RESEARCH ARTICLE

Functional and union outcome of combined column tibial plateau fracture treated with hybrid external fixator

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Abstract

Objective: To determine the combined column tibial plateau fracture treated with a hybrid external fixator in terms of knee functionality, union outcome and complications.

Method: The quasi-experimental study was conducted at the Department of Orthopaedic Surgery, Mayo Hospital, Lahore, Pakistan, from July 5, 2019, to December 31, 2021, and comprised patients of either gender aged 20-50 years who presented with 2-column or 3-column fractures of proximal tibia classified according to the 3-column classification system after being diagnosed using radiographs and three-dimensional computed tomography scan. Knee function, union and complications, like neural, vascular, infection, delayed union, nonunion, malunion and implant failure, were evaluated. The Knee Society Score was used to assess knee function, and modified Rasmussen score for the union, while complications were assessed clinically on the 2nd, 6th, 12th, 16th, 24th, 36th weeks and one year post-operatively. Data was analysed using SPSS 26.

Results: Of the 113 patients, 91(80.53%) were males and 22(19.47%) were females. The overall mean age was 35.56±9.00 years. From the 12th week to the 24th week 45(39.83%) patients had good and 59(52.21%) patients had excellent functional outcomes. Union outcome in the 16th and 24th week was good in 57(50.44%) patients and excellent in 47(41.59%) patients. No neurovascular injury was observed. Superficial pin tract infection was observed in 21(18.6%) cases that healed with wound debridement and antibiotics. No delayed union, malunion and implant failure was observed.

Conclusion: Good to excellent functional and union outcomes with minimum complications were observed with the hybrid external fixator.

Keywords: Tibial plateau fracture, Knee joint, Hybrid external fixator, Union, Combined column. (JPMA 74: 440; 2024)

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Introduction

The tibial plateau occurs because of axial compressive forces either indirect or direct.[1] They account for 1% of all fractures and 8% of fractures among the elderly. Men aged <50 years have a higher incidence. In women, fracture incidence increases markedly at age >50.[2] Such fractures have a complex pattern in the young, who sustain high-energy trauma, and people aged >60 years.[3]

Posteriorly, the tibial articular surface is sloped 10-15 degrees. Trauma knee series with five views help determine posterior step-off with caudally inclined plateau image. Computed tomography (CT) and magnetic resonance imaging (MRI) scans provide a substantial amount of new information, especially when dealing with high-grade fractures.[4] Luo et al. elaborated a new classification of proximal tibial fractures based on a three-dimensional (3D) CT scan of the knee joint, categorising the proximal tibial fractures as only single-column fractures (lateral column, posterior column, medial column), two-column fractures or three-column fractures. Two-column and three-column fractures are together known as combined column fractures.[5] The articular surface of the proximal tibia was divided into 4 parts by Chang et al., and fractures were classified as isolated anteromedial, posteromedial, anterolateral, or posterolateral quadrant fractures. There may also be any combination of these fractures as well.[6]

Simple tibial plateau fractures can be managed conservatively. Complex tibia fractures are difficult to treat. Soft tissue (abrasions, lacerations, or blisters), and neurovascular injury play a vital role in selecting the mode of treatment.[7]

Operative management of proximal tibial fractures includes bi-column plate fixation, screw fixation,[8] Ilizarov external fixator or hybrid external fixator.[9] The most common surgery is open reduction and internal fixation (ORIF) with double plating, which has a stiff joint, malunited fracture and skin deterioration, reportedly up to 50%.[10] Postoperative skin infection and osteomyelitis were

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reported in 42% and 33% of cases, respectively.[11] A hybrid external fixator can be considered another management option to minimise the occurrence of such problems. According to studies, using a hybrid external fixator and reducing the articular surface step to <2mm results in stable bony fixation without giving further injury to the soft tissue or periosteal stripping, permitting earlier postoperative knee range of motion (ROM).[11,12]

The current study was planned to determine the combined column tibial plateau fracture treated with a hybrid external fixator in terms of knee functionality, union outcome and complications.

Patients and Methods

The quasi-experimental study was conducted at the Department of Orthopaedic Surgery, Mayo Hospital, Lahore, Pakistan, from July 5, 2019, to December 31, 2021. After approval from the ethics review board of King Edward Medical University (KMU), Lahore, the sample size of 113 patients was calculated by taking the confidence level as 95%, absolute precision as 10% and expected prevalence of combined column tibial plateau fractures as 72% and outcome after applying External Hybrid Fixator as 90%.[1] The sample was raised using a non-probability purposive sampling technique. Those included were patients of either gender aged 20-50 years who presented with 2-column or 3-column fractures of proximal tibia classified according to Lou et al.[5] the 3-column classification system after being diagnosed using radiographs and 3D CT scan. Patients having a history of previous surgery on the same joint, pathological fractures, open fractures with soft tissue injury, other fractures on the same limb, and multi-ligamentous instability of the knee joint were excluded.

Written informed consent was obtained from all the subjects, and the same orthopaedic surgeon assessed the entire sample.

Patients were treated with close reduction by using a hybrid external fixator and, where needed, minimally open reduction was done. All surgeries were done under spinal anaesthesia by a single surgeon having more >5 years of experience as a consultant.

During the procedure, all antiseptic measures were taken. The fracture was reduced under the image intensifier with 300 knee flexion and sustained traction, or in cases with an articular step, the fragment was reduced with a Schanz screw on T-handle on the lateral side and held with reduction clamps. Additionally, any depression in the articular surface was rafted with a tamp through the cortical window and secured with the cannulated lag screw, if needed. The void was filled with a bone graft through a small skin incision if required. If the posterior column was not reduced, it was achieved with minimal postero-medial incision. The fragment was reduced and, held with a tamp and olive wire, was passed to hold the fragment. One Illizarov ring was applied over the proximal tibia and K wires or olive wires were used to hold the fracture segments anatomically parallel to the joint line; one from the posterolateral aspect and the other from the posteromedial aspect exiting anteriorly and forming an angle of >60 degrees between them. The olive wire was used to hold the posteromedial /posterolateral column fracture. Wires were tensioned with a tightener over the Ilizarov ring posts. Two Schanz screws were applied over the tibial shaft to fix the Association of Osteosynthesis (AO) external fixator rods to make a hybridisation of fixation with the Ilizarov ring (Figure).

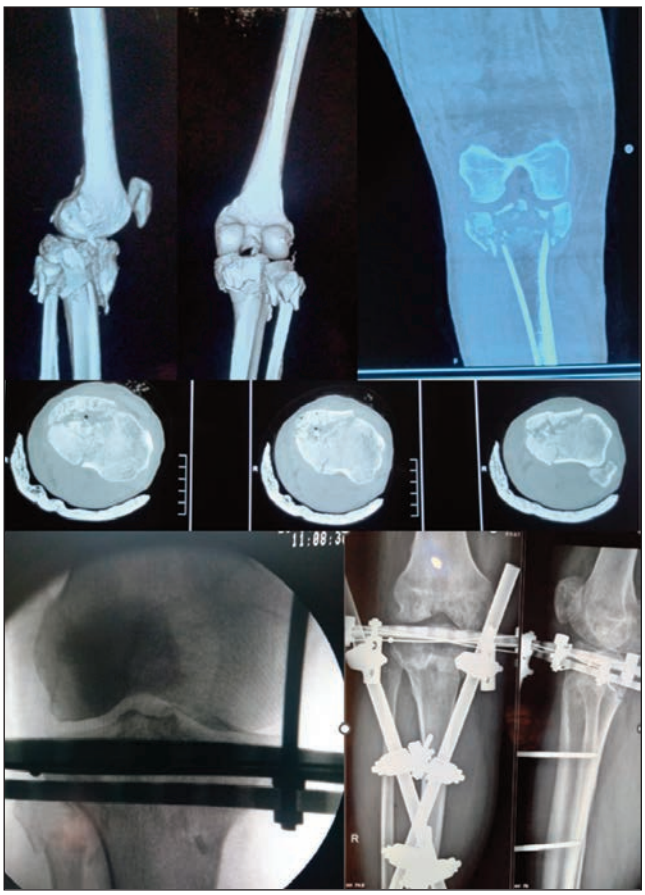

Figure: Three-dimensional (3D) compyted tomography (CT) scan of a patint with three-column fracture of proximal tibia operated with hybrid external fxator showing union.

Knee bending and quadriceps exercises, as pain permitted, were started after the first post-op day. Knee function, radiological union and complications were evaluated, including neural, like common peroneal or posterior tibial nerve, vascular, like popliteal vessels, superficial and deep

infection, delayed union, nonunion, malunion or implant failure. The evaluations were done on the 2nd, 6th, 12th, 16th, 24th, 36th week and one year post-operatively. Knee functions were evaluated using the Knee Society Score (KSS)[13] and union was evaluated using the Modified Rasmussen Score (MRS)[14] while complications were observed clinically.

Partial weight-bearing was started with a hybrid external fixator during the six post-op weeks, while complete weight-bearing was started with a hybrid external fixator after three months. A radiographic and clinical assessment of the union was made and the hybrid external fixator was removed after 4 months when there was evidence of union.

Data was analysed using SPSS 26. Quantitative variables were presented as mean and standard deviation, while qualitative variables were presented as frequencies and percentages. The difference between pre-treatment and post-treatment values was compared using chi-square test. P≤0.05 was considered significant.

Results

Of the 113 patients, 91(80.53%) were males and 22(19.47%) were females. The overall mean age was 35.56±9.00 years. There were 63(55.8%) patients with two-column fractures and 50(44.2%) with three-column fractures. There were 67(59.3%) patients whose right side was affected, and 46(40.7%) patients whose left side was affected. From the 12th week to the 24th week 45(39.83%) patients had good and 59(52.21%) patients had excellent functional outcomes (Table 1).

Table-1: Demographic data, clinical characteristics and knee functional scores (n=113).

Variables	n (%)
Gender	
Male	91 (80.5)
Female	22 (19.5)
Mean age (years)	35.5±9.0
Type of the fracture	
Two-column fracture	63 (55.8)
Three-column fracture	50 (44.2)
Mechanism of the injury	
Road traffic accident	95 (84.1)
Fall from height	18 (15.9)
Side of the limb	
Right side	67 (59.3)
Left side	46 (40.7)
Knee society score	
Moderate	09 (8.0)
Good	45 (39.8)
Excellent	59 (52.2)

Table-2: Modified Rasmussen Score (MRS) for the union.

	Poor (<5)	Fair (5-6)	Good (7-8)	Excellent (9-10)	Total	*p*-value
2nd Week	113(100%)	0(0%)	0(0%)	0(0%)	113	0.45
6th Week	1(0.9%)	11(9.7%)	65(57.5%)	36(31.8%)	113	
12th Week	0(%)	10(8.8%)	58(51.3%)	45(39.8%)	113	
16th Week	0(0%)	9(7.9%)	57(50.4%)	47(41.6%)	113	
24th Week	0(0%)	9(7.9%)	57(50.4%)	47(41.6%)	113	

Union outcome in the 16th and 24th week was good in 57(50.44%) patients and excellent in 47(41.59%) patients. No neurovascular injury was observed. Superficial pin tract infection was observed in 21(18.6%) cases that healed with wound debridement and antibiotics. No delayed union, malunion and implant failure was observed.

Discussion

The hybrid external fixator appeared to be a safe treatment modality to manage combined column tibial plateau fractures. Many surgical approaches and techniques have been mentioned in the literature, with every technique having its own set of benefits and drawbacks, and the same is true of fixation techniques and devices.[15]

Management choices include close cannulated screws, dual buttress plates, fixed angled locking compression plate, the combination of 1/3rd tubular plate and locking plate,[16] tubular external fixator, hybrid external fixation[10] and limited internal fixation combined with a tensioned wire.[17] Early ROM saves the major function of the joint.[18]

The role of external fixators, either Ilizarov or hybrid, has been evaluated in various studies, revealing good results.[19] In fractures with severe comminution, the use of bone graft and percutaneous screw fixation combined with an external fixator gives encouraging results.

In the current study, 113 patients' KSS values showed that from the 12th week to the 24th week, 39.8% of patients had good and 52.2% of patients had excellent functional outcomes. For union outcome, MRS values from the 16th and 24th week showed 50.4% and 41.6% of patients having an excellent outcome as a result of external hybrid fixation.

Babis et al. in 2011 used hybrid fixators in proximal tibial fractures in 33 patients and achieved excellent and good outcomes in 78.8% of cases.[19] Mankar et Al. operated on 78 patients and achieved excellent results in 47(60.25%) patients, good in 25(32.05%), fair in 2(2.56%) and poor results in 1(1.28%) patients.[9] Aseri et al. operated on 32 cases and got excellent outcome in 16(50%), good in 13(40.6%)m and fair in while 3(9.4%) cases.[1] Jahan et al. in 2017 observed excellent outcomes in 15 cases, while fair outcome was found in 4 cases.[21] The current results were comparable with these outcomes.

Reddy SR operated on 20 patients with hybrid external

fixation and got excellent outcomes in 3(15%) patients, good in 8(40%), fair in 8(40%), and poor outcome in 1(5%) patient.[21]

Ramos et al.[22] had 19 patients with combined column proximal tibial fracture treated by Ilizarov fixator. ROM at the knee joint was good (0-120 degrees). Kataria et al. concluded that 84% of the patients had good to excellent outcomes in terms of knee function.[23] El Barbary et al. reported similar results.[24]

Aseri MK. treated 23 patients with hybrid external fixation, and used Rasmussen's functional and radiological criteria for outcome assessment. There were 13(40.6%) patients with excellent radiological outcome, which is comparable to the results regarding union outcome.[1]

Jahan et al. used hybrid external fixation for managing complex proximal tibial fractures. Union was achieved in all cases till the 18th week post-operatively.[20] However, in the current study, at the 16th and 24th week, 50.4% of patients had good and 41.6% had excellent union, which is comparable to earlier findings.[21]

There are many advantages of external fixation techniques, like no stiffness at the knee joint with early and increased ROM, decreased hospital stay, and less financial burden. Also, fracture union time was found to be equal with internal and external fixation techniques.[25] It has been noted that external fixation has no extra advantage in terms of speedy fracture union when compared with internal fixation,[26] which was also found in the current study.

Boutefnouchet et al. stated in a 2015 meta-analysis that there was no conclusive proof that the hybrid external fixator technique was superior to alternative fixation procedures in terms of the functional outcome of the knee joint. The rates of complications were likewise comparable.[27]

Despite difficulties, a growing body of evidence suggests that ring external fixators for compound proximal tibial fractures have advantages over the traditional ORIF, including benefits of the union, lower rates of post-operative bone infection, and fewer soft tissue complications. The Ilizarov procedure has its own set of risks, the most prevalent of which are pin-site discomfort and infection. The patient should be compliant enough to take active care of the hybrid fixator construct so that one can reduce the incidence of the above-mentioned complications. A hybrid external fixator can be used as a definitive treatment modality for compound proximal tibial fractures if the surgeon knows well the basic principles of the hybrid fixator technique. Hence, the adverse complications related to this type of fracture can be reduced.[28]

The current study has limitations of short follow-up and having a single group treated with a hybrid external fixator with no comparison group having an internal fixation with plating in three-column fractures of the proximal tibia. Additional parameters of implant removal and patient satisfaction, joint collapse, displacement of fragments, metaphyseal angulation, and fragment tilt were also not evaluated. Future studies need to do away with such limitations to validate the current findings.

Conclusion

Good to excellent outcomes in terms of functional knee score and union with the use of a hybrid external fixator for treating patients with combined column tibial plateau fracture were observed with low complications.

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Author Contribution:

MA: Idea, data acquisition, interpretation and help in writing
SFHSG: Writing, acquisition and interpretation
IMD: Data analysis, acquisition, interpretation