International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2017; 3(1): 172-175

www.orthopaper.com
Received: 28-11-2016
Accepted: 29-12-2016

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Results of closed reduction percutaneous screw fixation and open reduction internal fixation in tibial plateau fractures

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DOI: http://dx.doi.org/10.22271/ortho.2017.v3.i1c.28

Abstract
Background: Tibial plateau fractures are common injuries that require anatomic reduction to obtain the best functional results. Advance in mechanization and acceleration of travel has been accompanied by an increase in number and severity of fractures and those of the tibial plateau are not an exception. This fracture constitutes approximately 1% of all fractures. Open reduction and rigid internal fixation for displaced tibial plateau fracture achieves the goals of restoring the anatomic articular congruity and mechanical alignment, while allowing early knee mobilization.
Aims and Objectives: To study the results and complications of open reduction and internal fixation by plate osteosynthesis versus closed reduction and percutaneous cannulated screw fixation for tibial plateau fractures.
Method: 43 patients with tibial plateau fractures treated either with open reduction and plate osteosynthesis or closed reduction and percutaneous cannulated screw fixation were followed up for a period of 18 months and their functional outcome was assessed according to Modified Delamarter functional scoring system.
Results: According to modified Delamater functional score, 90% had excellent to satisfactory result in patients treated with percutaneous screw fixation as compared to 67% in those treated with open reduction internal fixation. In both modalities 9% had poor results due to nonunion.
Conclusion: Closed reduction and percutaneous screw fixation for tibial plateau fractures is minimally invasive. It reduces the length of hospital stay and costs, enables early mobilization with minimal instrumentation, and achieves satisfactory outcome as compared to open reduction and plate fixation.

Keywords: Plate osteosynthesis, tibial plateau, fracture, knee joint, functional outcome, cannulated cancellous screw

1. Introduction
The number of tibial plateau fracture has increased significantly. The management of these fractures has been controversial. For many years, cast immobilization was the most common treatment. Apley (1950) recommended skeletal traction with early mobilization [1-4]. Many authors advocated selective cast bracing [5-7]. Comparable results with both conservative and surgical treatment have been found [8]. In recent years anatomical restoration has been recommended by operative measures [9-11]. Several authors advocate open reduction and internal fixation of the tibial plateau fractures. However poorly placed incision, extensive dissection tend to compromise the overlying soft tissue envelope and may result in soft tissue necrosis and deep wound infections adding to the disability [12-13].
Closed reduction by ligamentotaxis and if required, elevation of depressed plateau with various techniques and stabilization with percutaneous screw fixation have also given excellent results [14-16]. This technique is minimally invasive and avoids many of the complications of both conservative and open reduction and internal fixation [17-18]. The purpose of this study is to evaluate the results of tibial plateau fracture treated with open reduction internal fixation and closed reduction and percutaneous fixation.

2. Material and Method
- This study was carried out at Integral Institute of Medical Sciences And Research, Lucknow.

- **Type of Study**: Prospective
- **Duration**: September 2013 to March 2015.
- **Number of Patients**: A series of 43 patients was included in this study with fracture of tibial plateau. Tibial plateau fractures were classified according to Schatzker (1979) and Gustilo-Anderson classification. The mean follow up was 18 months.

Open fractures were initially debrided, immobilized and fixed later. Closed fractures were treated with early traction and immobilization followed by definitive fixation. Fractures with depression > 4mm of articular step were elevated with steinman pin percutaneously, however, if adequate reduction was not achieved, the fracture was open reduced.
The patients were mobilized as early as possible on CPM (continuous passive motion) and partial weight bearing was started at first radiological or clinical sign of union. Patients were followed up at months 6, 12 and 18. The outcome of each patient was analyzed functionally (pain, function, activity, residual angle, loss of extension and instability) according to the modified scoring system given by Delamarter [6] (Table 1).
The final analysis was done on 43 patients out of which Group A included 21 patients treated with open reduction and internal fixation and Group B consisted of 22 patients treated with closed reduction and percutaneous fixation.

Table 1: Modified Delamarter Scoring System

Functional Score		**Loss of extension**	
Pain			
: Nil	30	: Nil	5
: Occasional	25	:< 10 degree	3
: Over implant	20	: >10 degree	1
: During walking	15		
Function		**Instability**	
: Movement ≥ 120 degree	30		5
: 120-90 degree	25	: Nil	3
: 90-60 degree	20	: ACL or MCL or both	1
: <60 degree	15	: Above and PCL	
		Grading (Total Score)	
Activity		: Excellent (E)	90-100
: No limitation	15	: Good (G)	80-90
: Limited to walking	10	: Satisfactory (S)	70-80
: Assistance required	05	: Fair (F)	60-70
		: Poor (P).	<60
Residual angle	15		
: 0 -5 degree	10		
: 5 -10 degree	5		
: >10 degree			

3. Observations

Table 2: Mean Age

Group	A(n=21)	B(n=22)
Mean Age(Years)	37.35	34.10

Table 3: Mode of Injury

Group	A(n=21)	Percentage	B(n=22)	Percentage
RTA	20	95.2%	19	77.3%
Fall	0	-	2	18.2%
Assault/Others	1	4.8%	1	4.5%

Table 4: Sex Distribution

Group	A(n=21)	Percentage	B(n=22)	Percentage
Male	20	95.2%	21	95.5%
Female	1	4.8%	1	4.5%

Table 5: Side Distribution

Group	A(n=21)	Percentage	B(n=22)	Percentage
Right	8	38.1%	17	77.3%
Left	13	61.9%	5	22.7%

The mean age of Group A was 37 years as compared to 34 years in Group B (Table 2). Road traffic accident was the major cause of this fracture in both groups while fall also accounted for 18% mode of injury in percutaneous group (Table 3). Males (95%) were mostly afflicted with this fracture in both groups (Table 4). The fracture was more common on left side in group A whereas right side was more common in group B (Table 5).

Table 6: Schatzker Distribution

	A(n=21)	Percentage	B(n=22)	Percentage
I	0	-	1	4.5%
II	5	23.8%	0	-
III	2	9.5%	0	-
IV	7	33.3%	9	40.9%
V	1	4.8%	2	9.1%
VI	6	28.6%	10	45.5%

Table 7: Type of Fracture

	A(n=21)	Percentage	B(n=22)	Percentage
Simple	9	42.9%	11	50%
Compound	12	57.1%	11	50%
Grade I	1	4.8%	3	13.6%
Grade II	0	-	1	4.6%
Grade III	11	52.4%	7	31.8%

Grade III compound fractures were more common. Most of grade III were treated by open reduction and internal fixation (52.4%). Schatzker IV was the commonest fracture in Group A while Schatzker VI was commonest in group B. Most of Schatzker II required open reduction and internal fixation (Table 6, 7)

4. Results and Analysis

21 patients treated with open reduction and internal fixation and 22 treated with percutaneous screw fixation were analyzed.

Table 8: Mean Union Time

	Group A	Group B
Mean Union Time(Weeks)	29.2	23.5

Table 9: Range of Motion

	Group A	Group B
Mean Range Of Motion(Degree)	97.3	105.3

Table 10: Extensor Lag

	Group A	Group B
Extensor Lag(Degree)	8.1	4.4

Table 11: Residual Angle

	Group A	Group B
Residual Angle(Degree)	5	2.1

Patients in group B had earlier union time (23.5 vs.29.2 weeks), better range of motion (105.3degree vs. 97.3 degree), lesser mean extensor lag (4.4 degree vs. 8.1 degree) and lesser mean residual angle (2.1 degree vs. 5 degree) than in those where the fracture was open reduced (Table 8,9,10,11).

Table 12: Pain Distribution

	A(n=21)	Percentage	B(n=22)	Percentage
No Pain	6	28.5%	7	31.8%
Occasional	9	43%	11	50%
Over Implant	0	-	0	-
On Walking	6	28.5%	4	18.2%

Table 13: Activity Level

	A(n=21)	Percentage	B(n=22)	Percentage
No Limitation	4	19%	12	54.8%
Limitation To Walk	12	57.1%	7	31.8%
Assistance Required	5	23.8%	3	13.4%

Patients in group B were also more pain free (82% vs. 71%) and more active (55% vs19%) at the time of final follow up (Table 12, 13).

Table14: Rehabilitation

Rehabilitation (Weeks)	Group A	Group B
Immobilization	9.66	9.86
Non Weight Bearing	12.23	8.68
Partial Weight Bearing	17	14.63
Full Weight Bearing	24.38	17.23
Return To Work	29.65	20.8

The rehabilitation and return to work (21 weeks vs. 30 weeks) in the closed reduction percutaneous group was earlier than those with open reduction internal fixation. However, patients of group B had to be immobilized for longer duration (9.86 weeks vs. 9.66 weeks) Table 14).

Table 15: Functional Result

Functional Result	A(n=21)	Percentage	B(n=22)	Percentage
Excellent	1	4.8%	8	36.4%
Good	7	33.3%	5	22.7%
Satisfactory	6	28.6%	7	31.8%
Fair	5	23.8%	-	-
Poor	2	9.5%	2	9.1%

According to Delamertier functional score, the patients in percutaneous group had 90% excellent to satisfactory result as compared to 67% in group A. Both had 9% poor results, all of them were due to nonunion of these fractures (Table 15).

Table 16: Complications

Complications	A(n=21)	Percentage	B(n=22)	Percentage
Peroneal Nerve Injury	1	4.8%	-	-
Superficial Infection	1	4.8%	-	-
Stifness	6	28.6%	5	22.7%
Varus/Valgus Deformity	5	23.8%	2	9.1%
Skin Flap Necrosis	1	4.8%	-	-
Non Union	2	9.5%	2	9.1%

The complication rate was more in group A with stiffness (28.6%) and deformity (24%) as the major ones. Group B had lesser complication with stiffness (22.7%) as the common ones (Table 16).

Table 17: Average Number of Hospital Days

	Group A	Group B
Average No.of Hospital Days	18	11

Patients treated with open reduction internal fixation had longer stay in the hospital (11 days) as compared to closed reduction group (18 days) (Table 17).

5. Discussion

Fractures of tibial plateau are a challenging clinical problem. Various options of treatment are available but optimal treatment continues to be controversial subject. Satisfactory results have been obtained by both operative and nonoperative methods. Apley (1950), Hohl *et al* (1956) and Sarmiento (1971) recommended nonoperative treatment for tibial plateau fractures in which fracture united but there were more chances of deformity and loss of reduction [5, 6]. The indication for surgical treatment varies from articular depression of 4mm – 10mm to instability [6-8, 19]. If depression and instability are accepted then it persists and, because of overload and incongruity, results in early post traumatic arthritis.

Most fractures are severely comminuted, with extensive soft tissue injury and pose a serious dilemma to the surgeon, especially if osteoporosis complicates it more [20]. There is relative little soft tissue around the knee joint and excessive dissection is necessary to insert implants impairing the blood supply to bone and overlying tissues. Moore *et al*, Schatzker J used open reduction and internal fixation with plating to stabilize tibial plateau fractures at the expense of devastating complication such as wound infection and slough, osteomyelitis and joint sepsis at rate of approximately 20% (0-87%).

However, a competent internal fixation permits early movement of knee and contributes to improved functional and anatomical results. Agnew *et al* and Benirschke *et al* reported good results with immediate open reduction and internal fixation of complex tibial plateau (Schatzker V & VI) fractures with even larger wounds (Grade IIIA). Infection rate was 1% with gentle soft tissue handling, reduction with ligamentotaxis with plating and at times external fixation.

Percutaneous fixation of tibia plateau is intuitively attractive and optimally can be done with minimal impact on the overlying soft tissue in split fractures which can be reduced by ligamentotaxis with minimal depression, it has not replaced open reduction internal fixation under direct vision.

Marsh *et al* [21] reported on 17 Schatzker type VI fractures treated with percutaneous screw fixation and regained an average of 115 degree knee movement. Lasinger *et al* [8] reported 85% excellent to good functional outcome with both open reduction and internal fixation and percutaneous screw fixation. However there were no poor results in percutaneous group. Hohl *et al* [6] and Burri *et al* [19] reported about 60% good result and 11% poor result with open reduction and internal fixation as compared to 70% good result and no poor result by percutaneous screw fixation as reported by Dendrinos *et al*. Gahr *et al* [14] also found that the functional results of percutaneous fixation were in all respect comparable to those cases of open reduction and internal fixation.

6. Conclusion

Although percutaneous fixation is still in its infancy, it is expected to develop rapidly as an alternative to open reduction and internal fixation. The method appears to avoid major soft tissue complications, speed rehabilitation, shorten the length of patients stay in the hospital and reduce the cost of treatment and improve functional results.

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