The Egyptian Journal of Hospital Medicine (April 2019) Vol. 75 (5), Page 2942-2951

Treatment of Bicondyler Tibial Plateau Fracture by Single Lateral Locked Plate

Ahmed Badawy, Hesham Safwat, and Mohamed El-Sheshtawy El-Saedi*
Department of Orthopedic Surgery, Faculty of Medicine, Al-Azhar University
***Corresponding author:** Mohamed El-Sheshtawy El-Saedi, **Mobile:** (+20)01154405169, **E-Mail:** doc.mohamed.elsaedi@gmail.com

ABSTRACT

Background : bicondylar tibial plateau fractures need surgical treatment to achieve good clinical results. The locking plate combines the technical advantages of an angular stable plate with those of the modern biological plating technique. **Aim of the study:** to verify management of bicondylar tibial plateau fractures by single lateral locked plate including patient selection, fracture type suitable for this kind of surgery, timing of surgery, operative technique, postoperative instructions and follow up. **Patients and Methods:** between January 2018 and February 2019, 20 patients with a mean age of 38 years (Range: 24-57 years) with bicondylar tibial plateau fractures with or without metaphyseal extension. Patients were diagnosed clinically, checked with standard X-rays, CT was done for all cases. Patients were treated by single lateral anatomically contoured locked plate through LISS or polyaxial locking plate systems with or without additional screws from medial side. **Results:** the mean Functional Rasmussen Knee score at last follow-up was 94.7% ranged between 83.3% and 100%. The mean Anatomical Rasmussen Knee score at last follow-up was 92.2% ranged between 77.7% and 100%. Mean Functional Rasmussen Knee score of patients had (Schatzker V fractures) was 96%, however it was 82.5% in those had (Schatzker VI fractures).
Conclusion: surgical treatment of bicondylar tibial plateau fractures with the single lateral locked plate that was evaluated in our study can lead to a good functional and anatomical outcome and considered an effective system for providing fracture stabilization provided that the correct surgical technique is used.
Keywords: Tibial plateau fracture, Locked plate, LISS, Polyaxial locking plate.

INTRODUCTION

The tibial plateau refers to the proximal end of the tibia including the metaphyseal and epiphyseal regions as well as the articular surfaces made up of hyaline cartilage. By Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO-OTA) classification, the tibial plateau includes the metaphysis to a distal distance equal to the width of the proximal tibia at the joint line. Tibial plateau fractures constitute 1% of all fractures and 8% of fractures in the elderly [(1)].

The injury patterns to the tibial plateau depend on the magnitude of forces, the quality of the bone and the age. It is generally believed that the relatively increased strength of the medial tibial condyle structure, and the normal valgus alignment of the lower limb are responsible for the higher incidence of lateral tibial condylar fractures secondary to low-energy forces. Similar amount of forces cause split or wedge fractures in the young population, or depression fractures in the osteoporotic bone of the elders [(2)]. A thorough history should be obtained, including determination of the mechanism of injury and the patient's overall medical status, and functional demands. Physical examination is necessary to detect concomitant ligamentous injuries, neurovascular injuries, and other injuries. Anteroposterior, lateral and oblique radiographs and Computed Tomography (CT) scans are necessary to evaluate these fractures. The exact role of Magnetic Resonance Imaging (MRI) in evaluating patients with tibial plateau fractures is still evolving [(3)].

There are two main challenges in management of bicondylar plateau fractures. Firstly the compromised skin and soft tissue envelope which invite a high rate of complications following attempted open reduction and fixation. Secondly, poor bone quality and comminuted fracture patterns, which create difficulty in achieving rigid fixation since the purchase in osteoporotic and trabecular bone is less than optimal to permit weight bearing or even to start joint motion [(4)].

Surgical treatment of bicondylar plateau fractures foresees stabilization with an external ring fixator, and internal fixation with medial and lateral plates using two surgical approaches. The need to minimize the risk of such complications as soft tissue damage and instability calls for surgical treatment, which allows to restore joint congruency as well as correct rotational and axial alignment. Several Authors introduced the concept of ''indirect reduction'' of fractures, without damaging the surrounding soft tissues or without operating directly in the fracture site. Based on these concepts, the Minimal Invasive Plate Osteosynthesis (MIPO) has been studied and developed [(5)].

AIM OF THE WORK

- To verify management of bicondylar tibial plateau fractures by single lateral locked plate including patient selection, fracture type suitable for this kind of surgery, timing of surgery, operative technique, postoperative instructions and follow up.
- To investigate the advantages and complications of surgical treatment by single lateral locked plate and compare with other treatment options.

Received:0/2/2019
Accepted:12/3/2019

PATIENTS AND METHODS

This study was conducted in Al-Hussein hospital, Al-Azhar University and Al-Mansoura International hospital. Between January 2018 and February 2019, on 20 patients with bicondylar tibial plateau fractures with or without metaphyseal extension, who were diagnosed clinically, checked with standard X-rays, CT was done for all cases and treated by single lateral anatomically contoured locked plate through LISS (Low Invasive Stabilization System) or Polyaxial locking plate systems with or without additional screws from medial side. Radiological evaluation and functional assessment was done according to the Rasmussen score. Patients were followed-up for an average of 12 months. **The study was approved by the Ethics Board of Al-Azhar University and an informed written consent was taken from each participant in the study.**

Inclusion criteria: They were bicondylar tibial plateau fractures with or without metaphyseal extension. Fractures were classified by two classifications, Schatzker and AO-OTA classifications. Patients were aged between 24-57 years, diagnosed clinically and radiologically by X-.ray and C.T.

Distribution of patient sex and age: Patients were eighteen men and two women. Their ages ranged from twenty four to fifty seven years with a mean age thirty eight years**.**

Distribution of patient occupation: Ten patients were manual worker, 3 were retired, 2 work in Clerck job, 2 were drivers, 2 were teachers and 1 student.

Distribution of mechanism of injury: In 7 patients, mechanism of injury was pedestrian and another 7 patients had fractures due to fall from height. Last 6 patients had fractures due to motor vehicle accidents (MVA).

Distribution of Classification of the fractures: According to Schatzker classification, 10 cases had bicondylar tibial plateau fractures (Schatzker 5) and 10 cases had bicondylar tibial plateau fracture extending to metaphysis (Schatzker 6) fractures.

Distribution of Associated injuries: 10 patients had isolated bicondylar tibial plateau fractures whereas 6 patients had associated ipsilateral injuries including fracture femur, fracture radius, fracture talus, fracture dislocation elbow, fracture acetabulum, fracture shaft of fifth metacarpal bone and fracture both bone leg. All patients were examined using advanced trauma life support (ATLS) routines of primary and secondary survey. Immediate resuscitation and treatment of injuries that threaten life or limb was done. All patients were examined radiologically on admission with anteroposterior and lateral X-Rays for the whole leg including knee and ankle joints. Plain X-Rays were done also for associated skeletal injuries. C.T. films were done including 3D-C.T. for all cases. All patients were classified by Schatzker classification.

Operative technique:

A- Timing: Internal fixation was done within 24 hours from surgery for all patients except for 2 cases. *First case,* was open fracture (Gustillo II) upon which wound debridement & C/S, tetanus prophylaxis, empirical antibiotics till results of C/S came and spanning external fixation done. Internal fixation was done later on after 10 days. *Second case,* was comatosed having subdural hemorrhage. Definitive internal fixation was done after 14 days when vital signs were stable.

B- Anesthesia: The surgery was done to all patients under epidural anesthesia except polytraumaized ones upon which combined general and epidural anesthesia was given.

C- Patient positioning: The patient was placed supine with the knee semiflexed on radiolucent traction table to assist in reduction and maintain alignment by ligamentotaxis. The C-arm was placed opposite the injured extremity and perpendicular to the patient to aid the technician with orientation of the fracture. Traction table was used to assist in reduction and maintain it till fixation was done. Tourniquet was elevated within average 300 mmHg pressure; **Fig. (1).**

Figure (1): Patient position on traction table.

D- Approach: Based on minimal invasive surgery, LISS was used for 14 cases and polyaxial locking plate system for 6 cases. After proper draping, a short oblique anterolateral incision was made just proximal to the origin of tibialis anterior muscle distally and up to Gerdy's tubercle just distal to the joint then the fascia is released. Exposure of the lateral surface of the proximal tibia is performed with a periosteal elevator. The knee joint was exposed, if needed, via a minimal dissection and sub-meniscal arthrotomy where needed. If the meniscus was incarcerated in the fracture, it was extracted and stitched if possible; **Fig (2).**

Figure (2): Approach used for surgery.

E- Reduction of intraarticular fracture:

In displaced intraarticular fractures, we reduce the articular surface before plate application.

First, Medial plateau fracture should be reduced and fixed. We reduce articular fragments temporarily with reduction forceps and/or by applying subchondral K-wires under fluoroscopic guidance. Then, 3.5mm, 4.5mm or 5.5mm bone screws may be utilized for compression independently outside of the plate or within the metaphyseal head of the locked plate. Lag screws from medial side were utilised in ten patients.

Second, reduction of articular portion of lateral plateau was done by the same manner after elevation of depressed articular surface if present. If there was large intercondylar imenence fragment, it was reduced and fixed. Calcium phosphate ceramic bone graft was used in 2 cases for filling defects.

F- Determination of plate position: On the lateral C-arm position, the proper position for the plate is such that the anterior border of the plate parallels the anterior border of the tibial diaphysis and 5mm posterior to this border**.** The proximal/distal location of the plate is such that the posterior proximal hole should be at the level of the lateral joint line. Temporary fixation was done by small K-wire through specific holes in the plate.

G- Choice of the implant: We used Less Invasive Stabilization System (LISS) for fixation of 14 tibial plateau fractures. Polyaxial Locked Plate System used for remaining 6 fractures. We assembled the selected plate, tibial target guide, tibial handle and tibial connecting screw on the back table. Orientation of the tibial target guide was done for the appropriate left or right plate. Using the target guide as a handle, the plate was inserted in a submuscular, extraperiosteal fashion along the lateral aspect of the tibia. A Cobb elevator was used submuscularly to aid in plate insertion as needed. Then positioning of the proximal end of the plate along the lateral tibia and verifying the position with A/P and lateral fluoroscopic views of the knee were done. The plate was placed approximately 2 mm distal to the joint line **(Fig. 3)**. Gentle traction was applied to the limb followed by gross realignment of the tibia at that time.

Figure (3): Clinical intraoperative photo for positioning of the plate using target guide.

H- Fixation of the fractures:

The angular fragments reduced and fixed by ordinary cancellous or cannulated screws under fluoroscopic guidance prior to application of locking screws.

1- Application of Proximal Locking screws of LISS

2- Application of Proximal Locking screws of Polyaxial locking system.

3- Reduction of Shaft to Tibial Plateau.

4- Insertion of distal locking screws.

5- Insertion of Truss Locking screws into the angled holes.

Finally, we confirmed fixation and under fluoroscopic image guidance in both AP and lateral views. Then reexamined the limb again for alignment before wound closure.

Postoperative instructions:

1- Medications:

Intravenous antibiotic in the form of third-generation cephalosporins (Ceftriaxone) as a prophylaxis was given for all patients starting from the day of surgery and continued till drain removal after 48 hours. An anticoagulation therapy and antiembolic stockings were performed up to the start of ambulation from bed.

2- Follow up visits:

First visit was within 14 days from surgery for check up of the wound and removal of stitches if wound looked healed. R.O.M. was checked and recorded. Second visit was at 6-8 weeks **fig. (4),** third visit was at 4-6 months with the start of F.W.B, fourth visit was at 9 months and fifth visit was at 12 months unless complications occurred. Each visit had clinical evaluation of the wound, measuring R.O.M. and plain (AP & lateral) X-rays.

Figure (4): Follow up: second visit

The outcome following surgical intervention was determined using Rasmussen knee Score at the third visit with the start of full weight bearing and fifth visit with the end of follow up to assess the progress of healing and improvement of knee function with this type of fixation. This scoring tool consists of anatomical and functional grading.

Anatomical grading of Rasmussen knee score consists of 3 parameters: including assessment of joint depression, condylar widening and angulation. Total anatomical score is 18 points. Anatomical score was considered excellent if the score is 18. Good results if the range between 12 and18, while fair score range between 6-12 and poor score range less than 6 points.

Functional grading consists of five parameters that are used to assess the function of the knee: including pain, walking capacity, degree of extension, range of motion, and degree of stability. The minimum score is 4 and the maximum score is 30.

A low score means a worse functional outcome, while a higher score is correlated with better knee function.

Functional score was considered excellent if the points were between 27 and 30 points. Good results between 20 and 27 points while fair results between 10 and 20 points and results were considered poor if the range was less than 10.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc, Chicago, Illinois, USA). Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Independent-samples t-test of significance was used when comparing between two means.
- Chi-square (x^2) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant as the following:
- Probability (P-value)
- P-value <0.05 was considered significant.
- P-value <0.001 was considered as highly significant.
- P-value >0.05 was considered insignificant.

RESULTS

Postoperative assessment:

Mean knee range of motion after post-operative programmed physiotherapy and just before discharge from hospital was 3.9°—99.5° ranging from 0°—10° for extension lag to 90°—115° degrees of flexion from extension lag. Postoperative radiological assessment was done for all patients including assessment of joint depression, condylar widening, medial proximal tibial angle and posterior proximal tibial angle **(Table 1)**. All post-operative radiological parameters were within normal limits except one patient (#17; 5%); MPTA, PPTA and condylar widening were outside the normal range in this patient.

Table (1): Post-operative radiological assessment

Case	Depression	MPTA	PPTA	Widening
1	No	89°	10°	3mm.
2	No	86°	**9°**	3mm.
3	2mm.	91°	12°	3mm.
4	No	90°	**8°**	4mm.
5	No	87°	10°	No
6	No	85°	**9°**	2mm.
7	2 mm	90°	**8°**	1mm.
8	No	92°	**6°**	1mm.
9	No	91°	**8°**	No
10	No	91°	10°	4mm.
11	No	90°	**8°**	No
12	No	87°	**8°**	No
13	2 mm.	87°	**7°**	4mm.
14	No	86°	10°	3mm.
15	No	91°	**8°**	5mm.
16	No	89°	9*	2mm
17	No	94°	17°	5mm.
18	2mm.	90°	**7°**	2mm.
19	2mm.	92°	**7°**	3mm.
20	No	87°	12°	1mm.

Follow up period:

From 20 patients followed in our study, 17 patients were followed till final assessment after 12 months **(Table 2)**. One patient (#5) had deep infection

and followed up till removal of metal after 6 months. Another patient (#10) developed hardware irritation upon which removal of metal after 6 months. The third one (#17) was lost to follow up after revision of surgery due to unacceptable reduction.

Table (2): Follow up period.

Follow up in month	Number of patients	Percentage
< 3 months	1	5%
0-6 months	2	10%
0-12 months	17	85%
Total	20	100%

Table (3): Comparison between functional Rasmussen Knee Scoring system at 4-6 months and 12 months

Score	Functional outcome (4-6months)	Functional outcome (12months)
>90%	1	12
76-90%	18	5
50-75%	0	0
<50%	0	0
LTFU	1	1
Not included	0	2
Total	20	20

Comparison between anatomical Rasmussen Knee Scoring system at third and fifth visit: (Table 4).

Table (4): Comparison between anatomical Rasmussen Knee Scoring system at 4-6 months and 12 months

Score	Anatomical outcome (4-6months)	Anatomical outcome (12months)
>90%	6	10
76-90%	13	7
50-75%	0	0
<50%	0	0
LTFU	1	1
Not included	0	2
Total	20	20

Relation between age and mean Rasmussen knee score: The relation between age of the patients and the mean final result can be demonstrated in the following table and charts **(Table 5)**. Patients below 30 years approach about 99.1% of mean functional Rasmussen score and 100% of mean anatomical score while older patients had lower figures. The P value is 0.9350, considered insignificant regarding this relation. (Values of p less than 0.05 were considered statistically significant).

Table (5): Relation between age and mean final Rasmussen knee score

Age / years	Number of patients	Mean Functional Rasmussen Score	Mean Anatomical Rasmussen Score
From 20-30	4	99.10%	100%
From 30-40	7	97.10%	92.10%
From 40-50	3	92.20%	90.70%
From 50-60	3	85.50%	88.90%
Not included	3	————	————

Relation between fracture pattern and mean Rasmussen knee score:

The relation between fracture pattern and the mean final result can be demonstrated in the following table and charts **(Table 6)**. Patients having Schatzker V fractures approach about 96% of mean functional Rasmussen score and 93.8% of mean anatomical score while patients with Schatzker VI fractures had a lower figures. The P value is 0.0196, considered significant regarding functional score, while it was 0.9572 regarding anatomical score which was considered insignificant. (Values of p less than 0.05 were considered statistically significant).

Table (6): Relation between fracture classification and mean Rasmussen knee score

Schatzker Classification	Number of patients	Mean Functional Rasmussen Score	Mean
Schatzker V	9	96%	93.80%
Schatzker VI	8	82.50%	90.30%
Not included	3	————	————

Complications:

In our study, overall complication rate was 30% **(Table 7)**. Preoperative complications include one patient had Compartment Syndrome (C.S.) and one patient had common proneal nerve palsy. Post operative complications occurred as followed, one patient (5%) had superficial infection, one patient (5%) had deep infection, one patient (5%) has fixation failure, and one patient (5%) had hardware irritation.

Table (7): Summary of complications of our study

Complications	No. of Patients	Percentage
No Complications	14	70%
Preoperative C.S.	1	5%
Preoperative Proneal N. Palsy	1	5%
Infection(superficial&deep)	2	10%
Fixation Failure	1	5%
Hardware irritation	1	5%
Total	20	100%

CASE PRESENTATION
CASE (1)

Pre-operative data

- Age: 29
- Sex: male
- Occupation: bus driver
- Mechanism of injury: motor veicle accident
- Symptoms: severe pain, limitation of movement and deformity of the left knee
- Signs: mild effusion, tenderness over the bony landmarks and limited range of motion of the left knee
- Classification of the fracture: Schatzker V
  Associated injuries: no

Plain x ray:

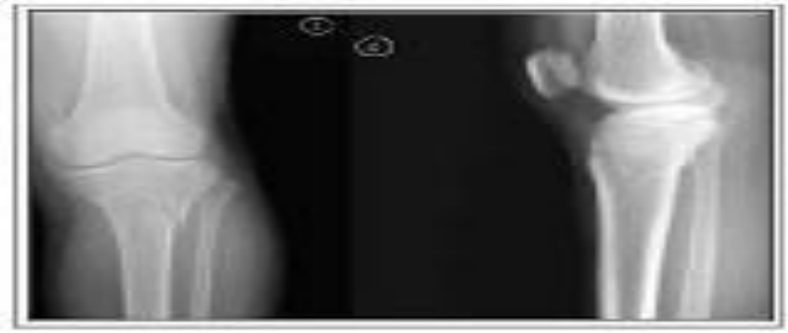

Figure (5): Pre operative ap & lat x ray of case 1

C.T:

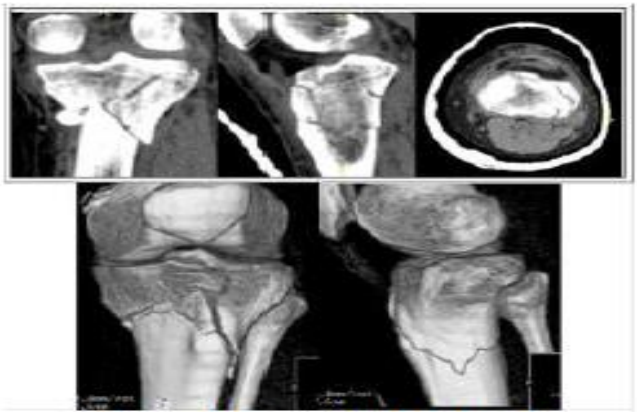

Figure (6): Pre operative C.T of case 1

Intraoperative views

Temporary fixation by k-wires:

Figure (7): Intraoperative temporary fixation by k-wires

Adjustment of plate position:

Figure (8): Adjustment of plate position in case 1

Post operative data

Immediate x-ray:

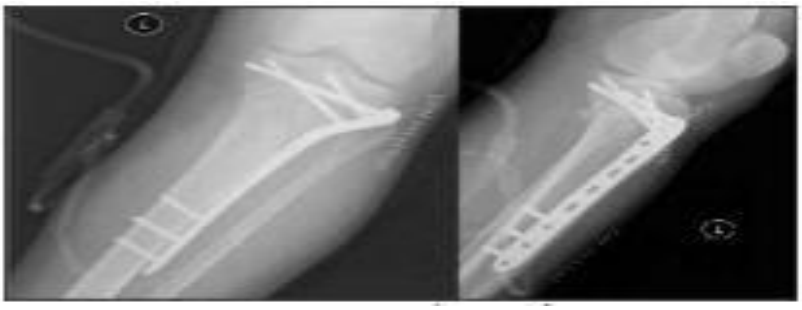

Figure (9): Post operative x ray in case 1

Post operative radiological assessment

Figure (10): Post operative radiological assessment of case 1

Follow up X-ray

Second visit: after 8 weeks:

Figure (11): Ap & lat X.ray of case 1 in 2nd visit of follow up

Third visit: after 4 months with assessment

Figure (12): X-ray with assessment of case 1 in 3rd visit Fourth visit: after 9 months

Figure (13): Ap & lat X-ray of case 1 in 4th visit

Fifth follow up: After 12 months with assessment

Figure (14): X-ray with assessment of case 1 in 5th visit

Knee R.O.M. was 0°- 135°. Plain X rays were done. No articular depression nor condylar widening. MPTA was 85°, PPTA was 10° and condylar widening was 2mm. Rasmussen knee score was assessed. Anatomical score was 18 points which was considered excellent. Functional score was 29 which considered excellent.

DISCUSSION

In our study we treated 20 patients, in a prospective study, having bicondylar tibial plateau fractures treated with single lateral locked plate using LISS in 14 cases and polyaxial locking plate system in remaining 6 cases. We compared between our study and other studies published since 2003 with the start of era of single lateral locked plating for bicondylar tibial plateau fractures.

Lee *et al.*[6] reported the results of 15 patients with bicondylar tibial plateau fractures treated with unilateral locked plate in a retrospective study with a mean age of 43 years. The incidence of female patient was 53% and male patients were 47%. The follow up ranged between 12-30 months

Phisitkul *et al.* [7] published a retrospective study of the results of 37 patients with bicondylar tibial plateau fractures treated with LISS with a mean age of 45 years. Male patients were 60%, while female patients were 40%. They followed the patients 11-12 months. That study revealed R.O.M. 1°-130° incidence of malalignment and fixation failure WAS 22%, post operative Compartment syndrome occurred in that study by 2.7%, Post operative proneal nerve palsy occurred as 2.7%, *Hardware irritation* incidence by 10.8% and the incidence of loss of fixation was 8%. *Delayed union or non union* was not reported.

Stannard *et al.*[8] published a prospective study of 37 patients having bicondylar tibial plateau fractures treated with LISS the mean age was 42 years; with incidence of male patients 68% and female patients 32%; they followed the patients from 12-38 months. The mean R.O.M. was 1°-127°. The incidence of malalignment and fixation failure was 5.8%. *Loss of fixation* was not reported. *Delayed union or non union* was not reported.

Cole *et al.*[9] reported a study of 54 patients treated with LISS with mean age of 44 years. The incidence of male patients was 72% and incidence female patients was 28%. They followed the patients 3-35 months. That study revealed R.O.M. about 1°-116°. Incidence of malalignment and fixation failure was 17%. Post-operative proneal nerve palsy occurred as 1.3%. *Hardware irritation* occurred as 5%.the incidence of loss of fixation was 3%.

In our study we treated 20 patients, in a prospective study, having bicondylar tibial plateau fractures treated with single lateral locked plate using LISS in 14 cases and polyaxial locking plate system in remaining 6 cases.

Ages of our patients ranged between twenty four to fifty seven years with a mean age thirty eight

years in our study that 90% of our patients were males, while 10% were females; in our study the follow up ranged between 1-12 months

The mean range of motion at the end of our study was1.5°-130°.

As mentioned before, the outcome following surgical intervention and insertion of a locking plate was determined using Rasmussen knee Score. From analysis of the literature concerning the use of single lateral locked plate in treatment of bicondylar tibial plateau fractures, our results are considered satisfying with mean functional Score that was 94.7% ranged between (86.7%-100%). Mean anatomical Rasmussen score in our study was 92.2% ranged between (77.8%-100%) which was considered satisfactory in comparison of other results.

Regarding Fracture pattern, analysis of the fracture has revealed that a better functional score was detected in Schatzker V fractures (an average of 96%) than in Schatzker VI fractures (82.5%). (significant results). Analysis of the fracture revealed that a better anatomical score was detected in Schatzker V fractures (an average of 93.8%) than in Schatzker VI fractures (90.3%). (No significant results).

The complication rate in our study is comparable to the literature, where the most recent studies report complication rates between 11.6 % and 68.2% [(90)].

The overall complication rate in our study is 30%. Preoperative complications include Compartment Syndrome 5% and common proneal nerve palsy 5%. Post operative complications occurred as followed, wound complications 10% including superfecial infection 5% and deep infection 5%. Fixation failure occurred in 5% of patients and 5% had hardware irritation.

Wound infection was the most frequent complication in our study with 10%. As mentioned before *superficial wound infection* occurred in patient (#19) and *deep infection* occurred in one patient (#5). Multifactorial reasons may be the cause of such wound complications. Both patients were having tibial plateau fractures (Schatzker VI). Second case having open fracture (Gustilo II), and general comorbidities as being diabetic and alcoholic. Considerable damage to their soft tissues and initial severe soft tissue damage or intraoperative over striping may result in a loss of vascular supply and increase the rates of infectionThe significance of posteromedial fragments in bicondylar tibial plateau fractures was recently addressed in the literature although both incidence and subsequent displacement are usually underestimated. **Barei *et al.*** [(10)] and **Higgins *et al.*** [(11)] reported that the incidence rate of posteromedial fragments in patients with bicondylar tibial plateau fractures was 28.8–59%. The presentation of posteromedial fragments makes reduction and fixation of complex plateau fractures more difficult, especially when a single fixed angle plate is used.

Weaver *et al.* [(12)] conclude that to use unilateral locked plating in cases where the medial tibial condyle is intact and is one large piece. If fracture fragments are large, and the joint surface itself is relatively preserved, LISS system could be used. For more complicated articular injuries they favour large fragment locking plates as the screw spread more effectively and could captures the medial tibial condyle. Additional fixation with independent small or mini fragment plates and/or screws is often required if the lateral articular surface is comminuted. If the medial fragment is either small (limiting fixation from the lateral side) or fractured in the coronal plane, dual plating have better results [(12)].

Some biomechanical studies have proved that the stability of fixation of a posteromedial fragment with a lateral locking plate is weaker than that with conventional lateral plating with a posteromedial buttress plate [(13, 14)].

Conversely, **Goesling *et al.*** [(15)] reported comparable stability against secondary loss of reduction for LISS compared to bilateral plating constructs, in their biomechanical model of unstable intra-articular proximal tibial fracture patterns. A formal prospective, randomised comparison of double plating, buttress plates, external fixation and locking plate techniques has not been published but could determine the optimal fixation method.

CONCLUSION

The fixation afforded by this type of plate allows early mobilization of the knee that contributed to the good functional outcome. We recommend early start of postoperative physiotherapy till a good functional recovery is reached. The use of locking plates in these complex fractures coupled with supervised physiotherapy provides a stable fixation and allows early functional recovery.

The timing of weight-bearing after surgical fixation of fractures may also affect the maintenance of reduction. Regarding our protocol, weight-bearing is not permitted until radiographic proof of callus formation is obtained even there was evidence of clinical union. However, patient noncompliance and incorrect radiographic interpretation can lead to inappropriate loading before the fracture is adequately healed. We believe that prolonged non weight-bearing may be necessary for patients whose fracture gap exists with a comminuted pattern or patients whose soft tissue status is unfavourable.

REFERENCES

1. **Schatzker J, Watson JT, Levy B *et al.* (2009):** Tibial plateau fractures. In: Browner, Jupiter, Levine, Trafton, editors. Skeletal trauma. 4th ed. Philadelphia, PA: WB Saunders Co., 2074-2131.
2. **Biggi F, Fabio SD, Antimo CD *et al.* (2010):** Tibial plateau fractures: Internal fixation with locking plates and the MIPO technique. Injury Int J Care Injured, 41:1178-1182.
3. **Canale ST, Beaty JH (2012):** Tibial plateau fractures. In: Campbell's Operative Orthopedics. 12th edition. Elsevier Mosby, PP: 2668-2681.
4. **Gosling T, Schandelmaier P, Muller M *et al.* (2005):** Single lateral locked screw plating of bicondylar tibial plateau fractures. Clin Orthop Relat Res., 439:207-214.
5. **Spagnolo R, Pace F (2012):** Management of the Schatzker VI fractures with lateral locked screw plating. Musculoskeletal Surg., 96(2):75-80.
6. **Lee KJ, Moon JY (2012):** Minimum Two-year Results of Revision Total Knee Arthroplasty Following infectious or non-infectious Causes. Knee Surg. Relat Res., 24(4): 227-234.
7. **Phisitkul P, McKinley TO, Nepola JV *et al.* (2007):** Complications of locking plate fixation in complex proximal tibia injuries. J Orthop Trauma, 21:83-91.
8. **Stannard JP, Wilson TC, Volgas DA *et al.* (2004):** The less invasive stabilisation system in the treatment of complex fractures of the tibial plateau: short term results. J Orthop Trauma, 18:552–558.
9. **Cole PA, Zlowodzki M and Kregor PJ (2004):** Treatment of proximal tibia fractures using the less invasive stabilization system: Surgical experience and early clinical results in 77 fractures. J Orthop Trauma, 18: 528–535.
10. **Barei DP, O'Mara TJ, Taitsman LA *et al.* (2008):** Frequency and morphology of the posteromedial fragment in bicondylar tibial plateau fracture patterns. J Orthop Trauma, 22(3):176-82.
11. **Higgins TF, Kemper D and Klatt J (2009):** Incidence and morphology of the posteromedial fragment in bicondylar tibial plateau fractures. J Orthop Trauma, 23:45-51.
12. **Weaver MJ, Harris MB, Strom AC *et al.* (2012):** Fracture pattern and fixation type related to loss of reduction in bicondylar tibial plateau fractures. Injury Int J Care Injured, 43: 864-869.
13. **Yoo BJ, Beingessner DM and Barei DP (2010):** Stabilization of the posteromedial fragment in bicondylar tibial plateau fractures: a mechanical comparison of locking and non locking single and dual plating methods. J Orthop Trauma, 69: 148-155.
14. **Zeng ZM, Luo CF, Putnis S *et al.* (2010):** Biomechanical analysis of posteromedial tibial plateau split fracture fixation. Knee, 18:51-54.
15. **Goesling T, Frenk A, Appenzeller A *et al.* (2003):** LISS Plate: Design, mechanical and biomechanical characteristics. Injury, 34 (1):11–15.