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Original Research Article.

Outcomes of Ilizarov Ring Fixator in Treatment of High Energy Tibial Plateau Fractures (Schatzker Type V & VI)

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ABSTRACT

Background: Tibial plateau fractures are common in young age group and present a surgical challenge to orthopedic surgeon. Over the years treatment has been changed from traction to cast immobilization to open reduction and internal fixation. More recently indirect reduction technique with external fixation has been used where skin condition is poor and internal fixation associated with too many complications. The advantages of using Ilizarov apparatus compare to internal fixation are that it provides stability, preserves blood supply and maintains the function of affected limb.

Aim: To evaluate the outcomes of Ilizarov ring fixator in treatment of high-energy tibial plateau fractures (Schatzker type V & VI).

Methods: At our institute from 2011 to May 2016, we treated 30 cases of tibial plateau fracture Schatzker type V & VI (v-6/ vi-24) treated with Ilizarov ring fixator. 25 cases reported of RTA, four cases of fall from height and one of train accident. Patients aged between 19-60 years. Eight cases were open and 22 were close and associated injuries reported in ten cases. One patient presented with compartment syndrome and required fasciotomy and split skin grafting. Open reduction with minimal fixation done in eight cases.

Results: We assessed our results based on Honconon and Jarvian criteria (1992). Average range of motion was >115^0. Posterior instability found in one case. No varus and valgus instability found. Three patients developed pin tract infection and one developed deep-seated infection required sequsterectomy. Two patients complicated with postoperative common peroneal nerve palsy, which recovered in 3-4 months. One patent developed varus collapse and osteoarthritic changes after three year of follow up.

Conclusion: Use of external fixation with Ilizarov is appropriate for treatment of high-energy tibial plateau fractures, especially those with poor soft tissue envelope when extensive dissection and internal fixation is not feasible. It limits the potential surgical morbidity associated with open reduction & internal fixation. It preserves the goals of stable fixation and early range of motion and is a good procedure for treatment of these difficult fractures. Key words: Ilizarov ring fixator, tibial plateau fracture.

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INTRODUCTION

Tibial plateau fractures are common injury and present a surgical challenge to orthopaedic surgeon and merits of operative V/S nonoperative management often have been debated. Numerous investigators reported satisfactory results using either closed or open treatment methods, especially for the less severe type of the injuries that occur as a result of low energy trauma.[1] High energy tibial plateau fractures occur primarily in younger population as result of blunt trauma[1] and road traffic accident is the most common cause. Characteristics of "high energy" tibial plateau fracture are large degree of articular depression, displaced multiple condylar fracture lines, diaphyseal metaphyseal extension and comminution, extensive soft tissue envelope damage. More recently indirect reduction technique with external fixation has been used where skin condition is poor and internal fixation associated with too many complications.

Various treatment modalities are available for treatment of these high energy fractures. Double plate and screw construction is most commonly used treatment modality but it needs expertise, require extensive exposure and further soft tissue compromise and devascularization of bone fragments.[2,3] This is associated with many complications such as compartment syndrome, infection, joint stiffness, mal-union, skin loss, osteomyelitis and amputation.[1] Locked plating it is new option to preserve the soft tissue but subsidence of medial condyle due to cyclic loading questioned the stability of single lateral locking plate. It restores articular surface with decreased complication rate but prolonged

non-weight bearing require to reduce the subsidence of medial condyle.[4-6] Less invasive stabilization system it is evolving technique. It requires less extensive exposure and is an indirect reduction technique. But unavailable to all surgeons and difficult to get good intraarticular reduction.[7,8] Monolateral half pin fixator it is technically easier but half pins may not achieve a secure fixation as small tensioned wires and high incidence of loss of reduction is there. JESS fixator it is cost effective, light weight, short operative time, minimally invasive technique. Early mobilization is possible but stability is not equal to ring fixator[9], an alternative method was proposed for treatment of high-energy tibial plateau fractures by Ilizarov external ring fixator. Ilizarov circular fixation is an ideal method of treatment of these fractures when extensive dissection and internal fixation are contraindicated due to trauma to soft tissue, deficiency of bone stock and bony comminution. Advantages of Ilizarov ring fixator are that it provides stability, Preserve blood supply, Maintain function and Avoids further soft tissue damage. Difficulties may be encountered using the Ilizarov method during closed reduction of fractures and may require a longer operative time but these difficulties can be overcome with surgeons experience. Difficulties of wearing of frame and frequent dressing changes are encountered by patient.

Looking at the controversies in the literature regarding the treatment of such fractures and to study the role of Ilizarov in these fractures; we at our institute conducted a study to evaluate the outcomes using Ilizarov ring fixator in high energy tibial plateau fractures and to compare our results with the literature on such fractures treated with Ilizarov technique.

MATERIALS AND METHODS

We conducted a study to find the outcome of tibial plateau fractures (Schatzker Type V and VI) treated using Ilizarov ring fixator. The study period extended from 2011 to May 2016. Age >18 and <60 years both closed and compound cases were included in study. Patients with tibial plateau fracture Schatzker type I to IV and associated fractures of femoral condyles were excluded from study. Preoperative evaluation included a thorough clinical examination to exclude neurovascular injury and any possibility of a developing acute compartment syndrome. Anteroposterior radiograph were taken to determine the extent of medial and lateral plateau involvement, whereas lateral radiograph were taken to gauge the extent of posterior displacement of condyles, degree of articular comminution, joint depression and position of posterior tibial slop. Fracture pattern were classified according to Schatzker classification. The extent of articular condylar depression was measured from remaining articular surface. Condylar widening measured in relation to intact femoral condyles.

Open fractures were managed by debridement, irrigation and i.v. antibiotics simultaneously along with external fixation. Coronal, sagittal and three dimentional CT scan were done which gave the precise location and degree of articular depression and incongruity and determined intact region of plateau where wires would be inserted. One patient presented with compartment syndrome and required fasciotomy and split skin grafting.

The patients were operated under spinal anaesthesia in supine position. The limb was kept in neutral position and traction applied to attain acceptable reduction under image control. Three to four olive wires were passed in tibial condyles in mid portion of each fragments and perpendicular to major lines, so as to act in a lag fashion and provide maximal intercondylar compression and then appropriate tension was given. An articular incongruity of more than 5mm required open reduction. The depressed articular fragments were elevated and fixed with screws. Juxta articular pins were placed 15mm away from the joint line to prevent synovial contact. The distal ring was placed just proximal and parallel to ankle joint line. The fixator ring should allow 1.5cm clearance over the anterior crest of tibia and 3-4cm clearance around the posterior calf to accommodate postoperative swelling. Femoral assembly with two rings applied in full extension and joint distracted when knee joint was found unstable. Dressing applied over pin tracts.

Isometric quadriceps exercises were started from post-operative day one and pin tracts dressings were changed in every 2-3 days. Across knee fixator if applied were removed after 6 weeks and knee bending started. Partial weight bearing was allowed after 8 weeks and full weight bearing after 12 weeks. Serial radiographs were taken at every 4 weeks. The fixator was removed at 15-16 weeks when the fracture showed radiographic healing (obliteration of major fracture lines) and a long knee brace given. Clinical healing was defined as ability to bear full weight with no pain on varus or valgus stress. Final assessment was done after one year of treatment by Honconon and Jarvian criteria (1992)[7]. It includes subjective, clinical, functional and radiological criteria.

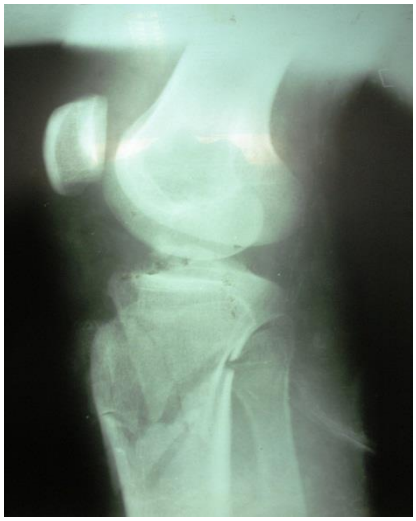

Fig 1: Pre op Lateral View

Fig 2: Pre op AP View

Fig 3: Compromised skin condition

Fig 4: Post-Op X Ray

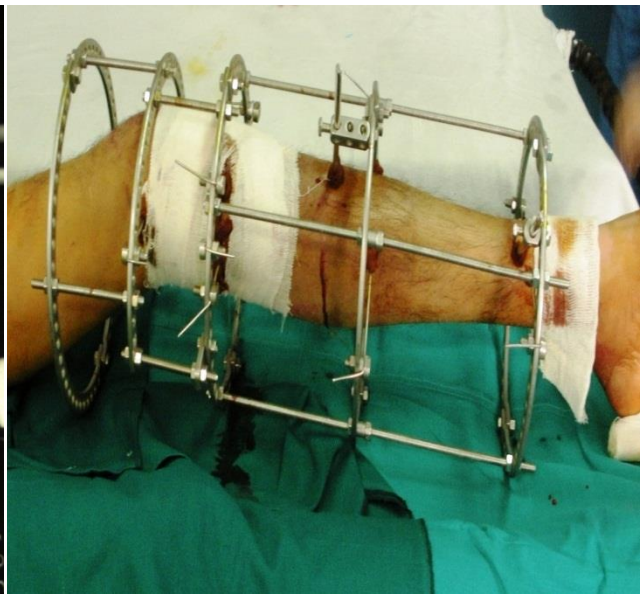

Fig 5: Ilizarov Application

Fig 6,7: Functional Results

Fig 8: Follow Up at 2 Years

RESULTS

Total number of cases was thirty (20 type VI and 10 type V) in our study. Patients aged between of 19-60 years with an average age of 41.3 years. 60% patients were from ≥ 40 years of age group. There were 29 males and only one female patient. Out of 30 cases, RTA was mode of injury in 83.3% cases, fall from height in 13.3% and train accident was in 3.3% cases. Out of 30 cases 22 were closed type of injury and eight open fractures. There were 24 cases of Schatzker type VI and 6 of Schatzker type V in our study. Ten cases had associated injury, out of which seven had injury in the same limb and three cases in contralateral limb. In 22 cases fractures reduced by closed method of ligamentotaxis and fixed with frame while eight cases fixed after minimum open reduction and internal fixation with cancellous screws. Three cases required application of bone grafting. 60% cases of our study fixed in first week after injury, 25% in second week and rest of the 15% in third and fourth week. Most of the closed injuries fixed in first week and most of open cases fixed in second week. The mean duration after injury fractures fixed was 1.75 weeks in close cases

and 2 weeks in open type of fractures. In 20 cases knee joint found unstable during surgery due to severe comminution with avulsion of tibial tuberosity, avulsion of tibial spine, fracture of patella or ligamentous injury in which across knee fixator applied. Most of the patients allowed full bearing weight after 10 weeks of fixation and duration of weight bearing having no significant relation with method of reduction. Mean duration after full weight bearing allowed was 11.9 weeks in closed reduction cases and 11.8 weeks in open reduction. In 50% of our cases fixator removal was after 15 weeks of fixation and most of the cases of fixator retention of more than 15 weeks are of having associated injuries. There were complications in six cases. Three cases developed pin tract infection, deep infection in one case and two cases developed post-operative common peroneal nerve palsy. Majority of cases (50%) of our study achieved ROM between 110^0- 129^0 and 30% cases achieved ROM >130^0. 10% cases achieved ROM in range of 90^0-109^0 and only 10% restricted to <90^0. Average range of motion achieved was 115^0. We assessed our results based on Honconon and Jarvian criteria[7] and found 6 cases (20%) excellent, 18 cases (60%) good, 5 cases fair and only one case poor. Excellent and good results were more in closed reduction method as compare to open reduction. Range of follow up was between 60 months to 24 months and average duration of follow up is 34.5 months.

DISCUSSION

With improved methods of internal fixation, operatively reducing and fixing tibial plateau fracture has become common. These techniques have the advantage of reducing of articular surface, aligning the limb, and mobilizing the knee early after injury.[10] As more and more tibial plateau fractures are surgically treated, surgical complications some of them severe, have become relatively common.[10] Postoperative complications include infection; wound dehiscence and wound healing problems.[2] Long-term complications include loss of reduction, collapse of articular fragments, malunion, nonunion and secondary osteoarthritis.[11]

Schatzker types V and VI tibial plateau fractures are usually due to high-energy forces and are often associated with compromise of the surrounding soft tissues due to the subcutaneous position of the bone at this site. In these cases, extensive exposure of the upper tibia with subperiosteal placement of large implants has been associated with an increased risk of wound dehiscence and infection.[10,12] 23% infection rate was reported with dual plating of bicondylar fractures.[2] 87.5% deep infection rate and 100% complication rate were reported with dual plating for comminuted bicondylar fractures.[13] The rate of infection of ORIF with dual plating reported by Malik et. al was four out of five. Young and Barrack report seven out of eight and Yang et al. reported five out of sixteen for type VI fracture.[13,14]

Fractures involving both tibial condyles routinely require repair and these fractures are frequently comminuted, and the shaft may be dissociated with the metaphysis, many of these fractures are better treated with external fixation.[10]

Monolateral half pin fixator is easy to apply but does not provide three-dimensional stability. JESS fixator is also cost effective, lightweight, takes less operative time but does not provide adequate stability for early weight bearing.[15]

Ilizarov ring fixator provides an alternative for treatment of these complex injuries. Its advantages over open reduction and internal fixation are that it provides stability, preserves blood supply, avoids further damage to soft tissue and allows early knee mobilization.[16] Four olive wires of ring fixator provide stability to condylar fragments comparable with double plating.[11]

Tibial plateau fractures are common in younger population, in our study most of the patients were of average 41.3 yrs (range 19 to 60 years) as compare to Dendrinos et.al 39 years, Dimitris et.al 43.5 years and kataria et. al it is 32 years.[17,18] Our mean age is comparable with Dendrinos and Kataria et. al study.

In our series 83.3 % cases are of road traffic accident comparable to Dimitris et. al study (95%) and Dendrinos et. al (70%). 13.3% cases are of fall from height and 3.3.% cases reported of train accident. 26.6% cases in our study had open fracture and 80% cases were classified as Schatzker type VI. Type of fractures was comparable to Ranatunga et. al study. Associated injuries include ipsilateral femoral and tibial diaphyseal fractures, fracture of patella, cruciate and collateral ligament injuries and meniscal tears. All these associated injuries directly impact surgical treatment and finally long term outcomes.[13] Seven cases had associated injury in our cases and five had injury in the same limb and two cases in contralateral limb. In our study one patient developed posterior instability after removal of fixator due to ligamentous injury. Dendrinos et. al reported 59% ligamentous injury and 46% other major musculoskeletal injuries. Dimitris et. al had 25% ligamentous injury, 27% meniscal injuries and tibial spine avulsion in 44% cases.

In 73.3% of our cases the Ilizarov fixator was mounted after closed reduction under image control. Open reduction and minimal fixation with screws was done in 26.6% cases and three cases required application of bone graft.

Instability of the knee after these fractures is a major cause of a poor result, whether it is due to ligamentous laxity or bone deformity is debatable.[19] There is no general agreement as to whether the repair of associated ligament injuries at the time of the fixation of the fracture is necessary, but many believe that operative repair should be undertaken.[20] The tibiofemoral circular fixation provides adequate bracing for management of any form of ligament disruption.[21] Marsh et. al stated that immobilization of knee for 6 weeks did not adversely affect the ultimate range of motion.[20] Analysis has confirmed that isolated injuries of the medial collateral ligament have a better prognosis than all other isolated or combined knee ligament injuries associated with fractures of the tibial plateau.[21] Indication of tibiofemoral circular fixation includes severe comminution, soft-tissue compromise and ligamentous injuries. The majorities of high-energy tibial plateau fractures are associated with such injuries; require knee bridging with tibiofemoral frame.[18,22] In our study 66.6% cases had either severe comminution with avulsed tibial tuberosity, avulsed tibial spine, fracture patella or poor soft tissue coverage; in which tibiofemoral fixation was given. This tibiofemoral fixation was removed after 6 weeks and knee mobilization started. Dimitris et. al required provisional extension of the femoral fixation in 73.2% cases. Fixed tibiofemoral fixation offers better subjective, clinical, functional, and radiologic results.[22] Marsh et al. in his paper advocated the 'spanning' concept across the knee joint to allow the knee joint to rest and further immobilize the articular fragments. Ranatunga et. al concluded that knee spanning ring fixation is a safe and viable technique for treatment of these highly unstable injuries.[22]

Ilizarov circular fixation allows both early movement and early weight-bearing. The value of early movement has been well established but early loading of fractures of the tibial plateau has generally been avoided because of concern that the reduction may be lost, resulting in depression of the articular surface or a valgus deformity. Early weight-bearing however stimulates bone healing and allows retention of muscular strength. The Ilizarov tibiofemoral frame allows adequate initial weight bearing.[22,23] In our cases full weight bearing allowed after average 11.8 weeks but in cases of associated injuries it was more delayed. Dendrinos et. al allowed weight bearing after 14.4 weeks and kataria et. al at 14.8 weeks. Average duration of fracture healing was 13.9 weeks which is comparable with other studies (Dendrinos et.al 14.4 weeks, Dimitris et. al 13.5 weeks, Ranatunga et. al 14.8 weeks). In 50% of our cases fixator removal was after 15 weeks of fixation and most of the cases of fixator retention for more than 15 weeks were those having associated injuries. In Dendrinos et. al study fixator removal was at 13 weeks.

In a comparative study of Jeremy A Hall et. al found that patients in the circular fixator group had less intraoperative blood loss than those in the open reduction and internal fixation group respectively and spent less time in the hospital. Seven (18%) of the 40 patients in the open reduction and internal fixation group had deep infection. The number of unplanned repeat surgical interventions, and their severity, was greater in the open reduction and internal fixation group compared with the circular fixator group.[6,18,22] Complications of ring fixator are minimal as compared with open reduction internal fixation. Morandi et al. reported that the advantage of external fixation of complex tibial plateau fractures had decreased rates of complications.[23] In our study six cases (20%) had got complicated. Three patients developed pin site infection which healed after removal of frame. One patient had open fracture, developed deep infection with sequestrum formation which required removal. In two cases we found postoperative common peroneal nerve palsy in which offending wire removed and recovered completely after 3-4 months.

Other complications like vascular injury, deep vein thrombosis, pulmonary embolism, compartment syndrome, septic arthritis, non- union and ankle stiffness were not reported in any case.

Good range of motion achieved in most of cases but those cases had associated injury have decreased range of motion. The average range of motion achieved was 115^0. More than 130^0 knee flexion achieved in 30% cases and $>110^0$ in 80% cases. Most patients were able to walk

normally and achieved functional knee flexion which allowed them to go back to their original occupation except one case, developed extensor lag of 10 degree and flexion upto 50 degree. In Dendrinos et.al ROM achieved $>110^0$ in 70%, Dimitris et.al in 74% cases. Kataria et.al achieved average ROM 132^0 whereas Ranatunga et.al had 85^0.

In our study 80% cases are in range of excellent to good according to Honconon and Jarvian criteria (Dendrinos et.al 70%, kataria et.al 84%).[24,25] Subjective, clinical, functional and radiological results were not parallel with each other but final results are comparable with Dendrinos et. al and kataria et al.

Range of final follow up was between 60 months to 24 months and average duration of follow up is 34.5 months. At final follow-up one patient developed varus collapse and arthritic changes in knee after 2.5 years having bone deep infection during treatment.

CONCLUSION

Use of external fixation with Ilizarov is appropriate for treatment of high energy tibial plateau fractures especially those with poor soft tissue envelop, when extensive dissection and internal fixation is not feasible. It limits the potential surgical morbidity associated with open reduction & internal fixation. It preserves the goals of stable fixation and early range of motion and is a good procedure for treatment of these difficult fractures.

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