are usually superficial and resolve with dressings. (14)

The commonly reported complications with the use of external wire fixator are superficial infections, pin site infections and common peroneal nerve palsy due to wire injury. (15) In our study, pin site infection and chronic osteomyelitis were seen in two patients and were treated successfully by dressing and antibiotics.

Table no 2: Various studies of Ilizarov fixation in treatment of Tibial plateau fractures.

Authors	Year	No. of patients	Mean duration of union/Average range of motion	Criteria	Results
Marsh J L et al(16)	1995	21	15weeks/133 degrees	The Iowa knee score and The SF-36 general health survey	Average Iowa score was 87.The SF-36 survey also correlated with the Iowa knee score
Watson J Tracy et al(17)	1998	14	16.57weeks/100.35 degrees	Knee Society Clinical Rating Score	Excellent-10 Good-2 Fair-2
Barbary H El et al(18)	2005	29	16.3weeks/112.5 degrees	Rasmussen radiological criteria and The knee society clinical rating system.	Radiological criteria – excellent in 17 and good in 11 cases. The knee society score- excellent in 18 , good in 7,fair in 1 and poor in 2 cases.
Ranatunga IR et al(19)	2010	18	16.16 weeks/85degrees	Duration of union and range of motion	9 patient had 0-110° ROM, <80° in 4 & <60° in 5 patients.7 patients took <12weeks for union, 8 patients took 16weeks and 3 patients took 20weeks for union.
Mohammad O A et al(20)	2013	30	14.4weeks	Honkonen and Jarvinen criteria	Excellent-10 Good-10 Fair-5 Poor-5
Sandeep Reddy R et al(21)	2014	43	24.51 weeks	Lyshom's score and Holl & Luck Grading	Mean Lyshom's score was 82.16. Holl & Luck grading- excellent in 9,good in 23 and fair in 11 cases. No poor score.
Our study	2018	30	14.48 weeks/ 110.33 degrees	Rasmussen's functional and anatomical criteria	Final outcome was excellent in 22 cases and good in 8 cases.

CONCLUSION

Illizarov external fixator can be used in high energy tibial plateau fractures even in poor skin conditions. Proper fixation of high energy tibial plateau fractures with severe soft tissue injury can be done early with better results. Removal of implant is easy and can be performed as an out-patient procedure. The closed method in the management of fractures of high energy tibial plateau by Illizarov external fixator helps achieve early mobilization and rapid rates of bone healing, without compromising joint congruity and limb alignment while minimizing complications compared to other fixation methods. The procedure need not be timed like internal fixation and has much lower reoperation rates. The rates of plastic surgical interventions also are minimal after Ilizarov. Hence, we believe a knee spanning ring fixator should be the first-choice procedure for fixation of high velocity tibial plateau fractures especially in settings outside specialized trauma centres lacking a multidisciplinary approach.

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