



International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2022; 8(1): 478-483
© 2022 IJOS
www.orthopaper.com
Received: 12-11-2021
Accepted: 16-12-2021

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Management of tibial condyle fractures with different treatment modalities and assessment with modified Rasmussen score

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DOI: <https://doi.org/10.22271/ortho.2022.v8.i1g.3059>

Abstract

Background: Fractures of the tibial plateau involve the articular surface of the proximal tibia. The principles and techniques of treating tibial plateau fractures have evolved dramatically over the past 50 years. Tibial plateau fractures have been studied and reported extensively and exhaustively but still controversy exists over its management. Our aim is to outline the various principles of management of tibial plateau fracture and to evaluate the results of surgical and conservative methods.

Materials and Methods: Fifty adult patients with closed intra-articular tibial plateau fractures were treated by various surgical and conservative methods during period from Oct 2020 to Oct 2021. The patients were followed for 3rd, 6th, 12th week and then every 6 weeks till 6 months. Results were assessed with Modified Rasmussen Clinical and Radiological Scores.

Result: According to Modified Rasmussen clinical score, we had 19(38%) excellent results, 19(38%) good results, 09 (18%) fair results and 03(06%) poor results. In surgically treated patients we found 16, 16, 3, 1 patients in excellent, good, fair and poor category respectively and in conservatively treated patients 3, 3, 6, 2 patients in excellent, good, fair and poor category respectively. Radiologically, we had 16(32%) excellent results, 22(44%) good results, 12 (24%) fair results and 00(00%) poor results. In surgically treated patients we found 14, 17, 5 patients in excellent, good and fair category respectively and in conservatively treated patients 2, 5, 7 patients in excellent, good and fair category respectively.

Conclusion: Conservative treatment used for un-displaced or minimally displaced fractures showed good results in general while operated patients uniformly showed good results with stable fixation irrespective of implants used. External fixator as a definitive modality predisposed to stiffness due to prolong immobilization. Surgically treated patients have better radiological as well as clinical outcomes compared to conservatively treated patients because of good anatomical reduction and early mobilization of knee joint.

Keywords: Tibial condyle, tibial plateau, intra-articular fractures, modified Rasmussen score

1. Introduction

Proximal tibial articular fractures can be caused by motor vehicle accidents or bumper strike injuries; however, sports injuries, falls, and other less violent trauma frequently produce them, especially in elderly patients with osteopenia.

Fractures of the tibial plateau involve the articular surface of the proximal tibia. Proximal tibia fractures that do not involve the articular surface and small rim avulsions that occur in conjunction with knee dislocations and other knee ligament injuries are not included in tibial plateau fractures. Despite these exclusions, tibial plateau fractures are a diverse group of fractures that represent a wide spectrum of severity that ranges from simple injuries to complex fracture patterns.

The principles and techniques of treating tibial plateau fractures have evolved dramatically over the past 50 years. In the decades of the 1950s, 1960s, and 1970s, these fractures were predominantly treated non-operatively by using a variety of techniques, including traction, cast bracing, and even spica casting^[1-4]. With improved methods of internal fixation, open reduction and internal fixation of tibial plateau fractures became common in the 1980s.

These techniques had the advantages of reducing the articular surface, aligning the limb, and mobilizing the knee early after injury. Favorable results were reported for the majority of patients [5, 6, 7]. Criteria were developed for which fractures needed to be surgically reduced, but this remains an area of controversy even today and different surgeons continue to use different criteria for operative intervention [8].

In lower-energy split depression fractures, techniques are being used to optimally support the reduced articular surface, including better implants, better methods to position implants, and better methods to fill the metaphyseal void created after reducing the articular fragments. These new techniques are important since some loss of articular reduction remains an important problem.

These fractures often affect patients during the most productive years of their lives with varying degree of morbidity. As with any intraarticular fracture, inadequate treatment may result in joint instability and deformity coupled with a restricted range of motion [9]. Because of the wide range of fracture types and associated soft tissue and neurovascular structures involved, it is not surprising that the literature has varied opinions regarding the outcome of various nonoperative or operative treatment protocols. But gradually the consensus has shifted to operative treatment especially in intra articular fractures. Many investigators report only slightly >50% satisfactory results with either open or closed treatment [10, 11, 12, 13]. Even in experienced hands, open reduction and internal fixation may require an extensible exposure resulting in long operative time, increased blood loss, and devascularization of bone fragments. Nonoperative treatment can result in particular incongruity and knee instability. An ideal form of management would be minimally invasive, yet allow for an anatomic reduction; fixation would be stable enough to permit early motion. Physiotherapy remains a keystone for favourable recovery.

On one hand, we have got a group of surgeons who says that most of the tibial plateau fractures can be managed by conservative treatment and on the other hand, other group says conservative treatment means therapeutic nihilism and except for displaced fracture every tibial plateau fracture should be operated upon to achieve anatomical reduction and rigid internal fixation. Even displaced tibial plateau fractures should be operated, so that early mobilization of knee is possible.

In this small study, our aim is to outline the various principles of management of tibial plateau fracture and to evaluate the results of surgical and conservative methods as practiced in our institution.

2. Materials and Method

In this study we included 50 cases with closed intra-articular tibial plateau fractures during period from Oct 2020 to Oct 2021. Patients who met the criteria are admitted through OPD or casualty and treatment was given as standard guidelines after obtaining their informed written consent. Patients were treated by various surgical and conservative methods.

2.1 Inclusion criteria

- All Tibial Plateau fractures except those described under exclusion criteria.
- Age above 18yrs

2.2 Exclusion criteria

- Patients Age below 18
- Extra articular, open and Pathological fractures

- Fracture involving ipsilateral intra-articular distal femur
- Severe head injury initial Glasgow coma scale < 8
- Previously Non ambulatory patients.

3. Methodology

After admission to the hospital, a careful history was elicited and meticulous examination of the injured part was performed locally in relation to soft tissues and bony injuries as per the standard method. Distal vascularity, capillary filling, pallor and paraesthesia over toe tips were assessed. Periodic local observations were carried-out in order to rule out any impending compartment syndrome. All the findings were duly recorded in the patient proforma. The involved limb was immobilized in above knee POP slab and kept elevated. Pain and inflammation were managed using analgesics.

Standard radiographs in AP and lateral views were taken for confirmation of the diagnosis and also to know the type of fracture. The fracture fragments were analyzed and classified according to the AO CLASSIFICATION. CT scan was done in most of the cases for better understanding of fracture pattern.

Patients managed conservatively by cast application: Only baseline investigations were done. Whereas Patients managed with operative intervention: Routine examination of blood and urine was done. Blood pressure and ECG were recorded in all patients. Preparation of the part was done a day before surgery. Intravenous antibiotics were given to all patients pre-operatively. Due counseling was done regarding nature of injury, severity of fracture and prognosis. Consent for surgery was taken and patients were operated after a pre-anaesthetic checkup and fitness.

4. Technique

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

1) Conservatively by cast application Indications [14]

1. Displaced or minimally displaced fractures and the joint is absolutely stable.
2. Medically compromised patient who is not fit for surgery.
3. Marked osteoporosis.
4. Patients who refused surgical option.

Patients were treated with long leg plaster cast and kept non-weight bearing for 4 to 6 weeks. Bed side mobilization keeping the patient non-weight bearing was started from 6 to 8 weeks. Partial weight bearing was allowed from 8 to 12 weeks, with progression to full weight bearing according to serial radiographs and pain tolerance of the patient [15]. Individual changes in protocol were sometimes done as per patient compliance and clinical merit of situation. No patient in conservative group was treated by any other method except plaster cast.

2) Surgical Procedures: Indications for Surgery [15]:

1. Displaced and unstable tibial plateau fractures.
2. Displaced medial plateau fractures and lateral plateau fracture patterns where valgus alignment will occur without surgically reducing and fixing the fracture.
3. For the lateral patterns, the presence of –
 - A split fragment, a depression affecting over half of the lateral articular surface,
 - A fibular head fracture,
 - Valgus alignment on injury radiographs, and

- Clinical valgus alignment on examination.

As per preoperative planning, approach was decided (percutaneous/open/minimally invasive). Fixation was performed as per fracture morphology. Various options used for fracture fixation are:

1. Percutaneous cancellous screw fixation.
2. ORIF with cancellous screws and Bone grafting.
3. ORIF with Buttress plate and screws.
4. ORIF with Buttress plate and screws and Bone grafting.
5. External fixator.
6. External fixation with minimal internal fixation.

During open reduction and internal fixation, on reducing depressed tibial plateau articular fragments, leads to empty areas in bone or voids beneath the reduced fragments. This void result due to compressed cancellous trabeculae because of the injury, it results in loss of substance after the articular fragments are reduced. They are an area that lacks support for the reduced articular fragments, increasing the risk that the articular fragments will redisplayed despite internal fixation. To minimize this risk, we fill the void to increase stability and prevent displacement by auto graft taken from iliac crest. Auto graft from the iliac crest is most common material for "grafting" the void [15].

5. Post-Operative

Postoperative X-ray was taken a day after surgery. Reduction was judged to be satisfactory if there was joint

depression of less than or equal to four millimeters and/or plateau widening of less than or equal to five millimeters compared with the width of the distal femoral condyles [16]. Condylar widening was obtained by measuring total width of tibial plateau just below the joint line and measuring the width of the femoral condyles just above the joint line. These two measurements are normally equal [17].

Depending upon the fracture configuration and stability of reduction achieved, the mobilization was planned. In most cases the protocol followed was –

Day 1 - Static quadriceps exercise

Day 3 - Active knee mobilization.

Day 7 - Non weight bearing crutch walking.

6th week onwards - Partial weight bearing.

12th week onwards - full weight bearing, as per healing seen on X-ray.

Wound inspection was done on 3, 5, 8 and 10th day with stitch removal. Total hospital stay was noted and patients were followed for 3rd wk, 6th wk, 12th wks and then every 6 weeks till 6 months.

6. Follow up

Range of movements of knee was assessed, and AP and Lateral X-Ray were taken and implant position and fracture union were assessed.

We used modified Rasmussen score [18] for our study as this score is simple, easy to use and practically applicable in our scenario.

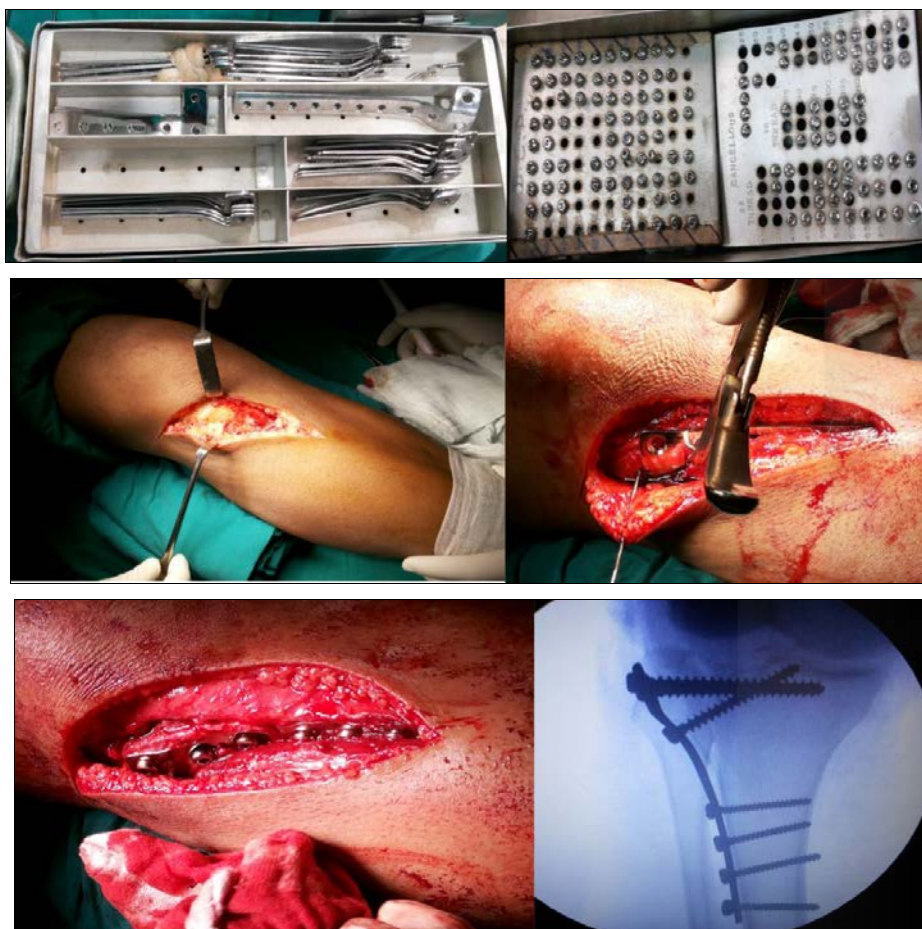


Fig 1: Intra-Operative Photographs

7. Results

We studied 50 patients with closed prospectively at Shri Shankaracharya Institute of medical science, Bhilai for 1-year period. The age of the patients were in the range from minimum 23 yrs to maximum 72 yrs with mean age of 45.94

yrs. 09(18%) 50 years, 13(26%) between 51-60 years and 08(16%) patients more than 60 years. 42 were men and 8 were women. The mechanism of injury was a fall from height in 10 patients and a road traffic accident in 40 patients. The right side was injured in 20 cases and the left side in 30 cases.

All patients had unilateral closed intra-articular tibial plateau fractures. According to AO classification system out of the 50 cases, 37(74%) cases of the fractures were of Type B classification and 13(26%) cases of Type C. Type A was not included in the study as they were extra articular.

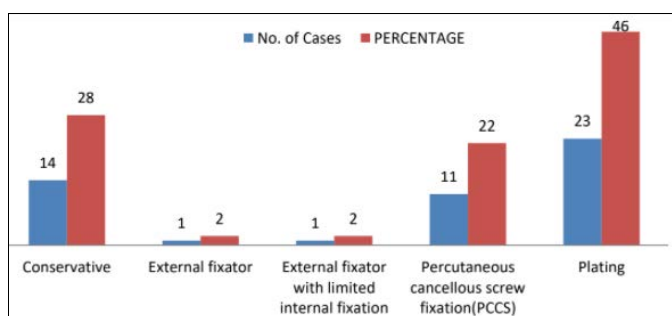
Depending upon preoperative fracture configuration assessment, each case was individually planned and we utilized various treatment modalities as shown in table.

Table 1: Case distribution according to methods of treatment

Method of Treatment	No. of Cases	%
Conservative	14	28
External fixator	01	02
External fixator with limited internal fixation	01	02
Percutaneous cancellous screw fixation	11	22
Plating	23	46
Total	50	100.0

In our study, complications were seen in 14 patients. 2 patients had isolated varus deformity. 3 patients had isolated articular depression and 1 patient had isolated condylar widening. Knee stiffness was seen in 8 patients, out of which 3 patients had associated condylar widening, 2 had associated varus, 2 had associated valgus deformity and 1 with articular depression.

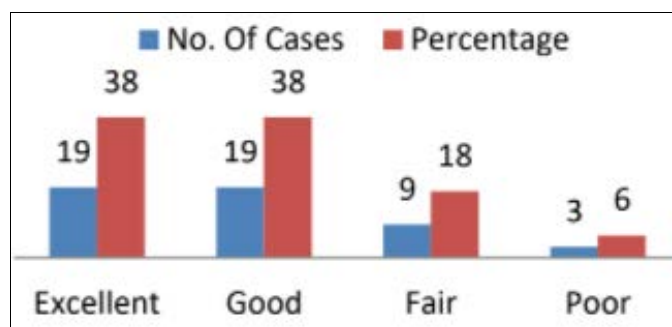
According to Modified Rasmussen Clinical score, we had 19(38%) excellent results, 19(38%) good results, 09 (18%) fair results and 03(06%) poor results. In surgically treated patients we found 16,16,3,1 patients in excellent, good, fair and poor category respectively and in conservatively treated patients 3,3,6,2 patients in excellent, good, fair and poor category respectively.



Graph 1: Case distribution according to methods of treatment

Table 2: Clinical scores of the patients

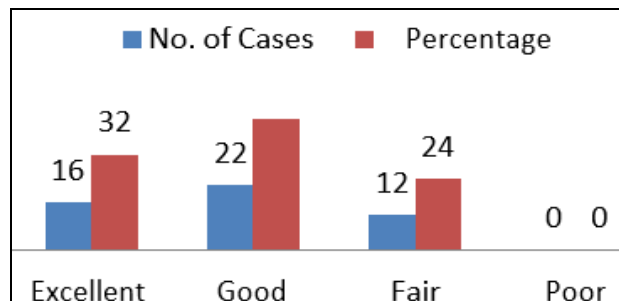
Results	No. of cases	%
Excellent	19	38
Good	19	38
Fair	09	18
Poor	03	06



Graph 2: Clinical scores of the patients

According to Modified Rasmussen Radiological score, we had 16(32%) excellent results, 22(44%) good results, 12 (24%) fair results and 00(00%) poor results. In surgically treated patients we found 14,17,5 patients in excellent, good and fair category respectively and in conservatively treated patients 2, 5, 7 patients in excellent, good and fair category respectively.

Showing Radiological Scores of the Patients



Graph 3: Radiological Scores of the Patients

Table 3: Radiological Scores of the Patients

Results	No. of cases	%
Good	22	44
Fair	12	24
Poor	0	0

On studying different parameters with respect to Modified Rasmussen Scores, results of clinical and radiological outcome are independent of gender, side injured and age of the patient whereas Method of treatment (surgical or conservative) influenced the clinical as well as radiological outcomes.

Showing clinical scores of the patients

Table 4: Clinical scores of the patients according to different parameters

Parameters		Excellent	Good	Fair	Poor	Significance (Chi Square Test)
Gender	Male	15	15	9	3	P>0.05 NS
	Female	4	4	0	0	
Side	Right	6	9	3	2	P>0.05 NS
	Left	13	10	6	1	
Age	≤40 YRS	10	5	3	1	P>0.05 NS
	>40 YRS	9	14	6	2	
Method	Conservative	3	3	6	2	P<0.05 S
	Surgical	16	16	3	1	

Showing radiological scores of the patients

Table 5: Radiological scores of the patients according to different parameters

Parameters		Excellent	Good	Fair	Poor	Significance (Chi Square Test)
Gender	Male	12	19	11	0	P>0.05 NS
	Female	4	3	1	0	
Side	Right	4	12	4	0	P>0.05 NS
	Left	12	10	8	0	
Age	≤40 YRS	7	10	2	0	P>0.05 NS
	>40 YRS	9	12	10	0	
Method	Conservative	2	5	7	0	P<0.05 S
	Surgical	14	17	5	0	

8. Discussion

Fractures that involve the proximal tibia can affect knee function and stability [19] and can be a source of prolonged morbidity if not treated well. Proximal tibial fractures are more commonly seen in the active productive age group due to high-energy trauma. High energy intra articular fractures of the tibial plateau remain challenging for orthopedic surgeons [20] especially in younger age group. Older age group patients with these fractures pose a challenge due to associated osteoporosis and poor bone stock. The ideal outcome of proximal tibial fracture is stable, pain free, non-osteoarthritic knee, with functional range of movement [21].

Ideal treatment of tibial plateau fractures has been a matter of debate for several years. Earlier there was reluctance towards open reduction and internal fixation of these fractures and mostly conservative and semi-invasive methods like external fixation were preferred. But with better understanding of biomechanics and imaging modalities like CT scan and MRI, a clear picture of these fractures emerged and with the development of newer implants like locking compression plates, led to a shift of trend towards fixing these fractures.

In our study many modalities of treatment were used included both operative and nonoperative treatment. We assessed, evaluated and compared the functional and radiological outcomes of management of tibial plateau fractures with those obtained by various other studies. Our analysis is as follows.

Age incidence: The age incidence in our study shows an average of 46.44 yrs (range 23yrs to 72yrs) which is comparable to that reported by various other studies, where average age ranged from 40 to 54 years.

Table 6: Age distribution comparison with other studies

Studies	Minimum age (in years)	Maximum age (in-years)	Mean age (in years)
Tillman M.Moore [22] <i>et al.</i> (1987)	17	81	44
M.V. Rademakers [23] <i>et al.</i> (2007)	16	88	46
Hitin Mathur [24] <i>et al.</i> (2005)	18	65	42
Our Study	23	72	46

8.1 Sex distribution: In our study is 42 males (84 %) and 8 females (16%) showing similarity with other studies i.e. male preponderance. This high association of proximal tibial fracture in males can be attributed to our Indian setup where female population largely work indoor and do not travel much.

Table 7: Sex distribution comparison with other studies

Studies	Male %	Female %
Tillman M. Moore <i>et al.</i> (1987) [22]	62.00	38.00
M.V. Rademakers <i>et al.</i> (2007) [23]	55.44	44.55
Hitin Mathur <i>et al.</i> (2005) [24]	85.18	14.81
Our Study	84.00	16.00

8.2 Mode of injury: High energy trauma, road traffic accident (RTA) predominate in our study causing 80 % of the fractures, and has been similarly reported as a major mode of injury by some studies, while fall from height predominate in some previous studies.

Table 8: Mode of injury comparison with other studies

Studies	RTA %	FFH %	OTHERS
Tillman M.Moore <i>et al.</i> (1987) [22]	25	40	35
Kenneth J. Koval <i>et al.</i> (1992) [25]	45	55	NIL
M.V. Rademakers <i>et al.</i> (2007) [23]	53	NIL	47
Our Study	80	20	NIL

8.3 Type of fractures: In our study the fractures were classified according to AO Classification which was quite comparable to other study.

Table 9: Type of fracture comparison with other studies

Studies	Cases		Percentage	
	Type B	Type C	Type B	Type C
M.V. Rademakers <i>et al.</i> (2007) [23]	139	63	69	31
Our study	38	12	76	24

8.4 Complications: In our study infection was not seen in any patient while Hitin Mathur *et al.* (2005) [24] 05%, M.V. Rademakers *et al.* (2007) [23] 5.4% reported infection in their series. Hitin Mathur *et al.* (2005) [24] found no case of nonunion in their series which is comparable to our series. While M.V. Rademakers *et al.* (2007) [23] found nonunion in 01% cases.

In our study articular depression was seen in 4(8%) patients, condylar widening was seen in 4(8%) patients. valgus was seen in 2(4%) patients and varus was seen in 4(8%) patients. Hitin Mathur *et al.* (2005) [24] found > 2 mm articular depression in 2(7.4%) patients and fracture displacement (varus/valgus) in 7(26%) patients. M.V.Rademakers *et al.* (2007) [23] found valgus malalignment in 6(3%).

Assessment of results: In our study there were 16(32%) excellent, 22(44%) good, 12(24%) fair radiological results with no patient having poor result according to modified Rasmussen score. In the series of Hitin Mathur *et al.* (2005) [24] there were 2(7.41%) excellent, 22(81.48%) good and 3(11.11%) poor results according to Rasmussen’s radiological score.

In our study according to modified Rasmussen score there were 19(38%) excellent, 19(38%) good, 9(18%) fair and (6%) poor functional results. In the series of Hitin Mathur *et al.* (2005) [24] there were 10(37%) excellent, 14(51.85%) good, 3(11.11%) fair with no poor functional results.

In the series of Kenneth J. Koval *et al.* (1992) [25] there were 6(33%) excellent, 10(56%) good and 2(11%) fair results.

In the series of M.V. Rademakers *et al.* (2007) [23] functional results were assessed by Neer score as well as HSS score. There were 76(69.7%) excellent, 27(24.8%) good and 6(5.5%) fair results according to Neer score while according to HSS score there were 68(62.4%) excellent, 23(21.1%) good, 10(9.2%) fair and 8(7.31%) poor results.

Finally, we concluded that surgically treated patients have significantly better functional outcomes than conservatively treated patients because of congruous joint surface and early knee mobilization.

9. Conclusion

The present study was undertaken to assess the management of tibial condyle fractures by various methods of treatment, following conclusions were drawn in our study:

- Tibial condyle fractures are seen maximum in 6th decade which is little different from previous studies which show maximum in younger age groups.
- Male preponderance is seen in tibial condyle fractures because of their more involvement in outdoor activities.
- Mode of injury is either a road traffic accident or fall from height. Road traffic accident is more common mode of injury especially involving two wheelers.
- The results of clinical assessment (Modified Rasmussen score) of our study shows that outcome of tibial condyle fractures are independent of gender, side injured and age \leq or $>$ 40 years.
- The results of radiological assessment (Modified Rasmussen score) of our study shows that outcome of tibial condyle fractures are independent of gender, side injured and age \leq or $>$ 40 years.
- Conservative treatment used for undisplaced or minimally displaced fractures showed good results in general while operated patients uniformly showed good results with stable fixation irrespective of implants used. External fixator as a definitive modality predisposed to stiffness due to prolong immobilization.
- Surgically treated patients have better radiological as well as clinical outcomes compared to conservatively treated patients because of good anatomical reduction and early mobilization of knee joint.
- Stable fixation gives early mobilization which improves functional outcome.
- Elevation of depressed intra-articular fragment and bone grafting restore articular architecture and provides overall favourable outcome.

Financial support and sponsorship: Nil.

Conflicts of interest: There are no conflicts of interest

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