International Journal of Research in Orthopaedics
Kumar S et al. Int J Res Orthop. 2022 Mar;8(2):124-131
http://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20220084

Functional and radiological assessment of complex tibial plateau fractures managed with Ilizarov fixator: a study of 60 cases

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Received: 31 December 2021
Accepted: 15 January 2022

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ABSTRACT

Background: Tibial plateau fractures represent 1% of fractures in adults. The soft tissue envelope is in jeopardy in these fractures and can be complicated by wound dehiscence and osteomyelitis. In an Ilizarov fixator, the juxta-articular wires are placed percutaneously with minimal disruption of periosteal and endosteal blood supplies, olive wires can compress the fracture lines. The aim was to analyse the results of application of Ilizarov fixator in patients with Schatzker V and VI of tibial plateau.
Methods: The study was conducted with 60 patients who sustained Schatzker V and VI type of tibial plateau fractures, of either sex, of an age of more than 18 years as a prospective observational study. 50 patients were treated with closed reduction and ligamentotaxis and 10 with mini open reduction prior to ring fixator application. They were followed up for a mean period of 15.4 months. The results were assessed in according to the criteria of Honkonen and Jarvinen (1992).
Results: All the fractures united at a mean of 13.2 weeks. 48 patients felt their knee to be fully stable and 4 patients had severe pain. All patients were able to fully extend their knee, 36 patients had a flexion of >130 degrees and in 24 ranged between 110-129 degrees. There were 40 excellent results, 12 good, 4 fair and 4 poor. 14 patients had pin tract infections which were treated by antibiotics, 4 patients required changing the pin.
Conclusions: Application of Ilizarov fixator is a useful method for early, definitive management of complex tibial plateau fractures with excellent results.

Keywords: Tibial plateau fracture, Complex fractures, Ilizarov external fixator, Ligamentotaxis

INTRODUCTION

Tibial plateau fractures account for approximately 1% of fractures in adults. Fractures in men occur at a younger age and tend to be the result of high-energy trauma; women have an increasing incidence in the sixth and seventh decades.[1] Even in closed fractures, the contused soft tissue envelope is at risk of necrosis because of the underlying fractures, severe swelling associated with the injury. Complications like skin necrosis, infection and osteomyelitis may also develop. The goals in the management of tibial plateau fractures are obtaining a stable, aligned, mobile and painless joint and minimising the risk of post-traumatic degenerative changes. This necessitates for precise reconstruction of the articular surfaces, stable fragment fixation allowing early motion.

In a circular, tensioned small wire external fixator, the juxta-articular wires are placed percutaneously with minimal stripping of the periosteum, preserving its periosteal and endosteal blood supply. Olive wires compress the fracture lines and fracture is stabilized without having to span the joint, avoiding knee-stiffness. Any rotational as well as translational deformities can be corrected as consolidation progresses. This study was undertaken to evaluate the outcome of such llizarov ring

fixator application in such fractures in view of these advantages.

METHODS

The study was conducted at Sir Ganga Ram hospital, Old Rajinder Nagar, New Delhi, India. Our study population were patients with high energy trauma with Schatzker V and VI type of tibial plateau fractures, attending the emergency or outpatient department of Sir Ganga Ram hospital, Old Rajendra Nagar, New Delhi, India. This study was a retrospective and prospective study of all such cases between April 2014 to January 2019. A sample size of 60 patients was taken.

Inclusion criteria

Patients with tibial plateau fractures (Schatzker V and VI type), either sex, age of more than 18 years were included in the study.

Exclusion criteria

Patients less than the age of 18 years and with pre-existing severe deformity of the knee were excluded in the study.

After ethical clearance, patients who gave their consent for participation in the study were included in the study. The pre-operative information included documenting clinical findings, antero-posterior and lateral view radiographs (X-ray), CT scan to assess the number size and arrangement of fracture fragments and articular surface depression. X-rays of the uninjured knee were also taken for comparison. Condylar widening was assessed by measuring total width of the tibial plateau just below joint line and compared with the uninjured leg. In retrospectively reviewed cases, the data was collected using hospital records.

Surgical technique

Preparation of the entire lower limb and the ipsilateral iliac crest was done (Figure 1). Fracture was reduced by application of traction, using principle of ligamentotaxis or by manipulation using wires. Elevation of the plateau, if required, was done by a limited incision and a cortical window and applying bone graft. Olive wire (1.8 mm Krischner wire with 4 mm bead located eccentrically on wire) was used to achieve interfragmentary compression of condylar articular surface. In some patients, we used cannulated screws (6.5 mm and 4.5 mm) with washer (Figure 2and 3). Placement of periarticular wires was performed under fluoroscopy. Tensioning of wires was also done under fluoroscopy to view the intercondylar compression and articular surface reduction. During frame construction, care was taken that the fixator rings allowed 1.5 cm of clearance over the anterior crest of tibia and 3-4 cm clearance around calf (Figure 4). This was to allow for post-operative swelling. The proximal tibial ring was then applied to the first olive wire and another olive wire passed to hold the reduced tibial condyle. The middle ring was placed just distal to fracture and distal ring placed above the level of ankle joint. The appropriate alignment of mechanical axis was ensured by forcing proximal and distal rings to become parallel to each other. If knee joint was found to be unstable due to ligament injury, which was confirmed by intra-op valgus-varus stress test in 20 degrees knee flexion after application of tibial frame and considered positive if >10 degree of varus or valgus then an additional 5/8 distal femoral ring was applied to provide angular stability.

Figure 1: Positioning of limb on table.

Figure 2: Percutaneous fixation of fracture under C-arm.

Figure 3: C-arm image after screw fixation.

Figure 4: Final Ilizarov fixator construct.

Follow up

The patients were followed up at 3, 6, 12, 24 weeks and then every 6 months till 18 months. Clinical and radiological evaluation in the form of knee range of motion measurement and X-rays were done at every visit. In case of distal femur ring application, after 3 weeks, hinge was applied between femoral and proximal tibial ring to allow range of motion of knee. The femoral ring was removed at 6 weeks. In all cases, toe-touch weight bearing was allowed from post-operative day one. The tibial fixator was removed after 8-12 weeks guided by radiological signs of union. Full weight bearing was allowed two to four weeks after that.

RESULTS

A total of 60 cases of high energy tibial plateau fractures, who fulfilled our inclusion and exclusion criteria and given consent were part of our study and were followed up for a mean period of 15.4 months. All the fractures united at a mean of 13.2 weeks. Age ranged from 30-60 years (mean age 44.93 years) and males dominated the study with 50 patients (Figure 5). 44 out of 60 patients were Schatzker VI type. 12 cases (20%) were open fractures and 48 (80%) were closed fractures but with definite soft tissue envelope compromise. Surgery was performed on an average of 3.67 days after injury, with 50% patients being operated within 3 days.

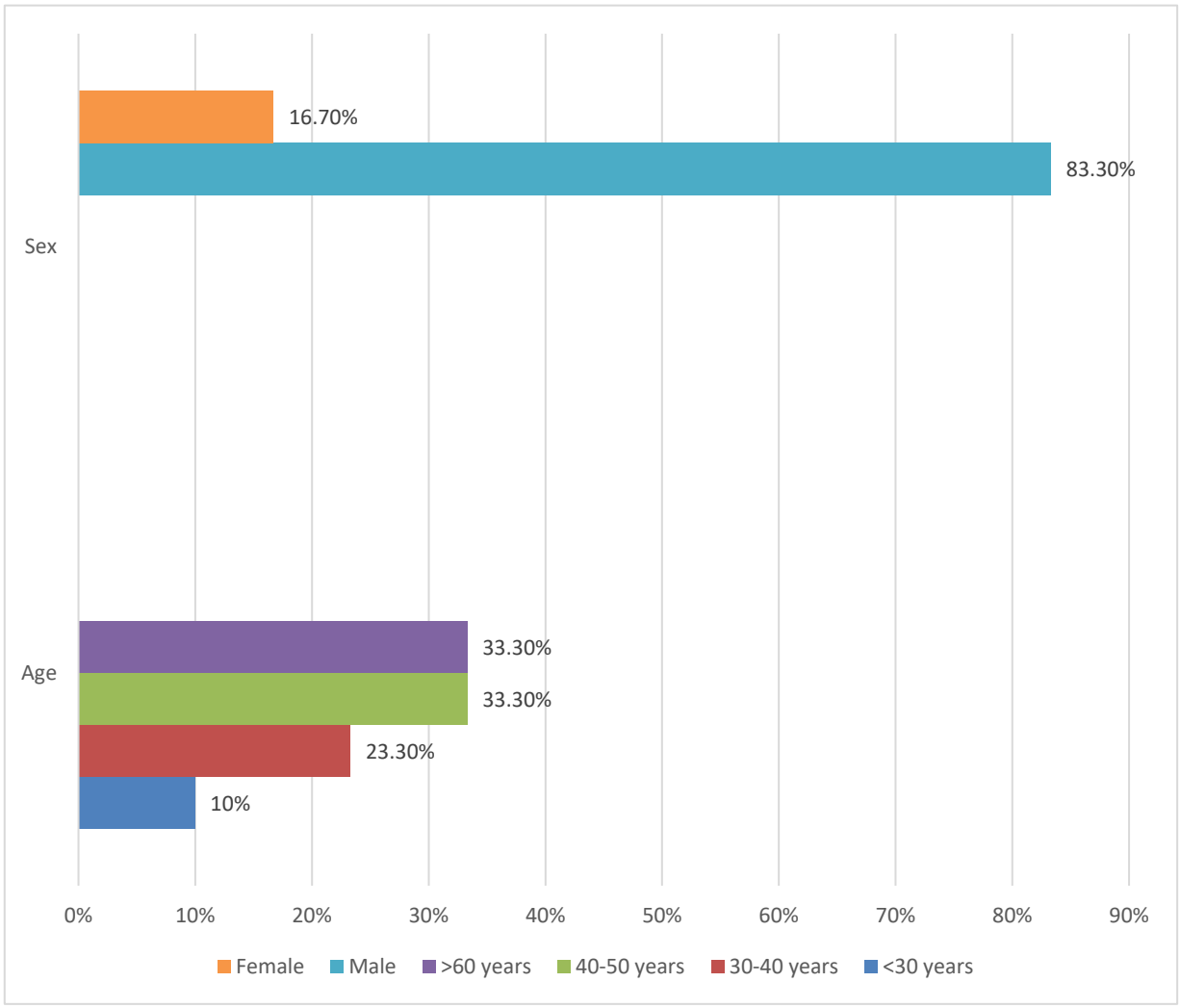

Figure 5: Bar chart showing the demographic details of the patients.

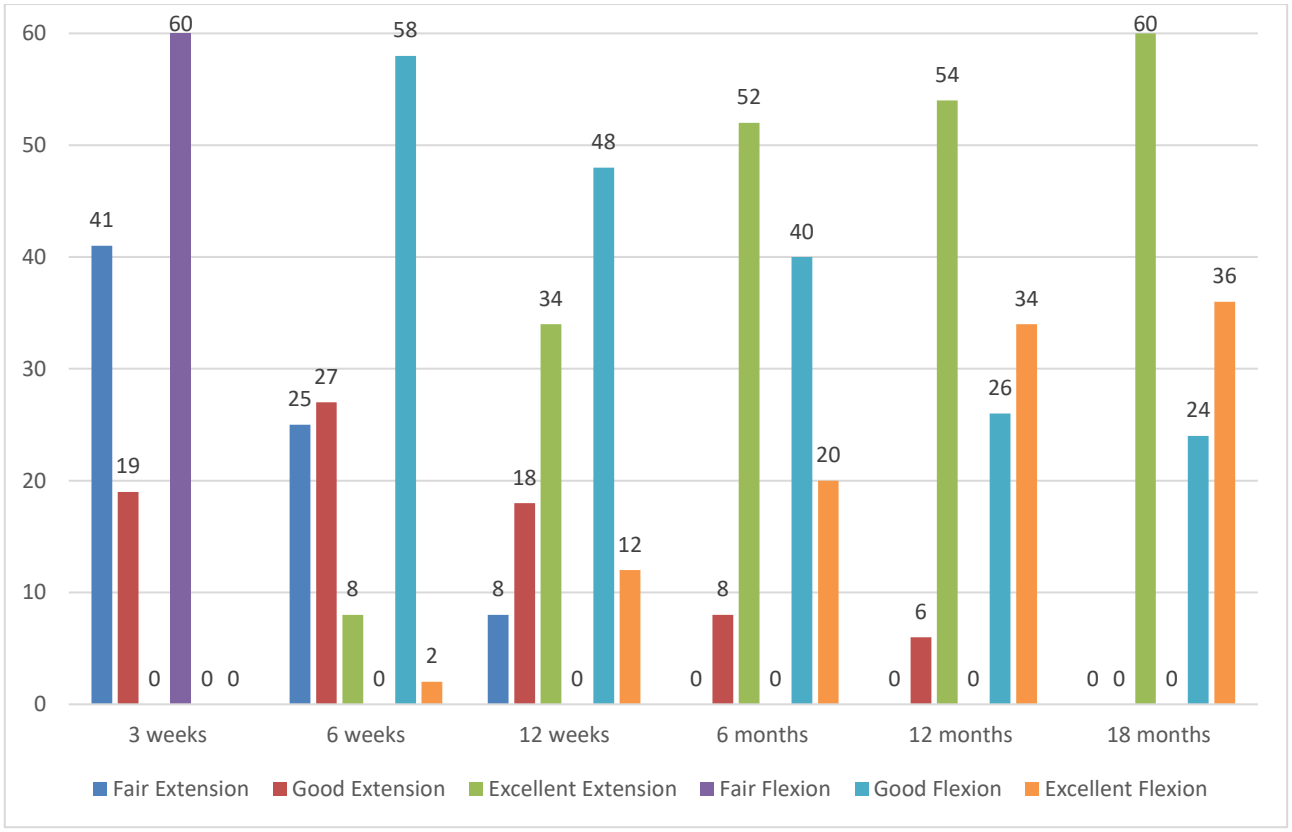

Figure 6: Bar chart showing the functional outcome in terms of extension and flexion at each follow up visit.

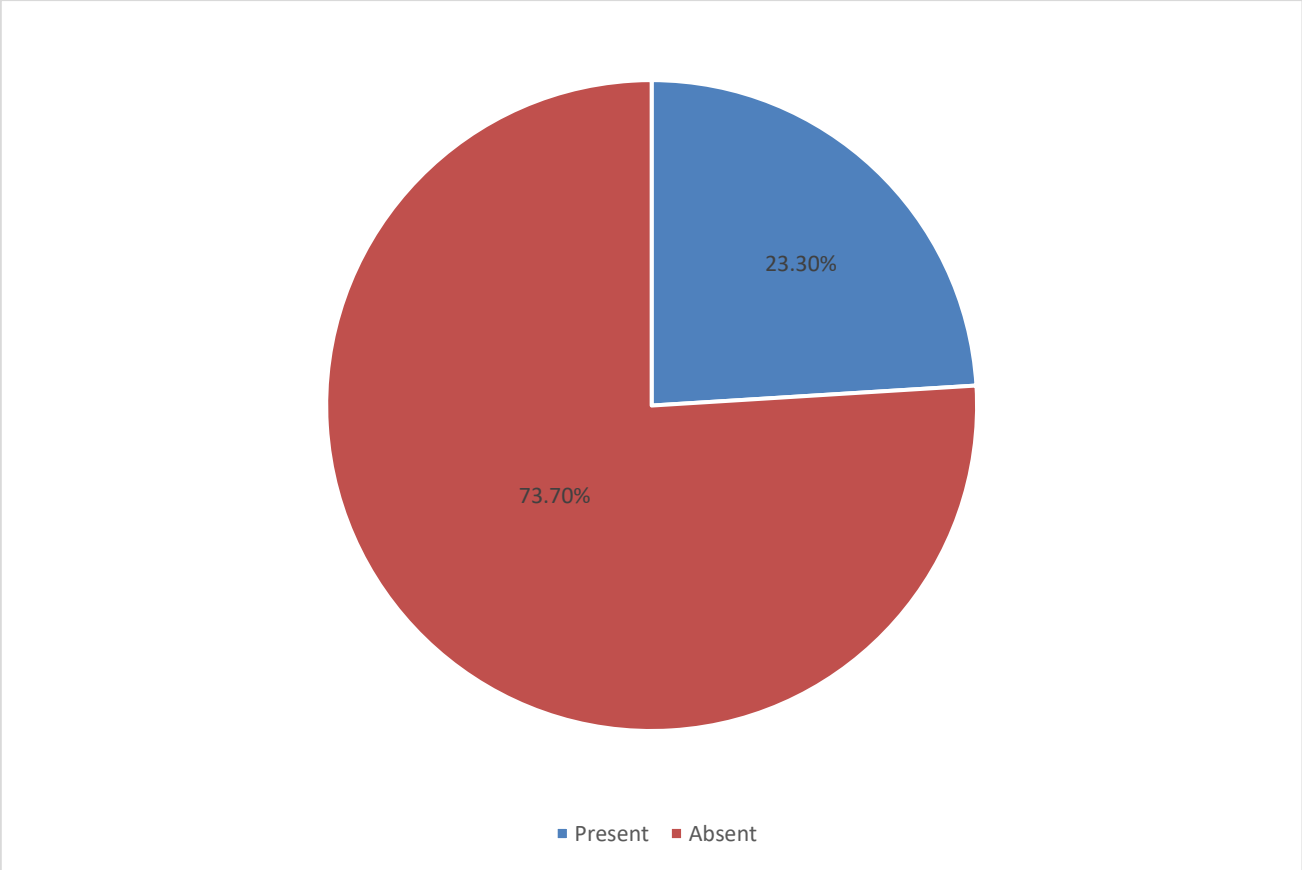

Figure 7: Pie chart showing the percentage of pin tract infection faced in our study.

Figure 8: (a) Pre-operative X-ray; (b) post-operative X-ray; (c) extensive soft tissue injury evolving even after fixator application; (d) healed soft tissue component of injury by post-op day 10; (e-g) functional status of patient at final follow up visit.

At final follow up 48 (80%) patients felt their knee to be fully stable and only 4 (6.7%) patients had severe pain. All patients were able to fully extend their knee without any extension lag while 36 patients had a flexion of >130 degrees and the rest 24 ranged between 110-129 degrees (Figure 6). 14 (23.3%) patients had pin tract infections which were treated by single dose of locally injected antibiotic and a 7-day course of oral antibiotics (Figure 7). In 4 (6.7%) patients we had to change the pin and debride for controlling the infection.

8 patients developed knee stiffness, 4 patients developed ankle stiffness and 4 patients developed both ankle and knee stiffness which were treated with extensive physiotherapy. An impending anterior compartment syndrome was recognized in one patient and managed by fasciotomy followed by regular dressings and coverage with split skin graft.

The results were assessed according to the criteria of Honkonen and Jarvinen which considered the subjective opinion of the patients, the clinical state, the function and the radiological assessment. Subjectively, a score of excellent in 44, good in 12 and fair in 4 patients was given at the final follow up. Clinically, upon evaluation, 36 patients were able to flex more than 130° and 24 patients

achieved flexion of more than 110° but less than 130°. None of patient was having thigh atrophy of >1 cm. At follow up, 48 knees were fully stable, while a few patients complained slight instability during strenuous activities (Fig 8 a-f). Normal gait pattern was noted in 52 patients and a slight limp in 8 patients. None of them have used walking aids. Normal squatting was possible in 30 patients and was impaired in 10, but all were able to flex knee more than 90°. 46 patients could climb stairs without difficulty, 10 with only slight difficulty. Radiologically, tilting of the plateau was measured in the frontal plane by drawing a line between the deepest points of the weight-bearing area of the two condyles. The angle between that line and the long axis of the tibia was recorded. Twenty patients had no tilt at follow up, two had a tilt of less than 6° and one a tilt of between 6° and 10°. Local step-off was assessed whenever there was an intact part of the articular surface, 2 patients had a step-off of less than 4 mm. The normal alignment of the plateau was derived from the radiograph of the uninjured knee. In 50 injured knees the alignment remained normal and only 2 deviated by more than 5° valgus/varus. Condylar widening was present in 6 knees and in only 2 of these was this more than 6 mm, the cause may be grossly comminuted fractures and multiple fragments. In this scoring, post-traumatic arthritis was seen as a comparative narrowing of the joint space in contrast to the uninjured knee. Subchondral sclerosis was not taken into consideration because it can be attributed to fracture healing. In view of the short follow-up, assessment of post-traumatic arthritis was considered as preliminary. There were 40 excellent results, 12 good and 4 fair and 4 poor.

DISCUSSION

Treatment of proximal tibial fractures had unique difficulties owing to the peri-articular location of the fracture and the scanty soft tissue cover of the fractured bone. The final result depends on many variables such as the amount of damage to soft tissues and articular cartilage, accurate reduction, the stability of the knee joint, stable fixation and the alignment of the limb.[2]

The various treatment modalities included the classic dual plating with single incision, dual plating with dual incision, single lateral column plating, less invasive internal stabilisation system (LISS) plating and finally fixation with Ilizarov fixator with or without minimal open reduction. In the case of ORIF with dual plating with single incision, there was extensive exposure allowing for near anatomical reduction of the fracture but the extensive soft tissue stripping led to devastating complications like wound dehiscence and surgical site infections. Another disadvantage is that the soft tissue injury needed to settle enough so as to allow for internal fixation. Therefore, the time from injury to fixation got prolonged.

Moore et al reported a 23% rate of infection in association with bicondylar fractures after internal fixation. They came across dehiscence of wound in 8 out of 11 knees that had been managed with bi-columnar plating.[3] After ORIF, Mallik et al found infection in 4 out of 5 bicondylar fractures tibia fractures.[4] Young et al reported deep infection in 7 out of 8 fractures that had been treated bi-columnar plating.[5] The use of dual incision also led to deep infection in 13.8% of the cases.[6] Jiang et al reported a deep infection rate of 4.7% with dual plating.[7]

In the study by Lee et al tibial plateau fractures were treated with the LISS, two out of 36 patients had deep infection and extended skin necrosis was seen in one patient, who ultimately required plastic surgery.[8] Jiang et al reported a deep infection rate of 7.3% with LISS.[7] LISS was associated with a higher risk of implant-associated pain than conventional plates.[9]

The olive wire provided better reduction and interfragmentary compression of the fracture and allowed fine adjustment of any rotational deformity, if present.[10] Watson et al demonstrated that four olive wires combined with a lag screw provided even more stability than dual plating. Allowing early joint mobilization without risking loss of reduction.

All the fractures united in a mean time of 13.2 weeks in our study. In a study by Ferreria all fractures united in a mean of 18.3 weeks.[12] All fractures united at a mean of 20.1 weeks (11 to 42) in external fixation. No patient required further surgery to stimulate union.[13]

In our study, at final follow up, 36 patients were able to flex more than 130 degrees and 24 were able to flex from 130-110 degrees. In the study conducted by Ferreria et al the average arc of knee motion was 100.5 degrees (35 to 125 degrees).[12] Pun et al reported that none of the patients had an extension lag and the average knee flexion was 128.09°.[14]

The advantages with a circular construct were that the load got distributed equally to both plateaus and cantilever bending on the pins was minimized. This reduced the risk of both angular deformity and infection of the pin-tracts.[15] Early weight-bearing led to axial micromotion without shear further stimulating fracture healing. This, coupled with distraction on either side of the joint allowed for a ligamentous reduction.[16] Compression can be directed across the site of bone loss or fracture gap without additional bone grafting. Any rotational and translational deformities can potentially be corrected as consolidation progresses.[11]

In our group of patients, partial weight bearing was allowed on post op day 1. Tibial fixator was removed at 8-12 weeks as per radiological signs of union. Full weight bearing was allowed 2-4 weeks after fixator removal. In a study by Ali in 2011, weight bearing was allowed at 3 weeks and alignment was maintained in almost all of them. In case of any loss of reduction, the circular external fixator offered the ability to correct acutely or gradually any residual axial deviation in any plane.[17]

The ring fixator can also be primarily used for definitive management of compound fractures irrespective of the soft tissue defect which was managed simultaneously, reducing overall number of surgeries, hospital stay and morbidity of the patient. The percutaneous placement of the wires led to minimal stripping of periosteum and devitalization of the bone unlike extensive procedures like ORIF with plating.[18]

Normal gait was not possible with a flexion of less than 60°.[17] In the study by El-Gharav et al most patients walked and achieved functional knee flexion allowing them to resumed their occupation.[19] All of our patients were able to flex their knee beyond 110 degrees and 36 were able to flex beyond 130 degrees which was in corroboration with the previous studies.

Several authors had reported infection, wound breakdown and subsequent osteomyelitis ranging from 25 to 87% with ORIF.[3,15,20] Parameswaran et al reported pin tract infection rates of up to 20% with traditional external fixators and 3.9% for circular ring fixators.[21] Pin-site infections were seen frequently (77 patients, 51.3%) but were all treated successfully with oral flucloxacillin.[13] To avoid septic arthritis, Kataria et al recommended placing wires at least 15 mm away from the joint surface and monitoring the status of pin sites.[16] 14 (23.3%) patients had pin tract infections which were treated by single dose of locally injected antibiotic and a week-long course of oral antibiotics. In 4 (6.7%) patients we had to change the pin and debride to control the infection.

CONCLUSION

The presented data of 60 patients provides significant evidence that use of Ilizarov fixator for the management of high energy tibial plateau fractures leads to timely union of fracture and avoids the soft tissue complications seen in other treatment modalities, in addition, it allows the patient to start bearing weight early in the post-operative period along with early mobilization of the knee, thus avoiding knee stiffness. That said, the procedure itself is technically demanding and requires a training with a surgeon proficient in its application.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Kumar S, Siddiqui S. Functional and radiological assessment of complex tibial plateau fractures managed with Ilizarov fixator: a study of 60 cases. Int J Res Orthop 2022;8:124-31.