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PROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF PROXIMAL TIBIAL PLATEAU FRACTURE AND MANAGE WITH HYBRID EXTERNAL FIXATION

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ABSTRACT

Background: Proximal tibial plateau fractures are complex intra-articular injuries that affect the weight-bearing surface of the knee joint. These fractures commonly result from high-energy trauma in younger individuals and low-energy falls in elderly patients with osteoporosis. The management of tibial plateau fractures is challenging due to associated soft tissue injury, fracture comminution, and the need to restore joint congruity and stability. Hybrid external fixation has emerged as an effective treatment modality, particularly in fractures with severe soft tissue compromise, as it provides stable fixation while minimizing additional soft tissue damage. **Aim of the study:** This study aim is evaluate the function of hybrid external fixatorin treating high-energy tibia plateau fractures with minimal invasion and tissue damage.

Objectives

1. To assess the performance of the Hybrid External Fixator in the treatment of tibial plateau fractures (Schatzker type V & VI).
2. To evaluate the functional outcome, soft tissue healing and fracture union and radiological outcome.
3. To evaluate the biomechanical and biological advantage of hybridexternal fixator.

Materials and Methods: This a prospective study conducted from October 2019 to March 2021.Thirty patients with schatzker type-5 and type-6 with high energy tibial plateau fractures admitted in Narayana Medical College and Hospital,Nellore, were included in the study after their valid informed written consent. Approval of the Ethical Committee was obtained before the commencement of the study.Patients meeting the inclusion criteria were enrolled and followed up at regular intervals. Fractures were classified according to the Schatzker classification system. Clinical and radiological assessments were performed to evaluate fracture healing and alignment. Functional outcomes were assessed using the Rasmussen Functional Score and/or other validated knee scoring systems. Complications such as pin tract infection, malunion, nonunion, knee stiffness, and post-traumatic osteoarthritis were documented.

Results: Hybrid external fixation provided satisfactory fracture stabilization and facilitated early mobilization in most patients. Fracture union was achieved in the majority of cases within an acceptable time frame. Functional assessment demonstrated good to excellent outcomes in a significant proportion of patients, with satisfactory knee range of motion and restoration of function. Complications were generally minor and manageable, with pin tract infection being the most commonly observed complication.. The difficulties are mainly related to sepsis, either superficial pin track infection or deep infection, preventable, treatable, and curable. We feel that the technique

merits a place in the armamentarium for managing complex, high-energy tibial plateau fractures.

Conclusion: Hybrid external fixation is an effective treatment option for proximal tibial plateau fractures, especially in cases associated with severe soft tissue injury. It provides stable fixation, promotes fracture healing, allows early knee mobilization, and yields favorable functional outcomes with a relatively low complication rate. Careful patient selection, proper surgical technique, and structured rehabilitation are essential for achieving optimal results.

Keywords: Proximal tibial plateau fracture, Hybrid external fixation, Functional outcome, Rasmussen score, Schatzker classification, Knee function, Fracture union.

INTRODUCTION

Proximal tibial plateau fractures are complex intra-articular injuries involving the weight-bearing surface of the knee joint. These fractures account for approximately 1% of all fractures and about 8% of fractures in the elderly population. They commonly result from high-energy trauma such as road traffic accidents in younger individuals and low-energy falls in osteoporotic elderly patients. The primary goals of treatment are restoration of articular congruity, maintenance of limb alignment, preservation of knee stability, and early mobilization to achieve optimal functional outcomes.[1,2]

Management of tibial plateau fractures remains challenging because of the associated soft tissue injury, comminution, depression of the articular surface, and potential complications such as infection, malunion, nonunion, knee stiffness, and post-traumatic osteoarthritis. Various treatment modalities have been described, including conservative management, open reduction and internal fixation (ORIF), minimally invasive plate osteosynthesis, circular external fixation, and hybrid external fixation.[4-8]

Hybrid external fixation combines the principles of ring fixation and unilateral external fixation, providing stable fracture fixation while minimizing soft tissue dissection. This technique is particularly advantageous in high-energy fractures with severe soft tissue compromise, open fractures, and fractures associated with extensive swelling where internal fixation may increase the risk of wound complications. Hybrid fixation permits early knee mobilization, maintains fracture alignment, and reduces the incidence of soft tissue-related complications.[9]

Functional outcome following proximal tibial plateau fractures depends on multiple factors, including fracture pattern, adequacy of reduction, stability of fixation, rehabilitation, and associated soft tissue injuries. Assessment of functional outcome is essential to determine the effectiveness of treatment and guide future management strategies. Various scoring systems such as the Rasmussen Functional Score and Knee Society Score have been used to evaluate postoperative outcomes.[5]

Given the increasing incidence of high-velocity trauma and the need for effective management strategies that preserve both fracture stability and soft tissue integrity, hybrid external fixation has emerged as a valuable treatment option. However, limited prospective data are available regarding its functional outcomes in patients with proximal tibial plateau fractures, particularly in the Indian population.

Therefore, the present prospective study aims to evaluate the functional outcome of proximal tibial plateau fractures managed with hybrid external fixation and to assess the effectiveness, complications, and overall clinical results associated with this treatment modality.

Aims and objectives

Aim of the study

This study aim is evaluate the function of hybrid external fixatorin treating high-energy tibia plateau fractures with minimal invasion and tissue damage.

The goals of tibial plateau fractures management are

1. Restoration of joint congruity by anatomical reduction.
2. Stable fixation of fractures thus allowing early movements.
3. Proper care of injured soft tissues.

Objectives of study

1. To assess the performance of the Hybrid External Fixator in the treatment oftibial plateau fractures (Schatzker type V & VI).
2. To evaluate the functional outcome, soft tissue healing and fracture union and radiological outcome.
3. To evaluate the biomechanical and biological advantage of hybridexternal fixator.

MATERIALSANDMETHODS

Methodology

This a prospective study conducted from October 2019 to March 2021.

Thirty patients with schatzker type-5 and type-6 with high energy tibial plateau fractures admitted in Narayana Medical College and Hospital,Nellore, were included in the study after their valid informed written consent. Approval of the Ethical Committee was obtained before the commencement of the study.

Inclusion Criteria

1. Schatzker type-5 and type-6 with proximal extra articular tibial plateau fractures.
2. Open tibial plateau fractures according to Gustillo Anderson classification Grade 1, Grade 2, Grade 3A, 3B, and 3C.
3. Tibial plateau fracture with compartment syndrome.
4. High velocity tibial plateau fractures in impending compartment syndrome.
5. Patients age over 18 years and ability to walk without assistance before injury.

Exclusion Criteria

1. Patients with tibial plateau fractures type 1, type 2, type 3 and type 4.
2. More than 2 weeks old fractures
3. Bilateral tibial plateau fractures.
4. Polytrauma patients with prolonged ICU care.
5. Skeletally immature patients
6. Patients who were medically unfit for surgery, pathological fracture.
7. Patients with poliomyelitis, severe osteoporosis.
8. Associated severe morbid comorbidies.

Before obtaining consent, the benefits and complications of all the available various treatment modalities for tibial plateau fractures were clearly explained to the patients.

PRE OPERATIVE CLINICAL EVALUATION

For better treatment, thorough clinical assessment is essential, which include the evaluation of the soft tissues to determinewhether a compartment syndrome is present and the patient has sustained a neurovascular injury. stress testing can be performed with the leg in extension to evaluate the ligaments' stability and assess any sign of fracture displacement.

HISTORY

After stabilizing the patient's general condition, a thorough history was recorded, including the nature of the injury and mode of injury. Mainly the fractures are caused by the strong force with the leg in varus or valgus or simultaneously vertical stress and knee flexion. These fractures are due to mostly car or motor accidents and sometimes sports accidents mostly sports with a high velocity.

PHYSICAL EXAMINATION

A careful, thorough examination of the affected limb was done, including soft tissue injury, edema, contusion, neurovascular compromise, and compartment syndrome.

Once the patient received closed fractures, the limb was well elevated to reduce the soft tissue edema and prevent compartment syndrome. Ice fomentation started.

The skin condition should be carefully analysed examined for contusion, any discoloration, blisters.

Compartment syndrome symptoms like severe intense pain more than what would be expected from that injury itself, stretching pain, muscle tightness should be monitored carefully.

RADIOLOGICAL EVALUATION & GRADING

Careful radiological assessment was carried out regarding fracture pattern(simple, omminuted, intraarticular involvement) and any loose fragments presentedinside the joint. If any loose fragment was presented inside the joint it was evaluated thoroughly by CT scan. Radiologically the tibial plateau fractures were classified according to Schatzkar types and open fractures by Gustilo Anderson classification. Undisplaced articular fragments were reduced with plain wires and displaced articular fragments were reduced with mini open method.

PRE OPERATIVE PLANNING

Goals of treatmentof tibial plateau fractures include restoration of articular congruity, axial alignment, joint stability and functional motion.

Fixation must be stable enough to allow early motion & minimize the wound complications.

X-ray of the tibia with knee joint and ankle joint (AP & LATERAL view) was assessed thoroughly and graded according to the fracture classification. Simple femoral distractor can be used for condyles reduction. The displaced articular fragments were planned for reduction accordingly. Plan and determine proper wire and shanz screw placement or if necessary plan for mini internal fixation with cannulated cancellous screws. Frame construction and 5/8thring with AO rods were planned.

SURGICALTECHNIQUE

Reduce the articular surface initially. Ligamentotaxis if needed can beused with femoral distractor. Articular congruity is achieved by elevating the depressed fracture fragments percutaneously under fluoroscopic control. If the articular fragments are displaced grossly reduce with K wire and fix it with 6.5mm cannulated cancellous screw swhich will provide inter fragmentary compression for the articular fragments.

WIREPLACEMENT

Wire Insertion

Determine the wire position. Minimum of 2or3 wires are needed. Position the wires in the safe zone. Wire should be inserted 14 mm distal to the tibial plateau so that the capsule will not be pierced by wires. We can avoid the secondary pin tract infection and septic arthritis by placing the wires in metaphysic distal to the capsule.

Position the wire distal to the cannulatedcancellous screws or ifpossiblehrough the screw.

Direction of Wires

1. Fibular head to tibia from lateral to medial
2. Anterolateral to posteromedial direction
3. If possible 3rd wire from posterolateral to anteromedial direction.

Each wire should be placed 30–50 degrees wide apart as possible. Olive wires are used to reduce and compress the fragments.

Make a stab incision and insert a protection sleeve. Manually push the wire through the sleeve until it contacts the bone. Drill the wire through the proximal cortex without changing the direction until it pierce the distal cortex. When the wire has pierced the opposite cortex proceed with gentle blows by the hammer.

Place the bolt on the wires (central or peripheral) Attach clamps to the 5/8thring.

First wrench tighten the wire–locking nut on one side and finger tighten the wire locking nut on the other side.

Tension the wire with the help of wire tensioner.

Wirecan be tensioned from 90– 120 kg.

The same way apply another 2 wires in the proper position and direction and then tension it.

SHANZ SCREW PLACEMENT

Pin Insertion Technique

When inserting shanz screws it is important to

1. Know the anatomy and avoid nerves, vessels and tendons injuries
2. Do not place pins or screws into a joint.
3. Avoid the fracture focus and haematoma.
4. Predrill the cortex.
5. Insert a shanz screw of the correct length.

Apply 4.5 mm or 5mm shanz screw in the diaphysis of tibia. Ideal placement is mid diaphysis

Apply the first shanz screw in mid diaphysis.

Connect the AO tubular rod to the shanz screw with AO universal clamp which is to be connected to the 5/8th ring with indigenous hybrid connecting clamp. It is the mono axial hybrid connecting clamp.

Another 2 shanz screws are placed proximal to the first shanz screw as wide as apart as possible so that frame stiffness and stability will be increased.

Shanz screws are connected with the tubular rod with the help of AO connecting clamps.

Reduction of the metaphysic to the diaphysis is achieved by indirect reduction technique, using the fixator.

Reduction isconfirmed by C-arm image .

Tighten thehybrid connecting clamp.

Two side rods on either side are connected with 5/8th ring with the help of short shaft proximally, and the same are connected to central rod with tube to tube clamp distally.

The whole frame is finally tightened.

OPERATIVE TECHNIQUE

1.8mm / 2.0mm k wires introduced in the safe zone of the proximal tibia, 15mm from the joint line, the minimum angle between the two wires is 60 degrees. Placement of wires planned preoperatively according to fracture planes. Interfragmentary compression was achieved using olive wires perpendicular to the fracture plane if needed; lag screws were used to hold the reduction and the proximal ring and tensioned wires. One drop pin was used in some cases to increase the stability of the proximal fragment. For articular fracture reduction, a distractor or pointed reduction forceps are used.

Insertion of wire:

Stab incision made and blunt dissection done down to the bone.Protection sleeves are inserted until it reaches the bone. Under image Intensification, wires pass parallel to the knee joint until they penetrate the far cortex without impaling the tendons or neurovascular structures. wires attached to the ring, wires tensioned

Schanz pins were connected to the external fixator rod, which was then coupled to the ring using the external fixator clamp after the correction of meta-diaphyseal alignment.

POST OPERATIVEPROTOCOL

Daily thorough pin track care with immediate passive range of motion started on 1st POD. The patients were encouraged to start controlled knee movement as soon as possible. Patients were discharged from the hospital between 5th POD and 30th POD, depending on their general and wound conditions. Wound management was done with daily dressing, higher antibiotics according to pus culture and sensitivity, wound debridement on a necessary basis, and plastic surgery management for the patients who had a loss of soft tissue.

Static quadriceps strengthening exercises, knee mobilization exercises, seated knee extension exercises, and non-weight-bearing walking with a walker were started on 2nd-3rd POD.

Partial weight-bearing was started from 6 to 10 weeks, depending on the radiographic appearance of the callus.

Weight-bearing walking started from 10 to 16 weeks, depending on the clinical and radiological signs of the union.

DYNAMIZATION

Non weight bearing followed by partial and full weight bearing is the most effective method of dynamization. As the healing progresses, the load is increased until full weight bearing is achieved.

The fixation of the fracture provides relative stability and weight bearing allows adequate dynamization of the fracture zone.

1. Passive and active range of motion exercises in the ankle are started early in 3rd post op day where as in knee joint Range of motion exercises are started at 1st week. Static Quadriceps exercises should be done along with knee joint ROM exercises.
2. In grossly comminuted tibial plateau fracture movements are started at 2nd week.
3. Non weight bearing crutch walking should be continued up to 8 – 12weeks.
4. Partial weight bearing is started at10 weeks post operatively.
5. Full weight bearing is started at14–24 weeks.

Every 4 weeks patient should be followed up for functional, clinical and radiological outcome.

Frame Removal

After strong evidence of adequate callus formation from 16 weeks to 24weeks frame can be loosened under minor OT. The patient is advised to walk after frame loosening. Stability is assessed clinically. After clinical and radiological evidence ofunion

frame can be removed under local or regional anaesthesia. Pin site wound care should be given.

Complications

1. Injuryto common peroneal nerve (immediate)
2. Pin site infection
3. Septic arthritis
4. Frame loosening
5. Varus collapse of knee joint
6. Delayed union
7. Non union

RESULTS

Table1:Sex Distribution

	Frequency	Percent (%)
FEMALE	6	20 %
MALE	24	80 %
TOTAL	30	100 %

Table 8: Side of Injury

	FREQUENCY	PERCENT
LEFT	9	30
RIGHT	21	70
TOTAL	30	100

Table 3: Nature of injury

	FREQUENCY	PERCENT
CLOSED	9	30
OPEN	21	70
TOTAL	30	100

Table 4: Gustilo Anderson

TYPE	FREQUENCY	PERCENT
NIL	9	30
I	9	30
II	6	20
IIIA	3	10
IIIB	3	10
TOTAL	30	100

Schatzker Classification

Table 5: Schatzker Classification

TYPE	FREQUENCY	PERCENT
V	9	30
VI	21	70
TOTAL	20	100

Table 6: Schatzker Classification
Complications

	FREQUENCY	PERCENT
NIL	24	80
KNEE STIFFNESS	3	10
DELAYED UNION	2	6.66
SEPTIC DELAYED UNION	1	3.33
TOTAL	20	100

Table 7: Additional Surgery

	FREQUENCY	PERCENT
NIL	24	80
DYNAMISATION	3	10
SSG	3	10
TOTAL	30	100

Table 8: Additional Surgeryresults

	FREQUENCY	PERCENT
EXCELLENT	15	50
GOOD	9	30
FAIR	4	13.3
POOR	2	6.6
TOTAL	30	100

After analyzing the above characters we have obtained. Excellent results in 15 patients (50%), Good in 9 (30%), Fair in 4 (13.33%), poor in 2 (6.66%)patient.

Patient results are given in master chart. Union was determined by the presence of a bridging callus on the follow up radiographs and by the clinical impression of stability.

All fractures healed, with an average time of treatment with the frame of 18 weeks. The external fixator was tolerated for the entire treatment period in all cases.

Pin track infection occurred in 6 patients. Out of 6 patients one patient got deep infection in knee joint. In 5 patients superficial infection or limited to soft tissues and did not extend to the bone & resolved with pin track care and oral antibiotics. Knee range of motiooccurred from 0 – 120 degree to 10 – 90 degree (Average 0 to 105 degrees).

Table 9: Complications:
In our case series we encountered the following complications

	FREQUENCY	PERCENT
NIL	24	80
KNEE STIFFNESS	3	10
DELAYED UNION	2	6.66
SEPTIC DELAYED UNION	1	3.33
TOTAL	20	100

To summarize, the advantages of hybrid external fixatorare

1. Minimally invasive procedure
2. Very good preservation of soft tissues
3. Better anchorage of tensioned wires than half pins in cancellous bone area and they give better stability.
4. Easy application of half pins in diaphysis without neuro vascular injury.
5. Early mobilization of knee joint.
6. Good skin care and easy application of flap cover.
7. Good acceptance to patient.

The disadvantages of hybrid fixator are

1. Risk of articular infection if pins area pplied very close to joint.
2. Tough to obtain articular reduction.
3. Radio opaquering obstructs radiological image.

EVALUATION OF FUNCTIONAL OUT COME

Functional evaluation of knee is assessed by so many scoring system like WOMAC, The Mean Knee Society Score, Functional Grading Method of Hohland Luck and Neer's Rating System. We followed the Neer's Rating System for evaluation ofKnee.

Table 10. NEER'S Rating System

Pain

No pain in all range of movements	**4**
Pain with normal daily activity	3
Minimal activity causes pain	2
Pain at rest	1

MOVEMENTS (In degrees)

Flexion>110degree	**4**
Flexion90 –110degree	3
Flexion70 – 90degree	2
Flexion<60degree	1

FUNCTION

Full weight bearing, Normal gait	**4**
Limping, no restriction of activity	3
Requires walking aid	2
Cannot walk	1

SHORTENING(cm)

0 - 0.5 cm	4
0.5 – 2.5 cm	3
2.5 – 5 cm	2
>5 cm	1

ANGULATION(Degree)

None	**4**
< 10 degree	3
10 – 15 degree	2
>15 degree	1

OUTCOME

Excellent	**16 – 20**
Good	16-Dec
Fair	8 – 12
Failure	8-Apr

Table 11: Neer's Rating System

Modified rasmussen criteria for clinical assessment

Parameters	**Score**
Pain	
None	6
Occasional	5
Stabbing pain in certain position	3
Constant pain after activity	1
Significant rest pain	-3
Walking Capacity	
Normal Walking Capacity for age	6
Walking outdoor for more than 1 hr	5
Walking outdoor 15 min to 1 hr	3
Walking < 15 min	1
Walking indoor only	0
Wheel chair or Bed ridden	-3
Knee extension	
Normal	4
Lack of extension < 10^0	2
Lack of extension >10^0	0
Lack of extension >20^0	-2
Totalrange of motion	
Full	6
At least 120^0	5
At least 90^0	3
At least 60^0	1
< 60^0	-3
Stability	
Normal stability in extension and 20^0 flexion	6
Abnormal stability in 20^0 flexion	4
Instability in extension <10^0	2
Instability in extension >10^0	0
Power of quadriceps	
Grade 5	2
Grade 3 – 4	1
Grade<3	-2
Maximum score	30
Excellent	28 – 30
Good	24 – 27
Fair	20 – 23
Poor	< 20

Table 16: Modified Rasmussen Criteria for Clinical Assessment.

Table 12. Modified rasmussen criteria for radiological assessment

Parameters	**Score**
Articular depression	
None	3
<5 mm	2
6 – 10 mm	1
>10 mm	0
Condylar widening	
<5 mm	2
6 – 10 mm	1
>10 mm	0
Varus-Valgus angulation	
None	3
<10^0	2
10^0 - 20^0	1
>20^0	0
Osteoarthosis	
None/No progress	1
Progression by 1 grade	0
Progression by >1grade	-1
Maximum score	10
Excellent	9 – 10

Good	7 – 8
Fair	5 – 6
Poor	<5

Table 17: Modified Rasmussen Criteria for Radiological Assessment

Table 13. Case Illustration

CASE I:

NAME	**ELISHA**
AGE	52
SEX	MALE
MODE OF INJURY	RTA
SIDE	LEFT
SCHATZKER TYPE	V
ASSOCIATED INJURY	NIL
TIME INTERVAL BETWEEN INJURY AND SURGERY	Three Days
RADIOLOGICAL UNION	Four months
RANGE OF MOVEMENTS	Full Flexion: 0 - 110 degrees
NEERS FUNCTIONAL OUTCOME SCORE	16
MODIFIED RASMUSSEN CRETERIA RADIOLOGICAL ASSESSMENT SCORE	9
COMPLICATIONS	PIN TRACT INFECTION (SUPER FICIAL)
RESULT	EXCELLENT

DISCUSSION

Schatzker type V and VI tibial plateau fractures are due to high-energy trauma, which is a significant cause of poor results. Primarily those fractures are associated with more soft tissue damage and compartment syndrome.[1-5]

Various methods for treating these complex injuries have been proposed, including limited open reduction and stabilization with percutaneous screws, open reduction and internal fixation,and indirect reduction and application of external fixator, ring fixator, or hybrid external fixator.

Traction, inturns of ligamentotaxis and casting, produces an improperarticular surface reduction, lacks the necessarystability, leads to varus/ valgus deformity, collapsed articular surface, and post immobilization stiffness. Tscherne et al., in a study correlating the results of surgical and conservative groups, reported a good range of motion due to early mobilization, reduced reoperation rate, varus/valgus angulation, and malunion for the operated group.[6]

Open surgical procedures provide significant articular reduction but do not preserve the already damaged soft tissue envelope.leading to skin or muscle necrosis, devascularisation of fracture fragments, thereby creating delayed healing and wound complications with high rates ofinfection. In a series of dual plating for bicondylartibial plateau fractures by Young and Barrack, they reported an 88% of deep infection rate. There was no notable difference between thesetwo groups in a study correlating the lateral and dual plating conducted by Mahadevaet al.[8]

The external fixation is the definitive treatment for the polytrauma patient with multiple skeletal injuries associated with soft tissue compromise. But it often leads to joint stiffness due to delayed mobilization of the knee joint.Some surgeons believed that the use of external fixation should be limited to high-energy tibial plateau fractures. But, from the past twenty years, the development of new external fixator devices and techniques has led many surgeons to use the external fixators to comminutedtibial plateau fractures. The advancement of circular and hybrid frames, the capability of axial, lateral compression, and dynamization, the development of olive wires have led to new ways of managing complex tibial plateau fractures with soft tissue damage.

In an another study conducted by Mahadeva et al,[8] comparing the external and internal fixation by Mahadeva et al., he concluded that hybrid external fixation provides theoretical advantages in soft tissue protection.

In this study, the mean age of the patient at the time of injury was 47.50 years (range 18-80years). Comparing to the similar research of modified hybrid fixator for high energy schatzker V and VI tibial plateau fractures conducted by Ariffin et al., the mean age was almost the same.[6]

Male predominance was seen (80%), which contributed to men's increased usage of motor vehicles. 70 % had a right-sided injury. Among the 30 patients, 21 patients (70%) sustained open injury. Comparing to a similar study of high-energy tibial plateau fractures treated with hybrid external fixation conducted by Holo M et al,[5] our study has a higher rate of open fractures.

Among the 21 patients who had open fractures with soft tissue injury, 9 patients had type I Gustilo Anderson injury, 6 patients had type llGustilo Anderson injury, 3r patients had type IIIA Gustilo Anderson injury, 3 patient had type IIIB Gustilo Anderson injury. After hybrid fixation, wound management was carried with regular Dressing, higher antibiotics, and wound debridement for these patients. Three patientswith type IIIB soft tissue injury needed skin cover and SSG done later. For one patient with compartment syndrome, fasciotomy with hybrid external fixation was done, and later

SSG was done for the fasciotomy wound. One patient developed septic delayed union and abscess over the thigh and leg, treated with abscess drainage and thorough debridement, and higher antibiotics according to the pus culture and sensitivity.SSG was done for this patient at a later date

In our study, 21 out of 30 patients (70%) had schatzker type-VI tibial plateau fracture.[6] The remaining nine patients had type V tibial plateau fractures. In a similar study conducted by Babis et al., he quoted almost equal amounts of type V and VI fractures.

The average duration of hospital stay after surgery was 8.20 days (range 3-18days). The mean interval between the injury and surgery was 5.55 days (range 0-30). The mean duration of surgery was 66.55 min (range 55-90) min. All fractures (27 out of 30 patients) united in an average time of 18 weeks (16-25 weeks). The external fixator was tolerated for the entire treatment period in all cases. 3 patients fracture (10%) took longer than six months to heal. Similar studies conducted by Papagelopoulos PJ et al,[7] quoted the average union at 14 weeks, four weeks earlier than our study. However, we feel that the delay in the union was acceptable since we encountered more open fractures and type-VI tibial plateau fractures.

Chin et al,[9] presented 38.9%good/excellent, and 61.1%fair/poor results in his type V and VI tibial plateau fractures. Katsenis et al,[10] recorded 76% excellent/ good final clinical results. Catagni et al,[11] reported 50.85% excellent and 45.76% good results. we noted that the results were almost similar in similar studies conducted by Chin et bal,[9]Katsensis et al,[10] (85% excellent/good and 15% fair/poor).

According to the Rasmussens 2 knee score the results were evaluated as excellent in 15 patients(50%),good in 9 patients (30%),fair in 4 patients(13.33%) and poor in 2 patient(6.66%). Comparing to a similar study done by chin et al., 9 we had a 41.1% better outcome in the excellent/good group and 4% better outcome in the excellent/good group comparing to similar a study done by katsenis et al,[10] and 16.61% less outcome in excellent/good group comparing to a similar study by Catagni et al.[11]

In our study, a total of 24 patients regained functional use of the knee joint, good axis without pain or instability. The patient's knee ROM was gradually increasing at consecutive clinical evaluations. After one year of follow-up, the knee ROM ranged from 30º to 130º with an average knee ROM of 102.5º. In similar studies conducted byHuston et al,[12] the average ROM was reported as 115º reduced functional outcome in our study was acceptable and attributed to the more compound fractures, more type VI fractures, and poor compliance of three patients to the rehabilitation exercises. Moreover, one patients had associated injuries like patella fracture and two patients had developed delayed union and septic non union.

In a multicentre, prospective, randomized clinical trial of type V and VI fractures treated by internal and external fixation, Canadian Orthopaedic Trauma Association reported similar osseous reduction and ROM for both groups but lower rate of early postoperative complications and improved HSS score for the external fixator group at the six-month follow-up.

In many older articles, authors don't break down their complication rate according to the type of tibial plateau fractures. Covall et al. treated 32 tibial condylar fractures during seven years period and reported42% deep infection rate for the patients treated with internal fixation.

In our study, three patients developed knee stiffness. A delayed union was encountered in two patient. It was treated with the dynamization of the hybrid external fixator and improved. One fracture was complicated with deep infection and diabetic cellulitis leading to septic non-union(3.33%); the patient with septic non-union was treated with surgical debridement and higher antibiotics until CRP and ESR reached typical values, and he is on further follow-up.

Overall, six patients (20%) faced knee stiffness, delayed union, and septic non-union complications. Infection was the main drawback when using the external fixator for treating fractures.

Hutson et al., in a meta-analysis of 16 studies with a total of 568 patients, found pin site infection rates of 10%(12).

Our rate of pin track infection was encountered in 7 patients. These infections were superficial or limited to the soft tissue and did not extend to the bone. None of the patients required hospital admission. These were treated with oral antibiotics and local pin care. All pin care infections healed without requiring wire or half pins removal that could compromise frames stability. The rate of septic arthritis was also nil. Septic arthritis is a rare complication arising from the faulty use of the technique and is related to the placement of wires in the capsular reflection of the knee joint. Our study safely avoided this by placing the proximal-most wires 14 mm below the joint line. The rate of deep infection was 6.66% which was almost similar to the previous studies. However, we feel that in this patient, this was attributed to the improper pin track care and the comorbid condition of the patient since the patient was known diabetic.

Complications concerning the external fixator, like intolerance or pin loosening, were not observed in our study.

Limitations

The disadvantages include the need for constant pin care, pin site infection, and the risk of septic arthritis from incidental intracapsular pin placement. This can be safely avoided by placing the proximal-most wires 14mm below the joint line.

A limitation of this study, one should consider its short-term follow-up. This follow-up was inadequate to draw a safe conclusion about post-

traumatic osteoarthritis. This report may be the basis for a new study examining the development of post-traumatic osteoarthritis in high-energy tibial plateau fractures.

CONCLUSION

The degree of soft tissue involvement in tibial plateau fractures is an essential determinant for the choice of treatment modality and the final outcome. Schatzker type V and VI tibial plateau fractures represent serious injuries with substantial limb-specific injuries and general health deficits. While confronting such life-threatening limb injuries, hybrid external fixation successfully provided continuous access to the surrounding tissues and proper osseous stabilization without compromising the sensitive soft tissue envelope. A modified hybrid external fixator is a safe and practical choice for treating high-energy tibial plateau fractures. It reduces soft tissue complications and improves bony union with acceptable reduction and favorable outcomes. It allows early mobilization of the patient. The difficulties are mainly related to sepsis, either superficial pin track infection or deep infection, preventable, treatable, and curable. We feel that the technique merits a place in the armamentarium for managing complex, high-energy tibial plateau fractures.

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