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Functional outcome of hybrid external fixator in proximal tibial fractures Schatzker type V and VI with impending compartment syndrome

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Abstract
Purpose: To study the functional outcome of Hybrid external fixator in Proximal Tibial Fractures Schatzker type 5 and 6 with impending compartment syndrome.
Methods:
Prospective Interventional Study: A total of 18 patients with Proximal Tibial fractures Schatzker type 5 and 6 with impending compartment syndrome were included in our study. Out of 18 patients, 8 had Proximal tibial fracture Schatzker type 5 and 10 had type 6. Patients were followed up weekly for first month and monthly for 6 months with both clinical examination and imaging. Clinical outcomes were evaluated using Neer's rating system for evaluation of knee.
Results: The results - bony union, range of movements, and associated complications were assessed. All fractures united in an average time period of 20 weeks. Excellent outcome was noted in 44%, Good in 33%, fair in 11% and failure in 11% cases. 90% of patients had clinical and radiological union in 20 weeks.
Conclusion: Hybrid external fixation is a reliable fracture fixation method that leads to satisfactory functional outcomes, while reducing the infection rate and wound dehiscence, allowing arthroplasty to be performed in the future if needed.

Keywords: Proximal tibial fractures schatzker type 5 and 6, hybrid external fixator, impending compartment syndrome

Introduction
The treatment of proximal tibial fractures or intra articular fractures are often challenging. Many surgeons encounter problems with wound healing even in closed tibial fractures because of coexisting soft tissue injuries. External fixation of these fractures has yielded satisfactory results, but some studies have reported problems in the achievement and maintenance of fracture reduction [1].
Bicondylar tibial plateau fractures (Schatzker types V and VI/Orthopaedic Trauma Association types C1, C2, and C3) typically follow high-energy trauma [2, 3]. They are complex intra-articular injuries with implications for articular congruity, cartilage integrity and extra-articular structures (4). Associated complications include compartment syndrome, soft tissue damage, secondary osteoarthrosis (OA), and persistent knee instability. Conservative treatment is rarely appropriate for these injuries [5].
External fixation is useful in trauma management, from damage control to definitive management. Although external fixation requires more careful clinical and radiographic monitoring than internal fixation, the general principles of application and management are relatively straight forward and its versatility allows its use in wide variety of fractures [6].
Hybrid external fixation is a type of non-spanning external fixator in which fracture reduction is enhanced using thin wires with or without olives to restore the articular surface and maintain bony stability. It is especially useful when internal fixation of any kind is contraindicated [7].
The Hybrid External Fixator system includes Ilizarov ring fixator and AO rod external fixator connected with indigenously manufactured connecting clamps and short shafts augmented with or without minimal internal fixation [8].

Hybrid External Fixator presents with mechanical characteristics that differs from other systems of external fixator. The mechanical characteristics of hybrid external fixator system can be called as Solid Elastic. It is solid enough for stabilization and providing micromotion which enhances good callus formation [9].

With this background, our main aim is to evaluate the functional outcome of Hybrid external fixation in proximal tibial fractures Schatzker type 5 and 6 with impending compartment syndrome.

Objectives

1. To study the functional outcome of Hybrid external fixator in Proximal Tibial Fractures Schatzker type 5 and 6 with impending compartment syndrome.
2. To evaluate the effectiveness and complications of Hybrid external fixation of proximal Tibial Fractures Schatzker type 5 and 6 with impending compartment syndrome.

Materials and Methods

Sources of data

This a prospective interventional study of 18 patients with proximal tibial Fractures Schatzker type 5 and 6 with impending compartment syndrome treated with hybrid external fixator at VIMS, Ballari between January 2021 and June 2022.

Inclusion Criteria

All patients with proximal tibial fractures Schatzker type V Aand VI with impending compartment syndrome

Exclusion Criteria

1. Children and adolescent patient < 18 years
2. Pathological fractures
3. Fractures associated with neurovascular injury
4. Patients not fit for surgery
5. Functional Assessment Evaluation:

The final outcome is evaluated using Neer's Scoring system of evaluation of knee.

This is system has a maximum score of 20, of which pain is the most important consideration to the patient and presence of any significant pain is considered as failure.

Surgical Technique

- Anaesthesia – Surgery performed under spinal/ epidural anaesthesia
- Position of the patient – Supine with affected limb on traction table
- Surgical site was scrubbed, painted with povidone iodine solution and draped appropriately
- 1.8 mm/2 mm k wires introduced in the safe zone of proximal tibia, 15 mm from the joint line, minimum angle between the two wires is 60 degrees. Placement of wires planned preoperatively according to fracture planes.
- Interfragmentary compression achieved using olive wires perpendicular to the fracture plane. If needed lag screws used to hold reduction. For articular surface reduction a distractor or pointed reduction forceps used.

Insertion of wire

- Stab incision made and blunt dissection done down to the bone.
- Protection sleeves inserted until it reaches the bone. Under image intensification, wires passed parallel to the knee joint until it penetrates the far cortex without impaling the tendons or neurovascular structures. Wires tensioned.
- Schanz pins inserted in the shaft
- Schanz pins connected to external fixator rod, which was then coupled to the ring using the external fixator clamp after the correction of meta- diaphyseal alignment
- Fasciotomy was done in cases with clinical suspicion of compartment syndrome and subsequently delayed closure of fasciotomy wound was attempted using shoelace technique or by split skin grafting

Post-operative Management

For all the patients IV Cephalosporins BD for 3-5 days was administered. Post-operative pain and inflammation was managed with NSAIDs, IM Diclofenac sodium 75mg BD for 3 days. Patient was advised for active knee and ankle movements. Check X-ray was taken on 1st post- operative day and pin tract dressing done on 2nd postoperative day. Patient was discharged with above knee slab on 3rd day with oral antibiotics and oral analgesics. Patient was advised for suture removal on the 14th postoperative day (if any sutures put).

Above knee slab continued for 2 weeks and then slab was removed.

At fourth week of follow up detailed clinical examination was done and the patient was assessed for symptoms like pain, restriction of joint movements, tenderness, nutrition and power of Thigh and leg muscles. Check X-ray was taken for radiological assessment of the fracture. Patient was advised for active assisted exercises at home like flexion and extension without loading.

Once radiographic evidence of callus was noted, Patient was advised for guarded weight bearing.

Fig 1: Positioning of the patient

Fig 2: K wire insertion technique

Fig 3: Case 1: 60 year old female patient with Schatzker type 6 proximal tibial fracture of right side with impending compartment syndrome

Fig 4: Pre operative radiographs of Case 1

Fig 5: Immediate post operative radiographs of Case 1

Fig 6: Case 1 at 6 months follow up

Fig 7: Case 1 at 9 months follow up

Fig 8: Case 2: 45 year old male with Schatzker type 6 proximal tibial fracture of left side; Pre operative radiographs

Fig 9: Case 2 Immediate post operative radiographs and clinical photograph

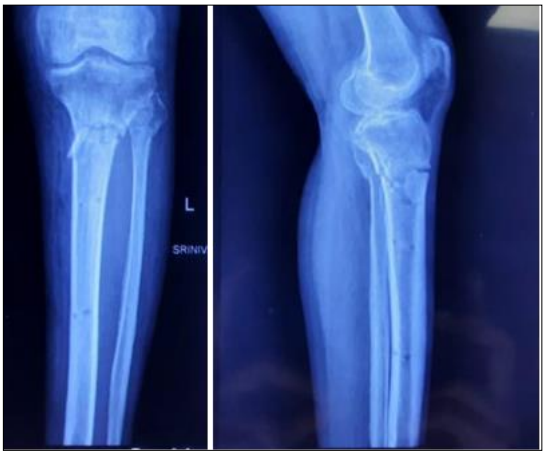


Fig 10: Case 2 at 6 months follow up

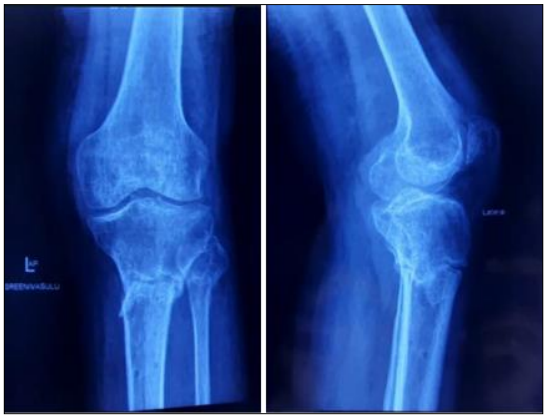


Fig 10.1: Case 2 at 9 months follow up

Fig 11: Case 2 range of motion after Ex fix Removal at 9 months follow up

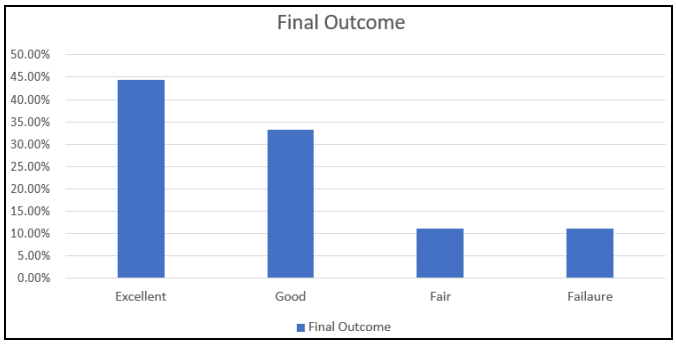
Fig 12: Fasciotomy wound of Case 3: 40 year old male with Schatzker type 6 proximal tibial fracture of right side

Fig 13: Fasciotomy wound closure with Shoe lace technique of Case 3

Fig 14: Final wound of Case 3

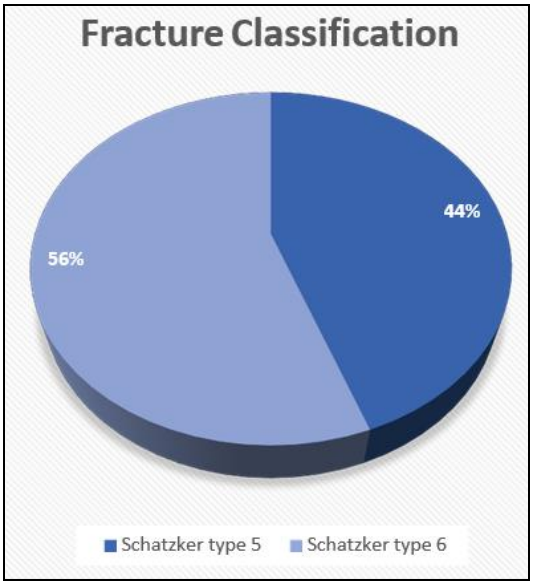
Results

A total of 18 patients, 8 with Schatzker type 5 and 10 with Schatzker type 6 were studied. Data obtained was analysed and final results and observations were interpreted as below.



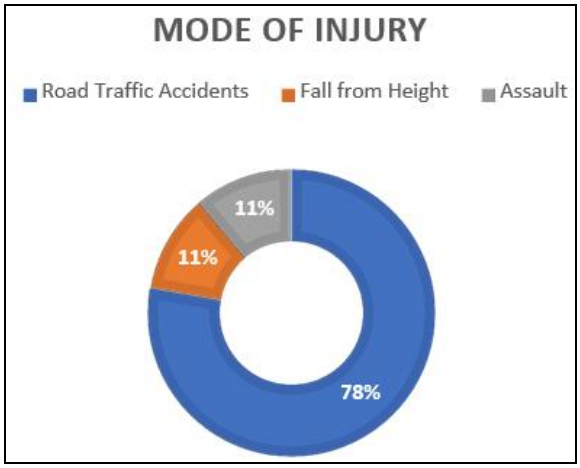
Based on type of fracture, 8 patients had Schatzker type 5, and 10 patients had Schatzker type 6. Their average Neer score was as follows.

Schatzker's type	No. of cases	Average Neer's rating score
5	8	17.4
6	10	16



Road traffic accidents were the predominant cause for Tibial fractures (78%), Fall from height (11%), and physical assaults (11%).

Mode of injury	No. of cases	Percentage
RTA	14	77.78
Fall from height	2	11.11
Assault	2	11.11



Following complications were noted; 2 patients had pin track infection, 1 patient had malunion and 1 patient had knee stiffness.

Complications	No. of cases
Pin track infection	2
Malunion	1
Knee stiffness	1

Discussion

Although ORIF is often successful in restoring articular congruity, it may further compromise the soft tissue envelope. Many case series have highlighted the dangers of wound breakdown and deep infection following ORIF of bicondylar tibial plateau fractures [11, 13, 20]. These problems have persisted, even in modern studies utilizing techniques such as delayed surgery and minimal soft tissue dissection. For example, Baeri *et al*. reported deep infections in seven (8.4 %) of 83 patients treated with ORIF, each of whom required a mean 3.3 additional operations as a consequence [21]. External fixation devices preserve soft tissues and an emerging body of evidence suggests they can achieve lower rates of deep infection [22, 23, 24]. Although external fixation might risk sacrificing the quality of fracture reduction, it is uncertain whether this ultimately affects functional outcome [25, 26, 27, 28].

The choice of the safest surgical option can be very challenging. Open reduction and internal fixation (ORIF) using medial and lateral plating or double plating first proposed as a possible treatment in 1969 [10]. The results of ORIF were variable, especially for comminuted articular or open fractures. The complications included infection (ranging from 50% to 87.5% of all reported cases), post-traumatic osteoarthritis, skin complications and tibial axial deviation [14, 15]. This can be related to the need for extensive surgical exposures, damaging periosteal vascularisation and resulting in an unacceptable rate of wound dehiscence, deep bone infection and delayed bone healing. External circular fixation has been reported to contribute to decreasing the risk of infection in BTPF lesions. Soft-tissue-related complications are also rare when combining minimally-invasive plating with external fixation [10, 12].

The development of circular and hybrid frames, the capability of axial, lateral compression and dynamization, the development of olive wires have offered new possibilities to the external fixators for the treatment of complex fractures [16]. Gaudinez *et al*. treated 18 type V and type VI fractures using a hybrid frame, recommended this technique because of low incidence of soft tissue complications and early knee range of motion. He recommended this technique for treatment of these difficult fractures [17]. Chin *et al*. presented 38.9% good/excellent, and 61.1% fair/poor results in his type V and VI fracture series [18]. Catagni *et al*. in their series of high-energy Schatzker V and VI tibial plateau fractures treated with circular external fixator, reported excellent and good results in 30 (50.85%) and 27 (45.76%) patients respectively [19]. Our study had an overall 78% acceptable outcome which is comparable to other studies.

In its high energy Schatzker V and VI series of tibial plateau fractures treated with circular external fixators Catagni *et al*. recorded good and excellent results for 30 patients (50.85%) and 27 (45.766%) respectively [29]. Chin *et al*. showed 38.9% good and excellent and 61.1% fair and bad results for its type V and VI fractures series [30].

Out of 18 cases in our studies, 6 patients presented with signs and symptoms of compartment syndrome such as rest pain, pain out of proportion to injury and required urgent fasciotomy and emergency fracture fixation with hybrid external fixator. 12 patients were managed conservatively and underwent closed reduction external fixation with hybrid external fixator [31].

Delayed closure of fasciotomy wound was done using split skin grafting or shoelace technique.

In our study, 44% of the patients showed excellent results and 34% showed good outcomes following treatment with hybrid external fixator which are similar to the results of other studies. A 11% failure rate was observed in this study. The most important wound complication associated with the procedure was pin tract infection followed by knee stiffness and wound infection. This minimally invasive approach can be utilized wherever possible, that prevents soft tissue damage, thereby avoiding wound healing issues. Early aggressive rehabilitation can help to regain the full range of movements. Further studies to ensure optimal functional recovery and patient satisfaction are needed.

Our study, had a small sample size and no compartment

pressure measurement was undertaken for diagnosis or monitoring of compartment syndrome. The diagnosis of compartment syndrome was made on the basis of clinical history and examination. Further studies need to be done with a larger sample size and prompt and adequate compartment pressure measurement and monitoring and results in terms of functional outcome need to be analysed.

Conclusion

Fracture fixation using a hybrid fixator is a reliable method for treating Schatzker V and VI proximal tibia fractures. Despite the high rate of imperfect reduction and secondary displacement, it leads to satisfactory functional outcomes in 78% patient and has a low rate of major complications.

We believe Hybrid Ex Fix is a appropriate and can be a definitive treatment of proximal tibial plateau fractures Schatzker type 5 and Type 6, especially is patients with impending compartment syndrome and poor soft tissue envelope.

Furthermore, this technique allows for revision by Total knee Arthroplasty at a future date in the event of unacceptable or poor patient outcome.

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Conflict of Interest: None

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