HIGH ENERGY TIBIAL CONDYLAR FRACTURES TREATED BY HYBRID FIXATOR - A CLINICAL STUDY

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ABSTRACT
The high energy tibial condylar fractures are difficult to treat because of comminution and injury to soft tissue envelop. With the advent of external fixators, fractures with overlying soft tissue compromise were amicable to surgical treatment. Hybrid External Fixator seemed suitable for such fractures as they combine the advantages of monolateral and circular fixators. Tensioned k-wires provide improved fixation in the cancellous metaphyseal periarticular fragments & threaded half pins gave good purchase in the cortical bone of the shaft. It allows early mobilization of the knee joint and also early weight bearing. Forty three consecutive patients with high energy proximal tibial condylar fractures with comminution were treated with hybrid fixator from June 2009 to June 2012 in our institution out of which two were lost to follow-up remaining forty-one were followed up for a minimum period of 12 months. 41 fractures were assessed for bony union, range of motion of knee and associated complications of the treatment. Out of 41 fractures studied, 39 united at an average period of 15.5 weeks. Two (type 3B) fractures resulted in non-union (treated with bone grafting and plate fixation). 8 patients developed superficial pin tract infections which resolved with regular dressings and oral antibiotics. 3 patients had stiffness of the knee joint which was corrected partially by aggressive physiotherapy. 3 developed angular deformity (2 varus angulation of <15°and one valgus of 20°). Results according to the IOWA score showed excellent outcome in 6 patients (15.3%), good outcome in 28 patients (71.7%) & fair in 5 patient (13%). Hybrid external fixator is very useful in the management of high energy tibial condylar fractures. It can be rapidly applied, is minimally invasive, least blood loss and adjustable to correct alignment post operatively. Allows soft tissue care and early weight bearing and early joint mobilization. It has negligible complications and resulted in good outcome for this type of injuries.

KEY WORDS: High Energy Trauma, Proximal Tibia, Condylar Fractures, Hybrid External Fixator.
INTRODUCTION
High energy tibialcondylar fractures present with a wide spectrum of soft tissue and bony injury patterns which are difficult to treat. For patients treated operatively the residual disabilities are not only attributable to the severity of the injury, but also to the complications and side effects of the operative intervention. As these fractures are caused by high-energy mechanisms, a careful evaluation of the entire patient must be done before the tibial injury is addressed. Open fractures, fractures accompanying a compartment syndrome and fractures associated with vascular compromise usually require immediate intervention\(^{1-12}\). Conservative treatment by traction, bracing & cast application rarely permits accurate reconstruction and reduction of the fracture, is not practical in presence of compromised soft tissue & it leads to joint stiffness due to prolonged immobilization, & also affects the quality of life of patient\(^{13-16}\).

Biomechanically proven best stabilization option is dual plating but it requires extensive soft tissue dissection with a potential high rate of post-operative complications particularly when single midline incision was used for dual plating\(^{17-18}\). Open reduction and plate fixation in the presence of soft tissue compromise (from the primary injury) and extensive surgical dissection leads to high rate of complications as infection and skin necrosis & loss of the limb function\(^{19-20}\).

Introduction of the external fixator was a revolution in the management of fractures with soft tissue injury. It has undergone sea of change from a simple frame to a more complex frame and various pin arrangements\(^{17,21-25}\). The Hybrid External Fixator combines the advantages of the monolateral pin fixators and the circular Illizarov wire fixators. It has been shown that the stability of construct is comparable to any other fixator. The tensioned wires provide improved fixation in the small cancellous fragment, whereas the threaded half pins give adequate stability to the diaphyseal fragment\(^{2}\). It provides a ligamentotaxis reduction force & maintains this reduction as a neutralization device. It is simple, minimally invasive, has a rapid and straight forward application technique. No devascularization of the osseousfragments, reduced surgical time and least blood loss. Ability to correct deformity in multiple planes, frame assembly is adjustable even in post - op period. Along with stable fixation, it allows immediate mobilization of the joints and early weight bearing and it is patient compliant\(^{14}\).
Material & Methods
We conducted a prospective clinical study in which 43 patients with high-energy proximal tibial condylar fracture with soft tissue injury were treated using hybrid fixator from June 2009 to June 2012 in our institution. Patients who presented to our hospital emergency department were identified by the attending orthopaedic surgeon. The patients were then screened for suitability, and, if they met study criteria, they were approached for enrolment in the study group and informed consent was obtained for study participation.

Inclusion criteria
Patients who had a high-energy proximal tibial fracture with compromised soft tissue envelop (contusion, deep abrasive wound, blisters over skin, compound fractures).

Exclusion Criteria
Patients were excluded if they had a vascular injury, compound fractures requiring extensive flap/ free tissue cover or joint spanning fixator, fractures with impending compartment syndrome requiring faciotomy, pathological fracture, delayed presentation (more than two weeks), cancer, renal failure, hemophilia, or a medical contraindication for surgery, skeletally immature (children), head injury and fractures which can be managed by open/ closed reduction and plating.

Surgical technique
Patients were evaluated and clearance for surgery was obtained from physician and anaesthetist. All the surgeries were done within 48 hour after admission.
Preoperative planning started with help of radiographs; standard AP & LATERAL views along with medial & lateral oblique views were also done when required. CT scan was used for planning surgery in patients with joint depression and coronal split fracture cases. Tibial plateau fractures were classified according to Schatzker$^7$ and Orthopaedic Trauma Association [OTA].
All the patients were administered prophylactic antibiotic before surgery .most of the patients were operated under spinal anaesthesia, with or without tourniquet control & always under image-intensifier assistance.
Compound fractures were treated with immediate debridement followed by immediate hybrid fixation. Redebridement was done with in 48 hr after index surgery if gross contamination was noted at index surgery cultures were routinely done and IV antibiotics were continued for two weeks if culture yielded growth. fixator assembly was planned according to soft tissue cover plan with help of plastic surgeon in cases with extensive soft tissue loss.
Our technique of metaphyseal reduction relied heavily on the principles of ligamentotaxis with manual traction or fracture table, fractures were reduced closed. Limited open reduction of the impacted, depressed, comminuted articular fragments was done with fluoroscopic guidance with percutaneously inserted elevators or reduction forceps to re-establish congruent articular surfaces.

Reduction was followed by the provisional fixation with k wire insertion followed by percutaneous lag screws to stabilize the articular fragments. Close-reduction of the major condylar components is achieved by the use of large, percutaneously placed reduction forceps.

After reduction of the condyles, lag screws are used to achieve interfragmentary compression of the condylar articular surface when needed otherwise plain k-wires (1.8 mm) were used. The wires were applied so as to cross the major fracture lines perpendicularly keeping neuro-vascular anatomy in consideration. Care was taken to avoid the proximal tibialcapsular reflection (> 1.5 cm distal to the articular surface). No bone grafts were used at index surgery.

Following articular reduction, the proximal ring is placed at the level of the fibular head, and the wires are attached and tensioned to the proximal ring. The half pins were placed percutaneously through healthy skin keeping in mind soft tissue coverage options. The distal aspect of the frame is attached to the bone using 5-mm half-pins (minimum three). The proximal ring was connected to half pins with fully adjustable components to allow for the appropriate correction and alignment of the overall mechanical axis. Finally fracture reduction, articular congruity was checked under image intensifier.

Postoperative Management: Partial weight-bearing was allowed second / third postoperatively day as tolerated by patient, early knee mobilization & quadriceps strengthening exercises were started. Full weight bearing was allowed after three weeks.

RESULTS
The mean patients’ age at the time of injury was 39.4 years (range 21-64 years). The average duration of hospitalization was 12 days (range 8–42 days). 39 Of 41 fractures united in the fixator at an average time of 15.5 weeks (range 12–20 weeks). Bridging callus in minimum three cortex and clinical impression of stability determined the union. The external fixation system was tolerated for the entire treatment period by all patients. There were no septic arthritis / no vascular injury or systemic complications attributable to our surgical treatments. Two fractures(2 out of 39, 5%) which failed to unite by 20 week were treated with fixator.
removal and after delay of four weeks with plating and bone grafting. Both the fractures eventually united at end of 32 weeks from time of injury. In our series 8 cases (19.5%) had superficial pin tract infection (limited to the soft tissue and did not extend to the bone). which was treated with regular dressing and oral antibiotics. 3 fractures (7%) resulted in malunion (one patient 20° of valgus, two patients varus 15°), all the three patients deferred further treatment for angulation. Of the 27 compound fractures, soft tissue wounds healed with dressing in 8 patients, 12 required SSG, 7 were managed with local adepo-cutaneous flaps & SSG. Two type 3 B open fracture which didn’t unite in fixator were treated with plating and bone grafting after four weeks from fixator removal. At the one year follow-up from fracture union and implant removal, range of motion averaged 110° of flexion (range 80° to 110°) and 10° extension lag was noted in 6 patients(14.6%). residual joint stiffness 3 patients (knee flexion 80° with extensor lag 10°). no chronic osteomyelities. No amputation was performed. At the end of 12 months results were evaluated using IOWA KNEE SCORE. we had excellent outcome in 6 patients (15.3%), good outcome in 28 patients (71.7%) & fair in 5 patient (12.8%).

Fig 1. compromised soft tissue upper third leg.

IFig 2. pre-op AP view.
DISCUSSION

Treatment of proximal tibial fractures with soft tissue injury is a challenge. High energy trauma resulting in intraarticular extension, comminution and soft tissue compromise are the cause of poor results in these fractures. Many treatment methods have been advised for these periarticular fractures. No single technique can addresses all problems at the same time in all fractures\textsuperscript{1-4}. 

Fig 3. Pre-op Lateral view.

Fig 4. Post-op views.

Fig 5. After union.
Anatomic reduction, restoration of articular congruity, proper alignment of the limb and stable fixation so as to initiate early joint mobilization are the goals of operative of these fractures. Dual-plate osteosynthesis is fraught with devastating complications as fixation failure, infection, soft tissue complication, malunion and nonunion if surgery is done before complete soft tissue envelop recovery\textsuperscript{11,17,25,26}. Hence different methods were advised like limited open reduction, percutaneous screw fixation, indirect reduction and hybrid / Ilizarov fixator fixation\textsuperscript{27-28}. In an attempt to achieve both stable fixation and preserving soft tissue we have chosen indirect reduction and external fixation in the treatment of these difficult fractures.

The principles of biological osteosynthesis and minimally invasive surgery is established science today with the development of simple hybrid fixator for these fractures which are capable of axial, lateral compression and dynamisation. The hybrid fixator can be rapidly applied, is minimally invasive, least blood loss and allows alignment to be corrected post operatively if needed. It also allows soft tissue care and early weight bearing and early joint mobilization\textsuperscript{4,29}. In our study we have used hybrid fixator as a definitive treatment for proximal tibial fractures with soft tissue compromise. We have used minimal open reduction and lag screw fixation when ever needed. Most of the articular reduction and lag screw fixations were done under image intensifier control.

Mahadeva et al in their study concluded that hybrid fixator has advantages in terms of soft tissue protection but benefit over internal fixation in accuracy of reduction is modest. with use of image intensifier and percutaneous techniques accuracy of reduction has been in improved in recent publications\textsuperscript{30}.

Barberi et al\textsuperscript{31} in their series of 34 tibial-intraarticular fractures treated with hybrid fixation had acceptable result in 28 pts and poor results in 6. In our series of 39 cases we had 6 excellent, 28 good and 5 fair results in concurrence with published reports.

Tornett et al\textsuperscript{32} and Barberi et al\textsuperscript{31} reported that union was achieved by 4.2 and 4 months respectively. In our series 39 out of 41 unite at an average of 15.5 wk from the time of index surgery. These fractures took more time to unite because of compromised soft tissue cover and comminution no bone grafting was done. The two cases of non-union were type 3 b compound fractures which needed local flap cover. Failure to unite was due to extensive soft tissue injury.
Bone grafting was done only for the remaining two fractures at the time of ORIF with plate fixation at 24 weeks from time of index surgery.

Coval et al. treated 32 bicortylartibial plateau fractures and reported 42% deep infection in their series when treated with internal fixation. Huston et al. in a meta-analysis of 16 studies with a total of 568 patients found pin tract infection in 9.1% cases. In our series we had 17% of pin tract infection (seven cases) had superficial pin tract infection which subsided with pin care dressing, antibiotics and replacement of pins in three patients. Deep seated infection was less in our series because of through debridement at index surgery and secondary debridement with in 48 hrs when soft tissue contamination was suspected. iv antibiotics were used for minimum of two week in case of culture yielding growth at second debridement.

Valgus malunion was seen in one case. Which was due to early full weight bearing by patient as well as loss of bony stability at fracture site. Patient refused further treatment as none of his activity was restricted by 20degree of malunion. Stiffness of knee joint was seen in 3 case. Range of movement in these cases was from 10 degree short of extension to further flexion up-to 80 degree only. Range of flexion in remaining 33 cases was from full extension to 120 deg flexion (average of 100 degree). Shortening upto 1.5 cm was noted in 12 cases. Two cases had 2 and 2.5 cm shortening which was managed by shoe rise. total of 14 case had shortening which was due to metaphysical comminution and compression at the metaphyseodiaphseal junction to encourage union and stability at index surgery.

CONCLUSION

High-energy proximal tibia fractures represent serious injuries which may end with substantial residual disability of the limb and general health. The degree of soft tissue injury associated with tibial plateau fracture is an important determinant for both the choice of treatment modality and the prediction of treatment outcome. We believe that the use of hybrid external fixation, is a very useful method of definite treatment for high-energy proximal tibia fractures which consistently yields good results. Hybrid fixator in treating limb-threatening injuries provides good osseous stabilization, minimally invasive, provides greater preservation of soft tissue & allows continuous access to the soft tissue management. It is easily adjustable post operatively also to achieve limb alignment .early mobilization of the joints prevent joint stiffness in immediate post –op period & early weight bearing enhances the rate of union of these complex fractures. good-to-excellent range of motion can also be achieved.
The disadvantage of the decreased accuracy of reduction of the articular surface compared with that obtained during open reduction is overcome by use of image intensifier and percutaneous reduction techniques. Dreaded complications as wound problems and septic arthritis are avoided. We conclude hybrid fixation is very useful tool that should be considered for treatment of high energy complex proximal tibial injury with soft tissue compromise.

Limitations of our study:

Long follow-up is needed to assess on set of early-osteoarthritis in these cases. No attempt was made preoperatively to assess ligament stability in our cases. Postoperatively MRI evaluation couldn’t be done because of implants.

REFERENCES


