A Prospective Study on Clinical and Radiological Outcome of Tibial Plateau Fracture Schatzker Type-2 Treated with Open Reduction and Internal Fixation by using Subchondral Raft Plate without the use of Bone Graft in a Tertiary Care Hospital

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Abstract: - Tibial plateau fractures have become very common because of increased road traffic accidents. These fractures make up about 1% of all fractures in the elderly and about 8% of all fractures. 21 Patients admitted with proximal tibial fracture type 2 - Schatzker are assessed and managed according to the advanced trauma life support protocol. Fixation of the fracture is done by using open reduction & internal fixation with an anatomical plate with the raft technique under spinal anaesthesia. Functional and radiological outcomes will be evaluated at 3 months and 6 months based on Rasmussen's score. 48% patients had excellent results, 43% good, 9% fair functional results at 3 months follow-up period. 65% patients had excellent results, 30% good, and 5% fair results at 6 months of follow-up. Following surgical management of proximal tibial plateau fractures, Schatzker type -2 fractures treated with a subchondral raft construct, patients had 76% satisfactory outcome.

Key-Words: - subchondral raft plate, internal fixation, open reduction, Schatzker type-2, tibial plateau fracture, clinical and radiological outcome.

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1 Introduction

The human knee joint is the most intricate synovial joint, [1]. Injuries to the knee joint have increased these days due to increased road traffic accidents and sports-related injuries, [2]. The knee joint, being a superficial joint and exposed to more external forces, is thus the joint gets injured easily, [3]. Human body weight is supported by the tibial plateau of the knee joint, [4]. Tibial plateau fractures have become very common because of increased road traffic accidents (RTA), [5]. The most frequent intra-articular fractures are tibial plateau fractures, [1]. Fractures constitute around 8%, including all the fractures in elderly people, and around 1% overall, [6]. The lateral plateau fractures are most common among these fractures, [2]. Treatment for proximal tibial plateau fractures is challenging since they are intra-articular fractures, [7]. With advancing age, osteoporosis and skin conditions will further increase the obstacles in the healing process of the fracture, [8]. These fractures are due to the result of axial loading with the combination of varus/ valgus stress forces, [9]. Depending upon the stress forces different types of patterns and configurations of fractures are seen, [3]. Depending upon the fracture

pattern, different modalities of treatment are available, [10]. These fractures are of concern to surgeons and difficult to treat because of their complex kinematics and their weight-bearing area and complex ligamentous stability and articular congruency, which may lead to disability of the patients, [11].

These fractures are intra-articular, the aim of surgical management of these fractures is to restore the articular congruency of tibial condyles and thus maintain the restoring ligamentous stability and mechanical axis, [12]. This will help to achieve functional, painless and good range of movements of the knee joint, [5]. Improper or inadequate management of these fractures leads to movement and ability dysfunctions, [13]. Of all proximal tibial plateau fractures, lateral tibial plateau fractures are the most commonly seen in Schatzker type-2 fractures, [14]. These fractures are intra-articular fractures with severely depressed articular surfaces, so these fractures require an open reduction for the elevation of the depressed fragment and to maintain articular congruency of the joint, [13]. The depressed articular fragments are elevated with the help of a bone tamp by making a cortical window in the metaphysis, followed by internal fixation, [15]. Cancellous autografts, bone substitutes, or allografts are used to fill the subchondral area to maintain the reduction, [16]. The autografts are taken from different sites, and the most common site used in these fractures is from the iliac crest, so autografting is associated with morbidity of the donor site, blood loss and increased surgical duration, [17]. Allografts are also used for filling the metaphyseal void, but these are associated with risk of transmission of disease, low initial stability and inadequate incorporation of the graft to host bone, [18]. By using the subchondral raft plate, the raft screws are placed in the subchondral area to maintain the articular surface, [14]. Regardless of the quality of the bone, these screws maintain the articular surface of the lateral and medial condyles of the proximal tibia. As a result, the raft construct keeps the articular surface from collapsing even in the absence of bone replacements or grafts, [19].

2 Materials and Methods

This is a prospective study done in the Department of Orthopaedics, Little Flower Hospital, Angamaly, Ernakulum district, Kerala. Study period from March 2015 to December 2016. Ethics committee clearance is obtained from the Research and Ethical Committee of Little Flower Hospital, Angamaly. The study maintains the confidentiality and privacy of the study participants. Participants in the study provide signed informed consent before data collection.

2.1 Inclusion Criteria

Patients admitted with proximal tibial fracture type 2 – Schatzker, with an age between 20 and 80 years, were included in this study.

2.2 Exclusion Criteria

Patients with pathological fractures, having multiple fractures of the same limb, peri-prosthetic fractures, existing deformity of the same limb, neuro-vascular deficit, patients associated with compartment syndrome, compound fractures, age below 20 years and above 80 years were excluded from this study.

2.3 Sample Size

The sample size is calculated from the formula, $n = Z^2 p(1-p)/ e^2$

Where n is the required minimum sample size, e = margin of error (5%), p = estimated proportion 1.6% [20] and z = standard normal deviate corresponding to 95% confidence level=1.96.

Considering a margin of error of 5% and a 95% confidence level, the minimum required sample size will be 20. The data is analyzed by using percentages. Mean and standard deviation were calculated by using SPSS version 16.

2.4 Statistical Analysis

Descriptive statistics were used to summarize baseline data. The mean functional outcome at 3 months and 6 months of tibial plateau fracture Schatzker type-2 was compared using Wicoxon test. A p-value less than 0.05 was considered significant.

2.5 Pre-operative Evaluation

Initially, all the patients in the casualty are assessed and managed according to the ATLS (Advanced Trauma Life Support) protocol. Then fractures are stabilized with the help of a splint or A/K slab. A detailed history is taken regarding the mode of injury, any other associated injuries, and other medical co-morbidities. Tetanus prophylaxis is given and antibiotics are started at the earliest, [20]. After the primary management patient is prepared for surgery with pre-operative investigations like x-

rays of the knee, antero-posterior and lateral views, CT scan of the knee for cross-sectional anatomy of fracture lines. Primary fixation is done if all circumstances are favourable, like fracture pattern and healthy skin conditions. Surgery is carried out through an anteroposterior-lateral approach, [21].

2.6 Instruments

Specialized sterile equipment, implants, and other instruments are used for reduction & fixation of the fractures, also a radiolucent fracture table, a full array of plates and screw length.

2.7 Operative Procedure

After induction of spinal/general anaesthesia, the patient is positioned supine on the operating table. The limb is prepared and draped under standard aseptic technique. A thigh tourniquet is applied routinely. The anterolateral parapatellar approach is used because of involvement of lateral tibial plateau fractures, [10]. For lateral condyle fractures, make a straight or slightly curved incision that extends distally below the inferior edge of the fracture site from immediately anterior to the lateral femoral condyle to Gerdy's tubercle, beginning 3 to 5 cm above the joint line proximally, [2]. After identifying the fracture site, a small, thin periosteal elevator is placed well beneath the depressed articular fragments. The articular fragments are then raised by applying moderate, careful pressure. The fragments are raised and reduced and momentarily secured by several tiny Kirschner wires, [16]. The split is decreased, closed, and a periarticular plate is inserted. Placing the row of rafting screws in the subchondral bone to support the reconstructed joint surface is essential in this step. If better support is needed, screws can be positioned outside the plate. Suture should be inserted via the proximal suture holes before plate fixation if the arthrotomy is to be closed with them, [10]. A periarticular raft construct plate is then used for definitive fixation. Appropriate cancellous screws that are long enough to engage the opposing cortex are used to secure the plate to the condyle. Five to seven Cortical (4.5 mm/5 mm) screws are used to attach the plate to the shaft of the tibia. Imaging confirms that the screws are placed in the densest subchondral bone to create a "raft" or "hammock" that supports the articular surface, compensating for the lack of bone graft, [8]. The best reduction and fixation are achieved by using an intraoperative image intensifier. Using the C-arm, ensure the raft screws are perfectly parallel to the joint surface, [6].

2.8 Postoperative Care and Rehabilitation

The limbs are kept elevated with pillows in the post-operative period to prevent oedema. Posterior splint can be kept for the protection of fixation if desired. Immediate post-operative day, check radiography is taken. Quadriceps exercises and early ankle mobilization are started on the 2nd post-operative day, [3]. Progressive weight bearing will be started as tolerated by the patient. After surgery, wound inspection is carried out on the 2nd and 4th post-operative days, and clinical signs of infection are observed. Then, suture removal is done on the 10th post-operative day, and the patient is discharged. Post-operative intravenous antibiotics are stopped on the 5th day and switched to oral antibiotics for another week. If any infection is noted, then antibiotics are changed according to culture sensitivity, [11].

2.9 Follow-up and Evaluation

Based on Rasmussen's score the functional outcome after subchondral raft plate of tibial plateau fracture, Schatzker type-2, will be assessed at three and six months. Rasmussen's Knee Score, Table 1, will be used to assess the radiological results for secondary displacement and condylar widening at three and six months. A reference line level with the undamaged plateau will be used to quantify condylar depression.

Table 1. Rasmussen's Knee Score

Parameter	Score	Excellent	Good	Fair	Poor
Depression None <6 mm 6-10mm >10mm	 6 4 2 0	6	4	2	0
Condylar widening None <6 mm 6-10mm >10mm	 6 4 2 0	6	4	2	0
Angulation (valgus/varus None <10^{o} 10-20^{o} >20^{o}	 6 4 2 0	6	4	2	0

Source: [21]

The width of the femoral condyles just above the joint line and the width of the tibial plateau just below the joint line will be measured to determine condylar widening. Normally, these two measurements are equivalent, [21].

3 Results

3.1 Age Distribution

In this study, most patients were between 61 and 70 years (33.33%). The mean age was 51.04. The age group was between 21 and 70 years. Details are shown in Table 2.

Table 2. Age distribution

Age	Patients	%	Mean
21-30	1	4.76	51.04
31-40	1	4.76	
41-50	6	28.57	
51-60	6	28.57	
61-70	7	33.33	

Source: created by the authors

3.2 Gender distribution

In this study, the male predominance is present. Among 21 cases, 13 (62%) were male patients and 8 (38%) were female patients. Details are shown in Table 3.

Table 3. Gender distribution

Gender	Patients (n)	%
Male	13	62
Female	8	38

Source: created by the authors

3.3 Side of Injury

In this study, 13 patients' fractures were on the right side and 9 patients' on the left side. Details are shown in Table 4.

Table 4. Side of injury

Side of injury	Patients (n)	%
Right	12	57
Left	9	43

Source: created by the authors

3.4 Mode of Injury

In our study, most of the patients were injured by road traffic accidents (18 patients, 86%). Details are shown in Table 5.

Table 5. Mode of injury associated with systemic injuries

Mode of injury	Patients (n)	%
RTA	18	86
Assault	1	5
Fall from height	2	9

Source: created by the authors

3.5 Associated with Systemic Injuries

In this study, out of 21 patients, 1 patient had an abdominal injury, and 1 patient had a chest injury. Details are shown in Table 6.

Table 6. Associated with systemic injuries

Associated systemic injuries	Patients (n)	%
Nil	19	90
Abdominal injury	1	5
Chest injury	1	5

Source: created by the authors

3.6 Associated with Bone and Joint Injuries

Among 21 patients, 1 patient had a lower limb fracture and 2 patients had upper limb fractures. Details are shown in Table 7.

Table 7. Associated with bone and joint injuries

Injuries	Patients (n)	%
No injuries	17	85
Upper limb	2	10
Lower limb	1	5
Spine	0	0
Pelvis	0	0

Source: created by the authors

3.7 Range of Motion

Among 21 patients, 6 patients had 140° range of motion and 1 patient had 80° range of motion. Most of the patients had a good range of movements of 130°-140°, at 6 months follow-up. The mean range of movements was 122.85. Details are shown in Table 8.

Table 8. Range of motion

Range of motion	Patients(n)	%	Mean
80	1	4.70	122.85
90	2	9.52	
100	1	4.70	
120	5	23.80	
130	6	28.60	
140	6	28.60	

Source: created by the authors

3.8 Fracture Union Time

In this study, the mean duration of fracture union is 14.66 weeks with a range of (12-18) weeks. Details are shown in Table 9.

Table 9. Fracture union time

Fracture union in weeks	Patients(n)	%	Mean
12	4	19.04	14.66
14	8	38.04	
16	7	33.33	
18	2	9.52	

Source: created by the authors

3.9 Functional Outcome at 3 Months

In this study, we found that 48% patients had excellent results, 43% good, 9% fair functional results at 3 months follow-up period. Details are shown in Table 10.

Table 10. Functional outcome at 3 months

Results at 3 months	Patients (n)	%
Excellent	10	48
Good	9	43
Fair	2	9
Poor	0	0

Source: created by the authors

3.10 Functional Outcome at 6 Months

In this study, we observed that 65% patients had excellent functional outcome at 6 months, followed by 30% patients had good, 5% patients had fair results. None of the patients had a poor outcome after 6 months of follow-up. Details are shown in Table 11.

Table 11. Functional outcome at 6 months

Results at 6 months	Patients(n)	%
Excellent	13	65
Good	6	30
Fair	1	5
Poor	0	0

Source: created by the authors

3.11 Comparison between Outcomes at 3 and 6 Months

When we compare the results, there is an increase in the percentage of excellent functional outcome results at 6 months as compared to 3 months follow-up. Comparison between outcomes at 3 and 6 months was analysed using the Friedman ANOVA test. A p-value of less than 0.05 was considered statistically significant. There was a significant difference in improvement (1.29, p=0.0035) between 3 months and 6 months. Details are shown in Table 12.

Table 12. Comparison between outcomes at 3 and 6 months

Results	3 months	6 months	P value
Excellent	48%	65%	0.0035
Good	43%	30%	0.035
Poor	9%	5%	0.038
Comparison between outcomes at 3 and 6 months was analysed using Wicoxon test. A p-value of less than 0.05 was considered statistically significant.			

Source: created by the authors

3.12 Rasmussen's Radiological Knee Score at 6 Months

We observed that the knee score was excellent in 67% of patients, 28% good, 5% fair results at 6 months of follow-up. The mean Rasmussen's radiological knee score at 6 months was lower than at admission in tibial plateau fracture. Details are shown in Table 13.

Table 13. Rasmussen's radiological knee score at 6 months

Scores	Patients (n)	%
Excellent	14	66.66
Good	6	28.57
Fair	1	4.76

Source: created by the authors

3.13 Tegner Lysholm Knee Score at 6 Months

In this study, 76% patients showed excellent results, 19% good, 5% fair results at 6 months follow-up. The mean Tegner Lysholm score at 6 months was lower than at admission in tibial plateau fracture. Details are shown in Table 14.

Table 14. Tegner Lysholm score at 6 months

Results	Patients (n)	%
Excellent	16	76
Good	4	19
Fair	1	5

Source: created by the authors

3.14 Distribution of Weight

3.14.1 Partial Weight Bearing

In our study, 38% of the patients started partial weight bearing at 6 weeks, and 62% of patients at 8 weeks of the post-operative period. Details are shown in Table 15.

Table 15. Partial weight bearing

Weeks	Patients (n)	%
6 weeks	8	38
8 weeks	13	62

Source: created by the authors

3.14.2 Full Weight Bearing

In our study, 81% of the patients were started on full weight bearing at 12 weeks and 19% of patients at 14 weeks of the post-operative period. Details are shown in Table 16.

Table 16. Full weight bearing

Weeks	Patients (n)	%
12 weeks	17	19
14 weeks	4	81

Source: created by the authors

3.15 Complications

During the study, 10% patients had knee stiffness, 5% patients had deep infection, 5% patients had stitch abscess. Details are shown in Table 17.

Table 17. Complications

Complication	Patients (n)	%
Knee stiffness	2	10
Deep infection	1	5
Stitch abscess	1	5
Nil	16	80

Source: created by the authors

4 Discussions

Proximal tibial fractures have become more common as RTA has increased, but their complexity has also changed because of high-velocity direct contact, which causes more comminution at the fracture site, [8]. It is crucial to treat any fractures near weight-bearing joints, such as the knee joint, since they can lead to serious morbidity and a reduced quality of life, [13]. As a result, Orthopedic surgeons will have increased difficulties in treating these fractures, [14]. Age, sex distribution, occupation, laterality of fracture, manner of injury, fracture union, range of motion, and complications are all taken into consideration while analyzing the data.

In this study, the patients with fractures occurred between the ages of 20 and 70 years, with the maximum incidence involving the age group between 40 and 70 years, with a mean age of 51 years. This correlates with a study, with a mean age of 53 years, [22]. In this study majority of the patients were male, 62%. Our study correlates with a study that found that Indian males are more commonly affected by road traffic accidents, [23].

In this study, the commonest mode of injury was road traffic accidents, 86%, the others being fall from height, 9%, assault 5% and this correlates with other studies, which found that most of the patients get injured by road traffic accidents. There was not much difference in the laterality of the fractures. The right tibia was affected 57% and the left tibia was affected by 43% of cases, [23], [24].

In this study average time for the union of fractures was 14.6 weeks. Similar results were observed that all patients had union in 8-22 weeks (average 14 weeks), which is comparable with this study, [25]. In this study, patients had a good range of movements, 130 -to 140, with a mean of 122. This study correlates with the study that the range of movements is between 120 and 140, with a mean of 118, [25].

In this study, one patient had a distal end radius fracture, was treated with open reduction and internal fixation with plate and screw fixation, and another patient had a medial malleoli fracture, which was treated with malleolar screw fixation. Another patient had both bones fracture of forearm, which was treated surgically and one patient had multiple rib fractures, which were treated conservatively. One patient had an abdominal injury, which was treated surgically and in the same setting, the fracture was also operated on.

In this study, the Rasmussen clinical knee score showed 65% patients having excellent results, 30% good, 5% fair results at the end of the 6 months follow-up and also the radiological knee score showed 67% of the patients having excellent results, 28% good, 5% fair results at the end of 6 months follow-up. Another study states that 11.53% patients had outstanding results, 76.92% had good results and only 11.53% had fair results according to Rasmussen's radiological grading system for fracture depression. Six months after surgery, the average fracture depression was 1.96 mm (0–7 mm) while the average preoperative fracture depression was 4.48 mm (range 2–7 mm), [26]. We also observed the Tegner Lysholm score at the end of the 6 months, which showed 76% patients had excellent results, 19% well, 5% fair results. These findings are consistent and comparable to those of other published research; achieve 50 % excellent results and 30.76% good results, 4% fair and 3.85 % poor results in terms of functional outcome, [27].

In this study, 4 (19%) patients developed complications, 2 (10%) patients had knee stiffness treated by physiotherapy, 1 (5%) patient had stitch abscess treated by antibiotics and 1 (5%) patient had deep infection after 4 months of operation patient was treated with antibiotics and implant removal. According to another study, 6 (28%) of 21patients developed complications, which included 2 (9%) knee stiffness, 1 (4%) post-operative loss of reduction,1 infection, 1 (4%) varus deformity and 1 (4%) knee instability, [28].

4.1 Strengths and Limitations

These are intra-articular fractures, so anatomic reduction and rigid fixation have to be achieved to maintain a (< 2mm gap) of the articular surface to avoid complications like knee stiffness, post traumatic osteoarthritis of the knee. By this method of fixation for type-2 Schatzker tibial fracture, complications associated with bone graft, allograft, and xenograft can be prevented. Use of intra-op image intensifier helps to know the articular congruency and prevent the complication like placement of intra-articular screws. Intraoperative anatomical reduction does not determine the stability and good range of movements, but also depends on the age of the patient, the quality of bone and early mobilization.

This study was conducted in a single institution, and the small sample size was a limitation. Further multicentric studies with a large sample size are recommended.

5 Conclusions

From our study, we concluded that, following surgical management of proximal tibial plateau fractures, Schatzker type -2 treated with subchondral raft construct patients had 76% satisfactory outcome. In elderly Patients with osteoporotic bones, treating with the subchondral raft plate is a better option and provides a good functional outcome. The complications associated with autogenous graft, allograft, or bone substitutes can be prevented by adopting this technique. Optimal knee function and good functional arc of motion are achieved by accurate anatomical reduction and stable fixation, followed by early mobilisation. Strict adherence to the post-operative rehabilitation program regarding non-weight bearing is necessary to achieve a sufficient range of motion and the best possible functional outcomes.

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Conflict of Interest

The authors have no conflicts of interest to declare.