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Original Research Article

Evaluation of the Functional Outcome after Single/Dual Plating for Proximal Tibial Articular Fractures

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Abstract:

Introduction: Knee being one of the major weight bearing joints of the body, fractures around it will be of paramount importance. The proximal tibial fractures are one of the commonest intraarticular fractures. They result from indirect coronal or direct axial compressive forces. The majority of tibial plateau fractures are secondary to high speed velocity accidents and fall from height. This study evaluates the functional outcome of high energy tibial articular fractures treated with use of single/dual plating.

Material & Methods: The prospective study conducted in the Department of Orthopaedics, MLB Medical College Jhansi from May 2019 to Oct. 2020 on 40 patients of proximal tibia fractures. The cases who were 19-49 years, unilateral, closed fractures, proximal tibial fractures (Schatzker type 1 to VI) with no previous involvement of ipsilateral leg in surgery were included in the study.

Results : The youngest patient was 19yrs old and the oldest was 47 yrs. Majority of the fracture were found to be type IV,V and VI fracture types. Most fracture union occurred between 4-5 months. Most of the cases were fell under good modified Rasmussen clinical score 45.0%, followed by excellent 30.0%. Most of the cases were fell under excellent modified Rasmussen radiological score 47.50%, followed by good 30.0%. Knee stiffness, knee instability, implant prominence and infection are the complications occurred in study.

Conclusion: Locking compression plate is mechanically and biologically an advantageous implant in tibial plateau fractures and is effective in prevention of collapse after osteosynthesis, thus allowing early mobilization.

Keywords: Fracture, Locking compression plate; internal fixator; MIPPO.

Introduction

The knee is one of the three major weight-bearing joints in the lower extremities. Tibial plateau fractures are a type of fracture that results from a high-energy impact between bone and another surface. They can be simple or complex in nature. Proximal tibial fractures are among the most common intraarticular fractures. These injuries are classified into two categories: high energy fractures and low energy fractures.

The majority of tibial plateau fractures occur as a result of high-speed velocity accidents and falls from height [1], with fractures caused by direct axial compression, typically with valgus (more common) or varus movement and indirect shear forces [2]. Extra-articular fractures of the proximal tibia are usually caused by direct bending forces applied to the metadiaphyseal region of the upper leg. Older patients with osteopenic bone are more likely to sustain depression type fractures because their subchondral bone is less likely to resist axial directed loads. [3]. The main aim of surgical treatment includes precise reconstruction of the articular surface with elevation of the depressed bone fragment with or without bone grafting, stable fracture fragment fixation and repair of concomitant soft tissue injuries allowing early range of movement to get better functional outcome. Various clinical studies established that bone beneath a rigid conventional plate is thin and atropic, which are prone for secondary displacement due to insufficient buttressing and secondary fractures after removal of the plate, fracture site take longer period to osteosynthesis due to interruption of vascular supply to bone due to soft tissue and periosteal stripping.

The emergence of a novel concept in biological fixation using plates, referred to as minimally invasive plate osteosynthesis (MIPO), has been established. However, this was challenging since conventional plates needed to be correctly shaped to ensure effective attachment. Additionally, osteoporosis posed the same problem of poor fixation with conventional plates. But this was difficult as conventional plates needed to be accurately contoured to achieve good fixation, osteoporosis also posed the same problem of poor fixation with conventional plates [4].

This leads to the development of the internal fixators. Point contact-fix I later PC fix II. As more and more concepts about biological fixation become clearer the innovation of plates progressed lead to development of less invasive stabilizing system (LISS).

The AO locking compression plate (LCP) was developed through research combining these two approaches [5]. The primary goal of the study was to assess the functional outcome of high energy tibial articular fractures treated with single/dual plating, so we can conclude that this new system is technically mature, offers numerous fixation options, and has proven useful in complex fracture situations and osteoporotic bones.

Material and Methods

The study was prospective study, conducted in the Department of Orthopaedics, MLB Medical College Jhansi from May 2019 to Oct. 2020 on 40 patients of proximal tibia fractures. The inclusion criteria for the study was age 19 years to 49 years, Unilateral, Closed Fractures, Proximal Tibial fractures (Schatzker type 1 to VI) and No previous involvement of ipsilateral leg in surgery.

The exclusion criteria for the study was age <18years and > 50 yrs. Patient with compound fracture and with associated ligamentous injury, associated Neurovascular injuries and patients having any other associated fracture in lower limb.

Pre-Operative Evaluation

Detailed history of all patients was taken and recorded in inpatient files. All patients were assessed clinically and also assessment was done for anteroposterior and mediolateral ligamentous laxity. The preoperative medical evaluation of all patients was done to prevent potential complications that can be life threatening or limb threatening.

Radiographic Assessment

Standard guidelines were utilized to get knee radiographs -anteroposterior view and lateral view. Respective essential scans of other body parts were taken to rule out other injuries.

In certain cases CT scans were also taken in order to have better analysis of fracture geometry. Also X-Ray and CT-Scan were screened for bony avulsion fractures of ACL, PCL, LCL, and MCL.

Operative Procedure

All patients after thorough pre-op evaluation were taken up for surgery by the same surgical team under general or spinal or epidural anaesthesia. Tourniquet was applied at the thigh region and sterile preparation done from thighs to toes and draped.

Implants Used

Plates:

- Proximal tibial hockey plates with right and left offset-Locking with 3.5 mm or 4.5 mm screws (high profile plate).
- L-buttress plate with right and left offset-Locking types (low profile plate).
- T-buttress plate locking types (low profile plate)
- Raft plate locking (3.5mm plate system)

Bone screws:

- 6.5 mm cancellous bone screws with thread length 16mm and
- 32mm
- 4.5 mm cortical bone screws
- 4mm cancellous bone screws
- 5.5mm locking screws
- 3.5mm locking screws

Surgical Technique

Surgical approach adopted was governed by the geometry of the fracture. The following were the approaches used-

- Anterolateral approach to the lateral tibial plateau
- Minimal access anterolateral approach to the proximal tibia (mippo)
- Posteromedial approach to the proximal tibia

The fractures will be graded preoperatively using the Schatzker's classification of tibial plateau fractures.

Functional outcome

The functional outcome will be evaluated according to Modified Rasmussen scoring system (Rasmussen, 1973).

Modified Rasmussen radiological knee 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 outdoors more than one hour	5
Walking outdoor 15 min -1 hour	3
Walking outdoor <15 mins	1
Walking indoor only	0
Knee extension	
Lack of extension <10°	2
Lack of extension >10°	0
Lack of extension >20°	-2
Total range of motion	
Full	6
At least 120°	5
At least 90°	3
At least 60°	1
<60°	-3
Stability	
Normal stability in extension and 20°flexion	6
Abnormal instability in 20° flexion	4
Inability in extension <10°	2
Inability in extension >10°	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

Modified Rasmussen clinical scoring system (Rasmussen, 1973) [6]

Articular depressions	
None	3
<5 mm	2
6-10mm	1
>10mm	0
Condylar widening	
None	3
<5mm	2
6-10mm	1
>10mm	0
Valgus varus angulation	
None	3
<10°	2
10°-20°	1
>20°	0
Osteoarthrosis	
None/ no progress	1
Ptrogression by grade1	0
Progression by >1 grade	-1
Outcome	
Excellent	9-10
Good	7-8
Fair	5-6
Poor	<5

Results

In this study the youngest patient was 19yrs old and the oldest was 47 yrs. Most of the patients belong to 21-40 yrs of age group who are more prone for RTA. Males are more commonly involved which reflects that outdoor population more prone for the proximal tibial fractures. Tibial fractures are more commonly in RTA (70%) followed by fall (30%).

Operation was performed within 3 days in 32.50% of cases while 30% of cases were operated between 4-7 days, and 37.5% of cases were operated between 8-14 days from trauma (table 1).

Table 1: Demographic parameters of the cases

	Number of patients	**%**
Age (yrs)		
<20	1	2.50
21 – 40	24	60.0
>40	15	37.50
Sex		
Male	33	82.5
Female	7	17.5
Mode of injury		
Fall	12	30.0
RTA	28	70.0
Time from injury to surgery (days)		
1-3	13	32.50
4-7	12	30.0
8-14	15	37.5

Majority of the fracture were found to be type IV,V and VI fracture types which are usually associated with high velocity RTA.

Table 2: Type of Fracture

Type of fracture	**Number of patients**	**%**
I	6	15.0
II	1	2.5
III	1	2.5
IV	10	25.0
V	8	20.0
VI	14	32.5

In this study most fracture union occurred between 17-20 weeks.

Table 3: Duration of fracture union

Duration (weeks)	**No. of patients**	**%**
13 – 16	3	7.50
17 – 20	32	80.0
21 – 24	5	12.50
Total	40	100

Most of the cases were fell under good modified Rasmussen clinical score 45.0%, followed by excellent 30.0%. 20% cases were given fair results and only 5% cases were poor Rasmussen clinical score

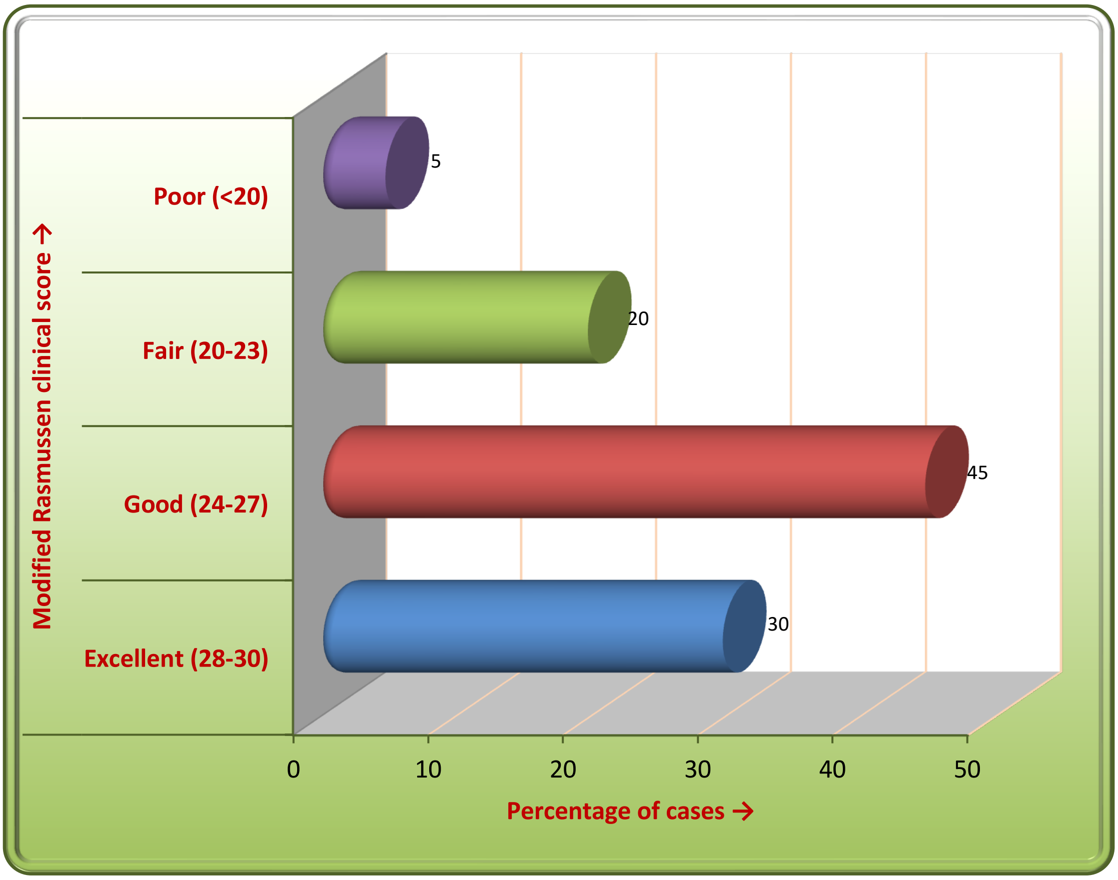

Figure 1: Distribution according to Modified Rasmussen's Clinical Score

The majority of the cases had a modified Rasmussen radiological score of excellent (47.50%), followed by good (30.0%). 17.50% of the cases had a fair Rasmussen radiological score, whereas just 5.00% had a bad radiological score.

Table 4: Distribution According to Modified Rasmussen's Radiological Score

Modified Rasmussen Radiological score	No. of patients	%
Excellent (28-30)	19	47.50
Good (24-27)	12	30.00
Fair (20-23)	7	17.50
Poor (<20)	2	5.00
total	40	100

In this study out of total cases, 87.5% cases were treated without any complications while 12.5% had some complications like knee stiffness, Knee instability, Implant prominence and Infection etc.

Table 5: Complication

Complication	Number of patients	%
None	34	85.0
Knee stiffness	2	5.0
Knee instability	1	2.50
Implant prominence	1	2.50
Infection	2	5.0
Total	40	100

Radiological pictures Clinical pictures

Figure 2: Radiological pictures at different time interval and clinical pictures after completion of treatment

Discussion

This is an observational, prospective study of 40 patients aged 19 to 47 years who were admitted to MLB Medical College in Jhansi, Uttar Pradesh, with closed intra-articular fractures of the proximal tibia and treated with a locking compression plate using various surgical approaches to address the fracture anatomy. The majority of fractures in this study occurred between the ages of 21 and 40 (65.0%) and above 40 (32.50%). Our findings are comparable to those of Honkonen (1994) [7], Lee et al. (2007) [8], Mankar et al. (2012) [9], and Myatt (2014)[10]. Male patients accounted for 82.5% of the total, while female patients made for 17.5%. Which is comparable to previous studies done by Dendrinos et al (1996) [11], Barei et al (2006) [12], Mankar et al (2012) [9] and Prasad et al (2013) [13].

Road traffic accidents were the most common mode of injury (70%). Our findings are analogous to those reported by Dendrinos et al. (1996) [11], Kim et al. (2012) [14], and Patil et al. (2015) [15].In our series, Schatzker IV and VI fractures were the most typically classified (25.0% and 32.5%, respectively), while type II and III fractures were among the least common injuries. The literature reports varying degrees of occurrence for distinct fracture forms.

Table 6: Comparing distribution of patients according to Schatzker's Type in various studies

Schatzker's type	**Schatzker**[16] **(1979)**	**Hondonen** [7] **(1994)**	**Ebraheim** [17] **2004)**	**Myatt** [10] **(2014)**	**Our series**
I	6	11.5	23.07	7.5	15.0
II	25.0	30.5	30.76	30.0	2.5
III	36.0	9.9	9.4	2.5	2.5
IV	10.0	9.3	5.12	20.0	25.0
V	3.0	21.3	18.8	27.5	20.0
VI	20.0	17.5	12.8	12.5	32.5
Sample size	94	131	117	40	40

The maximum fracture union time for proximal tibia fractures is 17-20 weeks. Our findings are similar to those reported by Ehlinger et al[18] (2012) and Prasad et al[13] (2013). The functional clinical evaluation produced 30.0% outstanding scores and 45.0% good results. We matched our findings to previous landmark investigations.

Table 7: Showing percentage of satisfactory results in various studies

Study	Sample size	Percentage of satisfactory result (Excellent + Good)
Schatzker[16] (1979)	94	86.0
Lachiewicz[19] (1990)	43	93.0
Chaix[20] (1993)	100	86.0
Honkonen[7] (1994)	131	86.0
Rademakers[21] (2007)	202	84.0
Our study	40	75.0

The results of radiological evaluation showed 47.50% excellent results and 30.0% good results. We have compared our results with some landmark studies done in the past.

Table 8: Showing percentage of radiological results in various studies

Study	Sample size	Mean radiological score
Dararaiah[22] (2016)	30	7.68
Reddy[23] (2017)	30	7.4
Our study	40	8.2

Out of 40 cases 10(12.5%) experienced problems including as wounds, knee stiffness, implant prominence, and surgical site infections. None of the instances were observed to have problems such as nonunions or neuron-vascular issues. No patient had a deep infection, and only two individuals had surgical site infections that were completely managed during the research.

Conclusion

Locking the threaded heads of the screws in the plate itself provides angular and axial stability, eliminating the possibility of screw toggling (windscreen wiper effect) or sliding of the screws in the plate holes, resulting in improved resistance to pull out and fixation failure.

It reduces the risk of thread stripping in osteoporotic bone since the plate/bone interface is not loaded along the screw axis. This also allows for more biological fixing since the underlying periosteum and blood supply to the fractured areas are less constricted. The best results occur when the operating procedure produces stable fixation. Fixation should be followed by early physiotherapy. The rehabilitation program has a significant impact on the functional result of tibial plateau fracture surgery.

Finally, a locking compression plate is a mechanically and biologically advantageous implant in tibial plateau fractures, since it prevents collapse following osteosynthesis, allowing for early mobilization.

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