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Original Research Article

Functional outcomeof tibial plateau fractures treated with locking compression plate

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Abstract

Introduction: Tibial plateau fractures have always been difficult to treat because of thesubcutaneous location of its anteromedial surface. These days significant attention hasbeen paid to the condition of soft tissue envelope. Study aims and objectives were to evaluate functional outcome of tibial plateau fracture treated by Locking compression plate in regards to Knee range of movements and complications.
Material and Methods:A prospective study was done on 30 patients of tibial plateau fractures treated by locking compression plate in Orthopaedic Department of Vijayanagara Institute of Medical Sciences, Ballari. Duration of study was from November 2019 to November 2021. We included patients of both the genders from 18 to 60 years of age, those were treated with LCP for tibial plateau fractures. However, open fractures (Gustilo Anderson), pathological fractures and patients with severe comorbidities were excluded from the study. Ethics committee approval was obtained.Informed written consent was taken. Data was collected from the patients.
Results: Majority of the patients (33.3%) were in the age group of 41-50 years. There was male preponderance (86.7%) in the study while female patients constituted 13.3% of the study group. Road Traffic Accident was found to be the most common cause of fracture. As per Schatzker classification system 3.3% of the patients were type I, 10% type II, 16.7% type III, 16.7% type IV, 30% type V and 23.3% type VI. ORIF technique was used in 6 (20%) patients while MIPPO was used in 24 (80%) patients. Most of the fractures (86.7%) were united by 12-16 weeks while 1 (3.3%) fracture was united in less than 12 weeks and 3 (10%) fractures were united in more than 16 weeks. 20(67%) patients had good results, 9(30%) patients had good result and 1(3%) patient had fair result.
Conclusion: From this study, we concluded that MIPPO with LCP seems to be good implant choice in tibial plateau fractures including difficult fracture situations.

Keywords: Tibial plateau fracture, LCP, MIPPO

Introduction

Tibial plateau fractures account for 1% of all fractures in adults and 8% in elderly. Fractures of tibial plateau more common in recent days due toincreasing number of road traffic accidents[1].These fractures resulting from direct axial compression(valgus) and indirect

coronal forces[2].The injuries span a wide spectrum, ranging from low energy unicondylar fractures to high energy bicondylarandcomminuted fractures.

In addition, in elderly with osteoporotic bones, even low energy injuries such as domestic falls may lead to complex tibial plateau fractures. Hence the treatment of tibial plateau fractures has become a challenge for the orthopaedic surgeons.

High energy tibial plateau fractures associated with severe soft tissue injury and this complicates the treatment of this injuries[3].The optimal treatment of tibial plateau fractures remains controversial and challenging due to highly demanding surgical procedure and perioperative complications[4, 5].

The goals of treatment of high energy tibial plateau fractures are to restore anatomical articular congruity, mechanical alignment restoration, joint stability with minimal soft tissue dissection to allow for early mobilization and establishment of good functional outcome[6].

Any fracture around the weight bearing joint like knee joint is of paramount importance as would result in significant morbidity and quality of life. The optimaltreatment for these fractures has always been a controversy. Studies have supported for both operative and non-operative methods. In low energy fractures both operative and nonoperative treatment results in good functional outcome.

Available management for high energy Tibial plateau fractures are skeletal traction,Plaster of Paris immobilization,Minimal internal fixation with external fixation, circular external fixator,Hybrid external fixator, open reduction and internal fixationwith conventional plate and locking compression plate[3].

High energy Tibial plateau fractures initially treated with dual plating, but associated with long term complications like wound problems,implant irritation and implant exposure.

Newer methods for the treatment of high energy tibial plateau fractures are locking compression plates and Hybrid external fixation.

External fixators are associated with complications like pin tract infection, knee joint stiffness, pain, discomfort and septic arthritis[4].

LCP has the advantages of better distribution of forces along the axis of bone. They can be inserted with minimal soft tissue stripping using minimally invasive percutaneous plate osteosynthesis(MIPPO). Substantially reducing failure of fixation in osteoporotic bones. Reducing the risk of a secondary loss of intraoperative reduction bylocking with screws to the plate. Unicortical fixation option.Better preservation of blood supply to the bone as a locked plating does not rely on plate bone compression. Provide stable fixation by creating a fixed angle construct and angular stability[7-9].

LCP is technically mature and as it offers numerous fixation possibilities and has proven to worth in complex fracture situations and in osteoporotic bones[8].

This prospective study aims at evaluating the surgical management and functionaloutcome of tibial plateau fractures with locking compression plate at Department of orthopaedics, Vijayanagara Institute of Medical Sciences, Ballari between November 2019 and November 2021.

Objectives

1. To study the functional outcome in Tibial Plateau Fractures managed with locking compression plate.
2. To assess the range of motion of knee and note the score for each patient at every follow up.
3. To study the complications.

Materials and Methods

Source of data

Our study was a prospective study, conducted at the Department of Orthopaedics, Vijayanagara Institute of Medical Sciences, Ballari between Nov 2019 and Nov 2021.

Inclusion criteria

- Schatzker type I-VI tibial plateau fractures.
- Patients of both sexes aged between 18 and 60 years.
- Closed fractures.

Exclusion criteria

- Open fractures.
- Age < 18 years and >60yrs.
- Associated with vascular injury.
- Pathological fractures.

Preoperative management

Patients were given adequate analgesia on reception in casualty. The injured limb was temporarily immobilized in Thomas splint and patients were shifted for X-ray.
Anteroposterior and lateral views were taken. Manual traction was used where appropriate.
CT scans were taken to assess three-dimensional fracture geometry in required cases. Skeletal traction was applied to some of patients in the form of calcaneal pin traction and weights applied with Bohler Braun splint. Ice fomentation was encouraged in the initial two days.
Skin over fracture was closely watched. Those presenting with severe soft tissue edema or blisters were taken up for surgery only after the appearance of wrinkle sign.
In case of severe soft tissue injury knee spanning external fixator was used up to the period of definitive surgery. Soft tissue tension and distal neurovascular status checked periodically to rule out compartment syndrome. Anti-edema measures were instituted for all of our patients.

Preoperative instructions

- Patients were kept fasting for 6 hours before surgery.
- A written informed consent for surgery and anaesthesia.
- Tranquilizers were given as advised by the anaesthetist.
- A systemic antibiotic usually inj.Ceftriaxone 1gm intravenously were administered 30 minutes before surgery to all patients.

The patient was suitably anaesthetized-regional or general according to the patient. Surgery was performed in supine position with the leg support. Anterolateral, posteromedial and anteromedial approaches were used for fixation.Recommended A-O technique of fracture fixation was used.

Surgical procedure[10]:

Under spinal anaesthesia patient was placed in supine position, with leg support bolster provided knee flexion or with traction table. Under C arm fracture pattern was visualized, in case of shortening and overriding of fracture fragments, reduction was achieved with traction.

Temporarily the reduced fragments were fixed with K wires.
Bicondylar fractures without coronal fracture in medial condyle were managed with lateral locking plate. Anterolateral approach was used for application of lateral locking plate.

Anterolateral approach for MIPPO

The lateral fracture was approached through anterolateral approach. For MIPPO technique curvilinear incision was made in between the Gerdy's tubercle and anterior to the head of fibula. Fascia was incised in line with the skin incision. Indirect reduction of fracture was done by femoral distractor or manual traction, articular reduction maintained with reduction clamp. Fracture was temporarily fixed with K wires.
Extra periosteal plane were created using blunt dissector. Locking compression plate was introduced extraperiosteally, plate position was checked under C-arm in both AP and Lateral views. Plate was temporarily fixed with proximal and distal K wire to avoid helicopter effect. Before applying screw axial alignment was checked under C arm guidance by cable technique.
First 6.5 mm locking cancellous screw was applied proximally parallel to the articular surface. Depressed fragments were elevated and void was filled with bone grafting or bone substitutes, distal most 5 mm cortical locking screw was applied through mini incision.
In case of difficulty in reducing the distal fragment (varus or valgus) we have used 4.5.mm non-locking cortical screws for reduction. K wires were removed, other screws were applied to the plate through multiple stab incision.

Open reduction and internal fixation

For open reduction incision was started from five cm above the joint line and extended distally upto the fracture site. To expose the fracture site clearly part of the ILIO tibial band released from Gerdy's tubercle.Further procedure as same as MIPPO technique.
Wound was closed in layers with suction drain. Sterile dressing applied.
Medial condyle fracture in coronal plane and small sized posteromedial fragment were addressed through posteromedial approach and fixed with 3.5 mm reconstruction plate(locking or non-locking). Wound was closed in layers, sterile dressing applied.

Posteromedial approach

The patient's knee was positioned in figure of four manner, incision was made posterior and parallel to the anterior tibial border. Incision was extended over the pes anserinus proximally.
Posteromedial fragment was exposed by retracting the pes anserinus anteriorly and popliteus and medial head of gastrocnemius posteriorly. Fracture was reduced and temporarily fixed with reduction clamp. Fracture was fixed with 3.5 mm locking reconstruction plate posteromedially.
Reduction was checked under C arm in both AP and Lateral views. Thorough wash given.Wound was closed in layers. Sterile dressing applied.

Post-operative protocol

Patients were maintained in a well-padded dressing postoperatively. Slabs werenot used for immobilization. Drain was removed on second postoperative day.
Antibiotics were used for 5 days. Suture removal was done on 12th postoperative day.
Patients were advised on non-weight bearing crutch walking. Knee mobilization was encouraged as soon as the patient was able to tolerate motion. 90 degrees active knee flexion

was achieved in all cases within 10 days post-surgery.

Follow up

The first follow up was usually between 4-6 weeks and later on patients were followed up at regular interval of 4-6 weeks till complete fracture union.
Partial weight bearing was started after 8 weeks when the fracture showed union. Full weight bearing was achieved only after solid fracture union usually between 12-14 weeks.Further follow up was done once every 3 months.

Assessment

Radiological assessment was performed taking into account two parameters:

1. Medial proximal tibial angle.
2. Articular step off.

Functional assessment was done using Modified Rasmussen Score.

Radiological assessment

Medial proximal tibial angle: Measured between proximal tibial knee joint orientation line(drawn connecting the concave surfaces of both tibial plateaus) and the mechanical axis of tibia. Medial proximal tibial angle (MPTA)-87+/- 5 degrees.
Articular step off: Measured in plain X-ray, < 2mm is acceptable.

Fig 1: Implants

Fig 2: Operative Instruments

Fig 3: Painting and Drapping

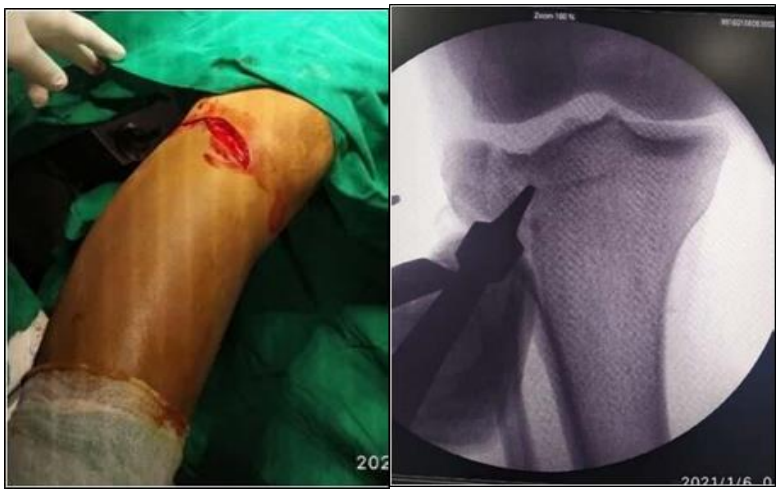
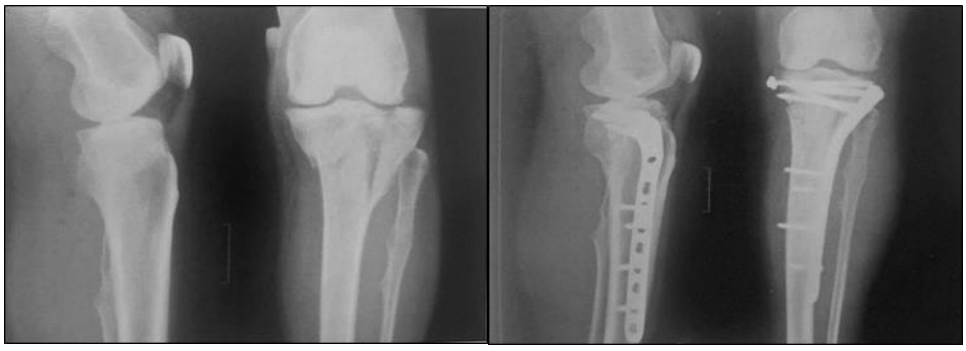


Fig 4&5: Incision & Reduction under C Arm Guidance

Fig 6: Plate Inserted **Fig 7:** LCP Applied under C Arm

Case 1

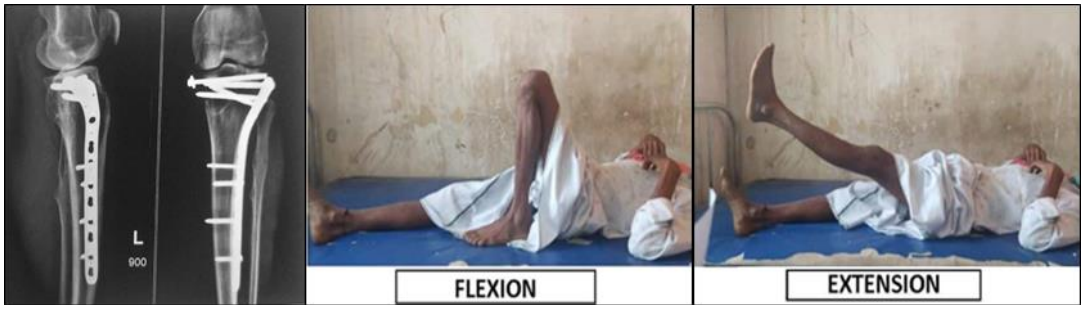


Preoperative X-rays **Immediate Post-Operative X-rays**

Fig 8 & 9: Pre-Operative and Immediate Postoperative X-Rays

6Weeks FollowUp **3Months FollowUp**

Fig9&10:6Weeksand3Months FollowUp



6 Month FollowUp **Post OP Range of Motions**

Fig10&11:6MonthFollowUpandPostOp Rangeof Motions

Fig 12: Infection and Implant Exposure

Results

We studied 30 patients with tibial plateau fractures who were treated with locking compression plate.

Table 1: Age Distribution

Age Distribution		
Age in Years	**Number of Patients**	**Percent (%)**
18-30	8	26.7
31-40	4	13.3
41-50	10	33.3
51-60	8	26.7
Total	30	100

In our study most of the patients were of 41-50 years age group of 30 patients,60% were of >40 years age.

Table 2: Gender Distribution

Gender	Number of Patients	Percentage (%)
Male	26	86.7
Female	4	13.3
Total	30	100

In our study 87% were male patients. Male to female ratio is 6.5:1.

Table 3: Laterality of Fracture

Side	No. of Patients	Percentage (%)
Left	10	33.3
Right	20	66.7
Total	30	100

In our study right, sided predominance is more than left side.

Table 4: Mode of Injury

Mode of Injury	No. of Patients	Percentage (%)
Accidental Fall	2	6.7
RTA	28	93.3
Total	30	100

In our study most common mode of injury is road traffic accidents.
It shows the high velocity injury nature of tibial plateau fracture is common.

Table 5: Fracture Pattern Distribution

Schatzker Type	No. of Patients	Percentage (%)
I	1	3.3
II	3	10
III	5	16.7
IV	5	16.7
V	9	30
VI	7	23.3
Total	30	100

Majority of cases in our study are Schatzker type V (30%) and next common is type VI (23%).

Table 7: Method of Reduction and Fixation

Method of Reduction	No. of patients	Percentage (%)
MIPPO	24	80
Open	6	20
Total	30	100

In our study 80% of the cases were fixed with MIPPO technique in order to avoid soft tissue damage and enhance the biological healing.

Table 8: Operative Time

Operative time in mins	No. of Patients	Percentage (%)
<60	7	23.33
61- 90	19	63.33
91-120	4	13.33

Mean duration of operation-82 minutes (50-120).

Table 9: Fracture Union

Duration in Weeks	No. of Patients	Percentage (%)
0-11	1	3.3
12-16	26	86.7
>16	3	10
Total	30	100

In our study majority of patients fracture united between 12-16weeks. All of our cases were united in an average 14.2weeks.

Radiological analysis

Medial proximal tibial angle (MTPA) measurement was taken to assess varus/valgus malunion postoperatively. The normal value of MPTA is 87+/-5 degrees. In our study, the average value was 85.4 degrees (normal range 83-91). Thus, we found that the normal proximal tibial joint orientation is maintained after application of LCP.
Articular step-off was assessed with less than or equal to 2mm step-off kept as acceptable limit. In our series, 1 cases had articular step off more than 2mm(range 3-5mm)and 29 cases had the acceptable result of less than or equal to 2mm step off.

Table 10: Range of motion

Range of Motion in Degrees	No. of Patients	Percentage (%)
>120	22	73.3
90-120	5	16.6
<90	3	10
Total	30	100

In our study majority cases had good range of motion of more than 120 degrees. Only 3 cases had knee stiffness because of poor compliance with physiotherapy.

Table 11: Clinical Results Based on Rasmussen Score

Score	No. of Patients	Percentage (%)
19	1	3.3
22	2	6.7
23	2	6.7
24	4	13.3
25	6	20
26	6	20
27	3	10
28	4	13.3
29	2	6.7
Total	30	100

Table 12: Clinical Results

Interpretation	Frequency	Percentage (%)
Excellent	9	30.0
Good	20	67.0
Fair	1	3.0
Total	30	100

Clinical results

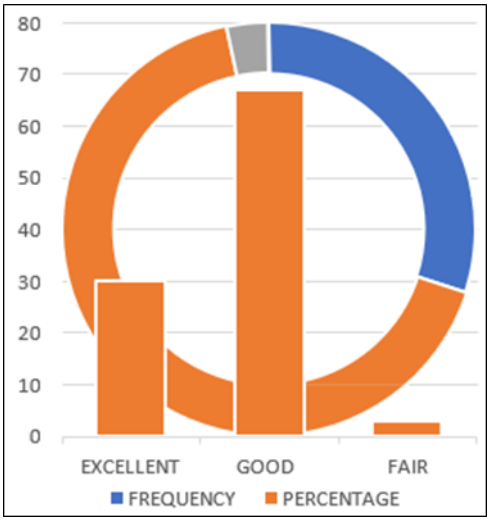


Fig 13

Post-Operative complications

Table 13: Complications

Complications	No. of Patients	Percentage (%)
Knee stiffness	3	10
Nonunion distal part of tibial tuberosity fragment	1	3.3
Distal screw infection	1	3.3
Implant exposure	1	3.3
None	24	80
Total	30	100

In our study we had 24 patients with no complications.
Three patients developed knee stiffness due to poor compliance with physiotherapy.
One of the patient had nonunion of the distal fragment of tibial tuberosity fragment which was not fixed primarily.
One patient developed implant exposure post-operative after 12 weeks. Implant removal was done and put on above knee cast for 4 weeks. Fracture united in 16 weeks and the cast was removed.
One patient developed distal screw infection for that patient was treated with oral antibiotics.

Discussion

Tibial plateau fractures are complex fractures accounting for about 1% of all fractures[11].They affect knee function and stability which results in considerable morbidity. These fractures are caused by high velocity injuries and often associated with severe comminution and soft-tissue damage. The goals of treatment are to restore joint congruity,

limb alignment and early mobilisation of joint[12, 13].Stable internal plate fixation without damaging the soft-tissue envelope is very difficult to achieve, only fair results are seen in 20% to 50% in these fractures[14].

Direct fracture visualization, reduction, and fixation are achieved with open reduction and internal fixation (ORIF) with plates and screws, but there is high risk of soft tissue injury, stiffness and deep infection[15].The soft tissue problems are avoided with hybrid external fixator, but risks malalignment, pin tract infections and poor patient compliance[16].

The concept of preserving the blood supply and atraumatic surgical technique led to the development of biological fixation techniques. Using this technique, soft tissue damage is reduced and shows higher union rate[17-19].

With development of locking compression plates has allowed the use of minimally invasive technique for unilateral plating with the soft tissue handling improvement.

Locking compression plates placed laterally provides better stability in presence of complex tibial plateau fractures with metaphyseal comminution and for medial column when non-locking plate is used for bicondylar fractures it serves as an alternative to medial plate or external fixator for additional support.

MIPPO enables indirect fracture reduction and percutaneous sub muscular implant placement[20].Favourable outcome is not due to MIPPO but due to less extensive dissection of soft-tissue envelope and devitalisation of fracture fragments.

The aim of our study was to evaluate the surgical management and functional outcome of tibial plateau fractures treated with locking compression plate.

There is no universal scoring system for assessing the functional outcome for these fractures. Literature shows multiple scoring system like Rasmussen; knee society score and oxford knee score.

In our study, we have evaluated the patients using Rasmussen score.

All the fractures were treated with single locking compression plate anterolaterally. In case of Schatzker's type V and type VI fractures, if needed the opposite condyle was fixed an additional medial plate[21].

Mechanism of injury in majority of cases (28 patients) was road traffic accident and remaining two cases has accidental fall. The fractures were classified by Schatzker's classification. 7 patients belonged to type VI, 9 patients belonged to type V, 5 patients belonged to type IV, 5 patient belonged to type III, 3 patients belonged type II and 1 belonged to type 1. Even though, according to literature type II fractures were the most common, only one patient with type II fracture was included in our study as all other type II & type I fractures in the study period were fixed only by percutaneous screws hence excluded from the study.Type V fracture with 9 patients (30%) were the most common in our study, next was type VI (23.3%) with 7 patients.

Average follow up period was 15 months (8-24).

HASNAIN RAZA20 *et al*., in their study of assessing the functional outcome of tibial condyle fractures of 41 patients by minimally invasive plate osteosynthesis by rasmussen functional score found excellent results in 18 patients, good in 19 patients and4 patients had unacceptable results. The mean rasmussen score was found to be 25.3 and range of knee flexion was 118 degrees. In our study mean rasmussen score was found to be 25.4 and average range of knee flexion was found to be 120 degrees. Of which nine patients had excellent and 20 had good results. Only 1 patients had fair result. This is comparable to the study done by Hasnain Raza.

Mohammad Ali Tahririan, Seyyed Hamid Mousavitadiand Mohsen Derakhshan in their clinical study comparing the functional outcomes of tibial plateau fractures treated with nonlocking and locking compression plate fixation by knee society score, found a score of 80.2 for locking plate and 72.5 for non-locking plate. Average range of knee flexion was found to be 122.3 degrees for locking compression plate and 115.7 degreesfor non-locking

plate. In our study, locking compression plate was used for all the cases. Average knee society score was found to be 92.5 and average knee flexion was found to be 120 degrees. So, functional outcome in our study was marginally better than the locking compression plate group in that study and significantly better than the nonlocking group. This shows the superiority of the locking compression plate in view of stable fixation and early range of motion when compared to non-locking plate[22].

Chang-Wug Oh [21]*et al*. in their study on double plating of (twenty three) type Vand type VI proximal tibial fractures using minimally invasive percutaneous osteosynthesis found Eighteen patients with excellent, three patients with good and two patients with fair results. Average rasmussen score was found to be 26 and average knee range of motion was found to be 123 degrees.

In our study, sixteen patients belonged to type V and VI fractures. Average rasmussen score of these type V and type VI fractures were found to be 24.25. Average range of flexion achieved by type V and type VI was found to be 117.5 degrees. Two patients had excellent, thirteen patients with good and one patient had fair results.

Conclusion

- At the end of our study, following conclusions could be drawn from the treatment of proximal tibial fracture with locking compression plate.
- Early mobilization is possible with LCP because of absolute stability given by the implant and this contributes to better knee range of motion.
- Medial condyle coronal fracture and small posteromedial fragment should be buttressed by posteromedial plating.
- LCP gives the promising results in osteoporotic bones.It prevents collapse of fracture both intraoperatively and postoperatively.
- Not all bicondylar fractures are same,treatment should be precise to individual fracture pattern.
- Bicondylar tibial plateau fractures treated with locking compression plate have an excellent to good functional outcome with very minimal wound complications.

References

1. HemilManiar, Erik NKubiak, Daniel SHorwitz. Tibial plateau fractures. In: Paul Tornetta III, William MRicci, Robert F,Ostrum, Margaret MMcQueen, Michael DMcKe,Charles M. Court-Brown(eds.) Rockwood and Green's fracturesin adults,9"edition,Philadelphia: Wolters Kluwer. 2019;2:4231-4324.
2. Matthew, Rudloff. Fractures of the lower extremity. In: Frederick MAzar, JamesHBeatys. Terry Canale(eds.) Campbell's Operative Orthopaedics.13" edition, Philadelphia: Elsevier. 2017;3:2762-2774.
3. Koval KJ, Helfet DL. Tibial plateau fractures: evaluation and treatment. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 1995 Mar;3(2):86-94.
4. Ali AM, Saleh M, Bolongaro S, Yang L. The strength of different fixation techniques for bicondylar tibial plateau fractures-a biomechanical study. Clinical Biomechanics. 2003Nov;18(9):864-70.
5. Papagelopoulos PJ, Partsinevelos AA, Themistocleous GS, Mavrogenis AF, Korres DS, Soucacos PN. Complications after tibia plateau fracture surgery. Injury. 2006 Jun;37(6):475-84.
6. Marti A, Fankhauser C, Frenk A, Cordey J, Gasser B. Biomechanical evaluation of the less invasive stabilization system for the internal fixation of distal femur fractures. Journal of orthopaedic trauma. 2001 Sep;15(7):482-7.

7. Schuetz M, Müller M, Krettek C, Höntzsch D, Regazzoni P, Ganz R,*et al*. Minimally invasive fracture stabilization of distal femoral fractures with the LISS: A prospective multicenter study results of a clinical study with special emphasison difficult cases.Injury. 2001 Dec;32:48-54.
8. Wagner M. General principles for the clinical use of the LCP. Injury. 2003 Nov;34:B31-42.
9. Ostrum RF, Geel C. Indirect reduction and internal fixation of supracondylar femur fractures without bone graft. Journal of orthopaedic trauma. 1995 Jan;9(4):278-84.
10. Agnew SG. Tibial plateau fractures. Operative techniques in orthopaedics. 1999 Jul;9(3):197-205.
11. Schatzker J.Tibial plateau fractures.in Browner, Jupiter, Levine and Trafton. Skeletal traumaWB. Saunders, Philadelphia, 1993, 1745-9.
12. De Coster TA, Nepola JV, Choury GY. Treatment of proximal tibia fracture. A ten year follow up study. Clin Orthop Relat Res, 1994, 196-204.
13. Brown GA, Sprague BL. Cast brace treatment of plateau and bicondylar fractures of the proximal tibia. Clinical orthopaedics and related research. 1976 Sep;(119):184-93.
14. Waddell JP, Johnston DW, Neidre A. Fractures of the tibial plateau: a review of ninety-five patients and comparison of treatment methods. J Trauma. 1981;21:376-81.
15. Lachiewicz PF, Funcik T. Factors influencing the results of open reduction and internal fixation of tibial plateau fractures. Clinical orthopaedics and related research. 1990 Oct;(259):210-5.
16. Khan MA, Khan SW, Qadir RI. Role of exteranl fixator in the Management of Type-II and III open Tibial Fracture. Journal of Postgraduate Medical Institute (Peshawar-Pakistan), 2004, 18(1).
17. Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P, Tscherne H. Minimally invasive plate osteosynthesis: does percutaneous plating disrupt femoral blood supply less than the traditional technique?Journal of orthopaedic trauma. 1999Aug;13(6):401-6.
18. Savoie FH, Vander Griend RA, Ward EF, Hughes JL. Tibial plateau fractures: a review of operative treatment using AO technique. Orthopedics. 1987;10:745-50.
19. Charnley J. The closed treatment of common fractures. Third edition. Baltimore; Williams & Wilkins, 1961.
20. Minimally invasive plate osteosynthesis for tibial plateau fractures. Journal of Orthopaedic Surgery. 2012;20(1):42-7.
21. Double plating of unstable proximal tibial fractures using minimally invasive percutaneous osteosynthesis technique. Chang-Wug Oh1, Jong-Keon Oh2, Hee-Soo Kyung1, In-Ho Jeon1, Byung-Chul Park1, Woo-Kie Min1 and Poong-TaekKim1 Acta Orthopaedics. 2006;77(3):524-530.
22. Cole PA, Zlowodzki M, Kregor PJ. Less Invasive Stabilization System (LISS) for fractures of the proximal tibia: indications, surgical technique and preliminary results of the UMC Clinical Trial. Injury. 2003 Aug;34:A16-29.