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Management of posterior column tibial plateau fracture via a posterior approach

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***Abstract*---**Background: Posterior tibial plateau fracture (PTPF) is a relatively uncommon injury. This kind of fracture appears confusing on initial radiographs because of the small displacement, so it is a special injury pattern. Aim and objectives: the aim of the study was to evaluate the safety and efficacy via a posterior approach in the posterior shearing tibial plateau fracture. Subjects and methods: The study was prospective study carried out in the Department of Orthopaedic surgery, Al-azhar university Hospital in Damietta. This study had been carried out on 24 patients. Results: there is statistically significant difference between immediate post-operative reduction and other post-operative reduction after 6 weeks, 3 months and 5 months. Conclusion: Posterior tibial plateau fracture is relatively rare in tibial plateau fractures. Our study highlights the importance of posterior tibial plateau fracture which was deemed unimportant in the past. Our results highlight the importance of fixation of PTPF and achieving an early and satisfactory functional outcome.
***Keywords*---**Fixation, Functional, Outcomes, PTPF, Tibial plateau.

Introduction

Posterior tibial plateau fracture (PTPF) is a relatively uncommon injury, with an incidence of 28.8%. This kind of fracture appears confusing on initial radiographs because of the small displacement, so it is a special injury pattern that is not sufficiently included in any type of the classification systems. [1] There are

controversies over surgical approaches and fixation methods for PTPF, because it is difficult to reduce and stabilize the injury through conventional strategies. It is a specific fracture pattern that is not well described by the AO (41- B2.2/B3.2) or Schatzker (IV, V, VI) classification systems because these classification systems do not differentiate cases in which the medial fragment is primarily posterior and sometimes associated with a dislocation or subluxation of the knee joint. [2]

Recently, posteromedial fracture was well defined in the revised Duparc classification using important findings to classify Schatzker type IV fractures as spinocondylar (74%), unicondylar (19%), posteromedial (5%) or bicondylar (2%). [3] Posteromedial fractures, either isolated or associated with another fracture, was a challenge for observers to classify, because they are not described in the Schatzker or AO classifications. Moore classified this type of fracture but did not describe management in depth. On the Moore classification, type 1 fracture-dislocation corresponds to the modified Duparc category of posteromedial split fracture, and type 2 to medial spinocondylar and lateral spinocondylar fracture. [4] These fractures are mostly caused by high-energy trauma and are sometimes associated with significant ligament and soft tissue injuries. They may include anterior cruciate ligament (ACL) avulsion fracture, posterior cruciate ligament (PCL) avulsion fracture, and posterolateral corner (PLC) injuries. This fracture pattern, however, is inherently unstable and difficult to adequately reduce and stabilize by conventional techniques and approaches. [5]

A reduction problem is often faced during posteromedial or posterolateral displacement of the tibial fragment under knee flexion. The supine position with a posteromedial or posterolateral approach requires extensive dissection for reduction purposes. Furthermore, the biomechanical principles of management of these fractures require placement of a posterior anti-glide buttress plate, therefore, the posteromedial fragment sometimes cannot be optimally treated by conventional anterior, medial, or posteromedial approaches in the supine position. [6]

A conventional vertical incision of the posteromedial collateral ligament and detachment of the medial capsule and medial head of gastrocnemius from the medial femoral condyle are required for full exposure of the posteromedial facet. Posterior approaches, such as described by Trickey in the 1960s, are more demanding and involve dissection of the neurovascular bundle .To overcome these problems, Galla and Lobenhoffer described a direct posteromedial approach for managing Moore type I tibial head fracture-dislocations. [7] The study aimed to evaluate the safety and efficacy via a posterior approach in the posterior shearing tibial plateau fracture.

Patients and Methods

The study was prospective study carried out in the Department of Orthopaedic surgery, Al-azhar university Hospital in Damietta. This study had been carried out on 24 patients. The study contained 24 patients who met the inclusion criteria assuming that attendance rate for patients with tibial plateau fracture admitted in the Department of Orthopaedic surgery, Al-Azhar university Hospital

in Damietta was 4 patients per month so the comprehensive sample was 24 patients per study duration using epi info at power 80% and CI 95%.
Inclusion criteria: Patients with posterior column fracture and age: 20 to 60 years**.**
Exclusion criteria: Patients above 60 or below 20 years old, neglected fracture more than 3 weeks, pathological fractures**.**

Methods

The included patients were subjected to:
Detailed history taking including: Patients' age and gender, occupation, tibia affected (Right or left), time of fracture, medical comorbidities as (DM, Rheumatoid…etc.), past history of previous operative procedure of the leg, present history of any disease and present history of any medication
Careful clinical examination: General: Blood pressure, pulse, cardiovascular, neurological and respiration assessment. **Local: Inspection:** for deformity, oedema, skin condition, wounds, **and palpation:** for tenderness, **range of motion and neuro-vascular examination** with examination of dorsalis pedis artery, posterior tibial artery, common peroneal nerve& posterior tibial nerve.
Investigations: Laboratory: Serum urea, serum creatinine and complete blood count (CBC): hemoglobin concentration (Hb %), red blood cells (RBCs), white blood cells (WBCs), platelet count. **Radiological:** CT scan examination was performed to every patient as well as plain radiographs for classification**.** All fractures were classified using the "three-column" concept. Using the axial CT view, the tibial plateau was divided into three areas: lateral column, medial column and posterior column.These three columns were separated by three connecting lines: CA, CL and CM.

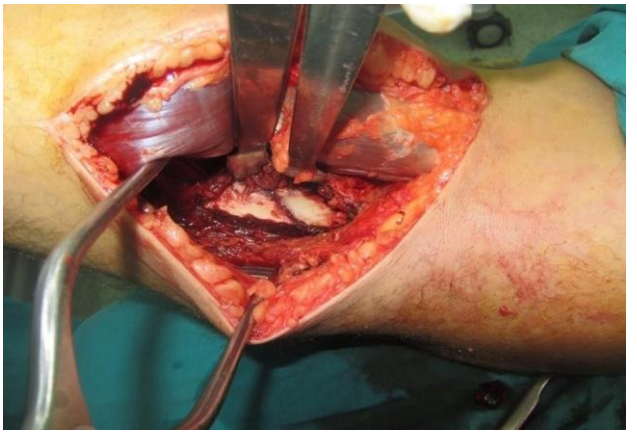

Fig.1 The medial border of the medial gastrocnemius was identified by blunt dissection in a distal-to-proximal direction and was retracted laterally.

Fig.2 With the medial head of the gastrocnemius muscle retracted laterally and the hamstring muscles medially, subperiosteal dissection of the popliteus was performed, using either a cautery or knife.

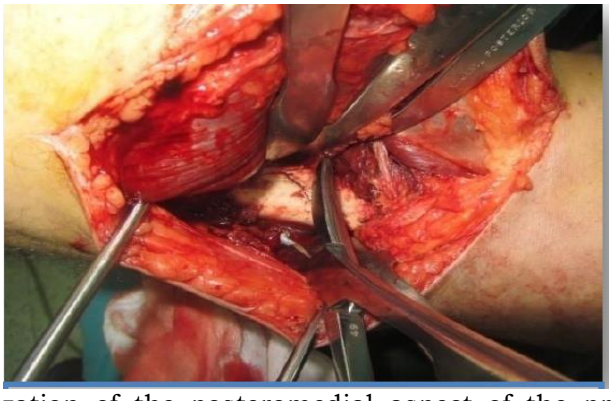

Fig.3**:** full visualization of the posteromedial aspect of the proximal tibia. The fracture was visualized and reduced with hyperextension of the knee

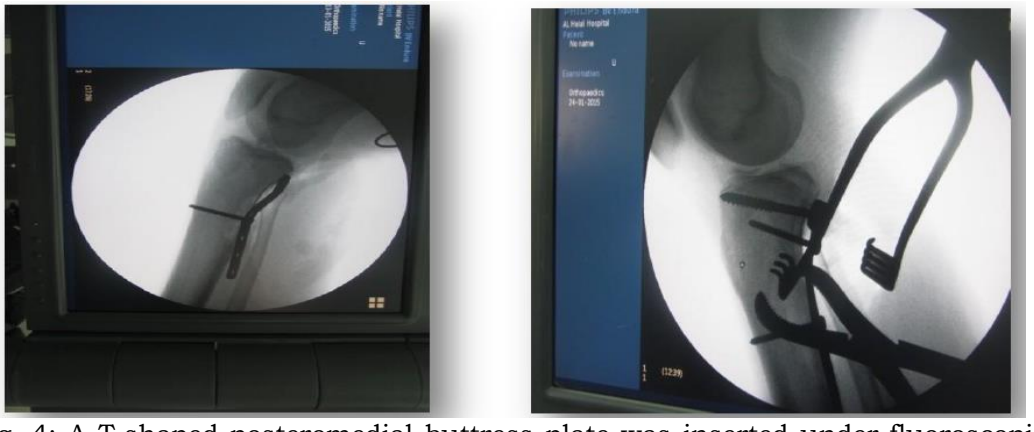

Fig. 4: A T-shaped posteromedial buttress plate was inserted under fluoroscopic guidance in the lateral plane and held in place with a temporary Kirschner wir

Postoperative evaluation: Patients were seen for clinical and radiological assessment at 6 weeks and 3, 6 months. Reduction quality of the articular surface was evaluated from lateral plain film and was categorized as anatomic (0

mm step-off), acceptable (< 2 mm step-off) or poor (2–4 mm step-off). Union were defined as no fracture site pain reported by the patient and no fracture gap on last radiographic evaluation. Functional outcome were assessed using Lysholm score (0–100) and Tegner score (0–10). Post-traumatic osteoarthritis was graded on the Kellgren-Lawrence system.[158]

Ethical consideration: Informed consent was obtained from all participants after being informed about the aims and process of the study as well as applicable objectives. The study procedures were free from any harmful effects on the participants as well as the service provided.

Data management and Statistical Analysis: Data entry, processing and statistical analysis was carried out using SPSS version 20 **(Statistical Package for the Social Sciences).** Tests of significance (Kruskal-Wallis, Wilcoxon's, Chi square, logistic regression analysis, and Spearman's correlation) were used. Data were presented and suitable analysis was done according to the type of data (parametric and non-parametric) obtained for each variable. P-values less than 0.05 (5%) was considered to be statistically significant.

Results

Variables	N= 24
Age	
Mean± SD	37.2± 8.7
Range	29 (22, 51)
Gender	
Male n (%)	16 (66.7)
Female n (%)	8 (33.3)
Side of fracture	
Right n (%)	11 (45.8)
Left n (%)	13 (54.2)

Quantitative data represented as mean± SD
Qualitative data represented as frequency and percentage

Table 1: Basic characteristics of the participants
In table 1 a total sample of 24 participants aged from 22 to 51, the mean age of the participants is 37.2± 8.7. There was 66.7% males and 33.3% females. According to the side of fracture, there were 45.8% of the participants had right sided fracture and 54.2% had left sided fracture.

Variables	Mean± SD
Femorotibial angle	178.8± 5.5
Medial proximal tibial angle	86.1± 3.6
Lateral posterior slope angle	8.7± 2.2
Condylar width	2.6± 1.0

Quantitative data represented as mean± SD

Table 2: Radiological features among the participants
The radiological features showing in table 2 the mean femorotibial angle is 178.8± 5.5, the mean medial proximal tibial angle is 86.1± 3.6, the mean lateral posterior slope angle is 8.7± 2.2 and condylar width is 2.6± 1.0.

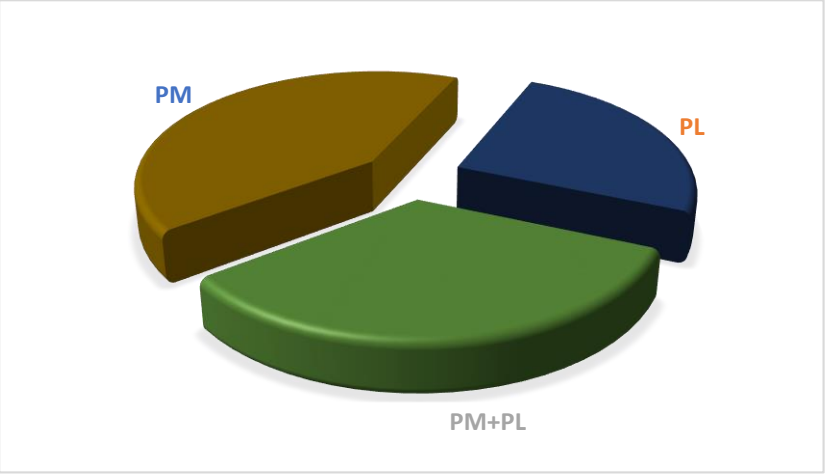

Figure 5: Three column classification system among the participants

Regarding three-column classification system there was 41.7% of the participants classified as only PM, 25% only PL and 33.3% PM+PL as shown in Fig 5.

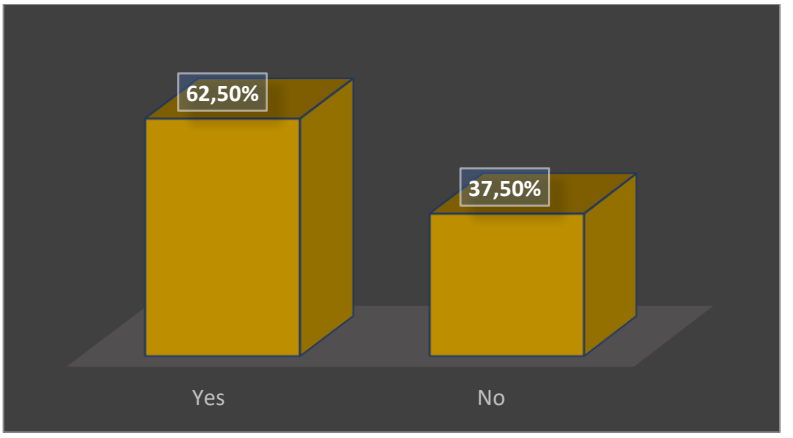

Figure 6: Fracture dislocation among the participants

As shown in Figure 6 there were 62.5% of the participants had fracture dislocation and 37.5% had not.

Variable	N= 24
Operation time	
Mean± SD	108.1± 44.7
Range	150 (30, 180)

Table 3: Operation time among the participants
In table 3 the mean operation time is 108.1± 44.7 and ranging from 30 to 180 minutes.

Post operative reduction	Anatomic n (%)	Acceptable n (%)	Poor n (%)	P value
Immediate post operative	8 (33.3)	13 (54.2)	3 (12.5)	—
Follow up after 6 weeks	12 (25)	12 (25)	0 (0)	0.001*
Follow up after 3 months	13 (54.2)	11 (45.8)	0 (0)	0.003*
Follow up after 5 months	15 (62.5)	9 (37.5)	0 (0)	0.011*

Fisher Exact test
*P is significant at <0.05

Table 4: Post operative reduction at different points of follow up among the participants
In table 4 there is statistically significant difference between immediate post-operative reduction and other post-operative reduction after 6 weeks, 3 months and 5 months.

Follow up points	Grade 0	Grade 1	Grade 2	P value
Immediate postoperative	10 (41.7)	12 (50.0)	2 (8.3)	____
Follow up after 6 weeks	10 (41.7)	12 (50.0)	2 (8.3)	<0.001*
Follow up after 3 months	11 (45.8)	11 (45.8)	2 (8.3)	<0.001*
Follow up after 5 months	13 (54.2)	9 (37.5)	2 (8.3)	<0.001*

Fisher Exact test
*P is significant at <0.05

Table 5: Kellgren and Lawrence system at different follow up points among the participants
According to table 5 there is statistically significant difference between immediate post operative Kellgren and Lawrence score and scores after 6 weeks, after 3 months and after 5 months.

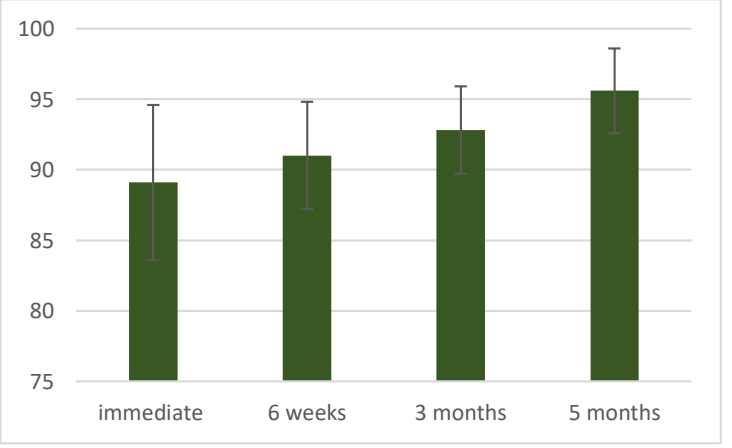

Figure 7: Lysholm score at different follow up points among the participants

In Figure 7 the mean Lysholm score immediate post operative was 89.1± 5.5, after 6 weeks was 91.0± 3.8, after 3 months was 92.8± 3.1 and after 5 months was 95.6± 3.0.

Follow up points	Mean± SD
Immediate post operative	6.5± 0.9
After 6 weeks	5.6± 0.8
After 3 months	4.4± 0.7
After 5 months	2.6± 0.9

Table 6: Tegner score at different follow up points among the participants
Table 6 showing Tegner score at different follow up points. The mean score immediate after operation was 6.5 ± 0.9, after 6 weeks was 5.6± 0.8, after 3 months was 4.4± 0.7 and after 5 months was 2.6± 0.9.

Complications	n (%)
No complications	18 (75)
Infection	2 (8.3)
DVT	1 (4.2)
Neural Palsy	2 (8.3)
Non-union	1 (4.2)

DVT: deep venous thrombosis

Table 7**:** Early complications among the participants
In table 7 there was 75% of the participants had no complications while 25% had early complications among them 8.3% had infection, 4.2% had DVT, 8.3% had neural palsy and 4.2% had non-union.

Variables	P value
Post operative reduction	0.150[1]
Kellgren and Lawrence system	0.630[1]
Lysholm score	0.416[2]
Tegner score	0.323[2]

1 Fisher Exact test
2 Student t test
*P is significant at < 0.05

Table 8**:** Association between complications and clinical and radiological findings among the participants

According to table 8 there is no statistically significant association between complications, post operative reduction, Kellgren and Lawrence system, Lysholm score and Tegner score.
Case no. (1)
Male patient 38 years old had RT combined fractures posteriomedial and anterolateral tibial platea fractures due to road traffic accident and under went internal fixation with plate through the posteriomedial approach and 2 screws introduced lateral. Ap, lateral vews before surgery, and three column CT

performed before surgery indicated posteromedial collaps . the end results of knee function were excellent after six month.

Fig (8): Pre-operative X-ray knee

Fig (9): Pre-operative X-ray knee LAT view

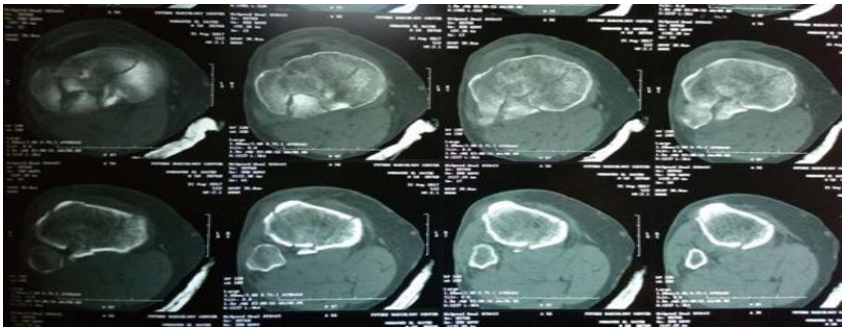

Fig (10): preoperative CT axial cut.

Fig (11): preoperative CT coronal

Fig (12): preoperative CT sagittal

Fig (13): immediate postoperative AP

Fig (14): immediate postoperative Lat

Fig (15): postoperative 1 month AP view

Fig (16): postoperative 1 month Lat view

Fig (17): postoperative 6 month AP view

Fig (18): postoperative 6 month Lat

Fig (19): range of knee flexion

Fig (20): range of knee extension

Discussion

Tibial plateau fracture could be caused by indirect violence or direct violence. Some scholars thought that, in double condyle fractures of tibial plateau, incidence of posterior-medial block fracture was 59%. In the past, doctors and patients lacked of sufficient knowledge about posterior tibial plateau fracture due to various causes. [8]

The main aim of this study was to evaluate the safety and efficacy via a posterior approach in the posterior shearing tibial plateau fracture. This prospective study was carried out on 24 adult patients with tibial plateau fracture admitted in the Department of Orthopaedic surgery, Al-azhar university Hospital in Damietta.

Regarding Basic characteristics of the participants, our results showed that a total sample of 24 participants aged from 22 to 51, the mean age of the participants is 37.2± 8.7. There was 66.7% males and 33.3% females. According to the side of fracture, there were 45.8% of the participants had right sided fracture and 54.2% had left sided fracture.

A prospective study by Qiu et al., [9] aimed to investigate intraoperative and postoperative complications and outcomes of a posterior reversed L-shaped approach (PRLA) in the treatment of the tibial plateau fractures. The study enrolled 95 Patients with average age was 46.2 years old (range, 22.0–89.0) 67 patients were males and 28 females. And 55 fractures occurred in the left leg while 40 in the right leg. The fractures were mainly from high energy injuries involving posterior (and medial) column.

As well a prospective study by Sebaie et al., [10] aimed to spot light on posteromedial approach as new concept in treatment of tibial plateau fracture as regarding to clinical and radiological outcome and to assess its surgical efficacy and advantages in such cases and to show is it beneficial to the patients or not, the study enrolled 15 patients, 2 of them were females and 13 were males with age ranged from 20 years to 48 years and a mean age at the time of the injury of 34.8 years. A total number of 8 patients (53.3%) presented by tibial plateau fracture in the right limb and 7 patients (46.7%) in the left limb.

Furthermore He et al., [11] present a case series of patients with posterior bicondylar tibial plateau fractures treated by direct exposure and buttress plate fixation through posterior inverted L-shaped approach, the study enrolled 8 cases there were 3 women and 5 men with an average age of 46.4 years (36–56 years). Two fractures were on the left side and six on the right.

Regarding Radiological features among the participants, we found that the mean femorotibial angle is 178.8± 5.5, the mean medial proximal tibial angle is 86.1± 3.6, the mean lateral posterior slope angle is 8.7± 2.2 and condylar width is 2.6± 1.0. While the study by Qiu et al., [9] revealed that the Immediate postoperative the mean femur-tibial-angle (FTA) was 174.3±3.9, tibial-plateau-angle (TPA) was 87.4± 3.1, and posterior-slope angle (PA) was 8.1±2.7 and Stepoff 1.3±0.8 mm. Furthermore He et al., [11] reported that there were no significant differences in FTA, TPA and PA on the radiographs immediately postoperatively and 24 months postoperatively.

Regarding three-column classification system our results revealed that there was 41.7% of the participants classified as only PM, 25% only PL and 33.3% PM+PL. we also found that there were 62.5% of the participants had fracture dislocation and 37.5% had not. The study by Lin et al., [12] investigated Prone and direct posterior approach for management of posterior column tibial plateau fractures, the study enrolled sixteen posterior column tibial plateau fractures (10 male and

6 female patients, with a mean age of 41.5 ± 14.3 years). There were 8 isolated PM fractures, 4 isolated PL fractures and 4 PM+PL fractures, and dislocation (yes/no) was 10/6 cases.

In addition, a study by Yin et al., [13] investigated a modified direct posterior midline approach for the treatment of posterior column tibial plateau fractures, the study involved Fifteen patients were subjected to follow-ups for 18 to 24 months (20.9±1.8 months). Among these patients, eight patients required four quadrants fixation (PM, PL, AM, and AL), three patients required three quadrants fixation (PM, PL, and AM), three patients required two quadrants fixation (PM and PL), and one patient required one quadrant fixation (PL). Our results revealed that the mean operation time is 108.1± 44.7 and ranging from 30 to 180 minutes. The study by Qiu et al., [9] reported that the average operation time was 121 (100-160) min. (95)

While Sinha et al., [14] reported that mean operation time for groups A and B were 120.5±21.3 (90-180) and 87.5±31.6 (65-120) with significant difference p=0.001. The study by He et al., [11] reported that the total mean operation time was 60 min (45–100 min). Regarding Post-operative reduction at different points of follow up among the participants, we found that there is statistically significant difference between immediate post-operative reduction and other post-operative reduction after 6 weeks, 3 months and 5 months.

The study by Lin et al., [12] reported that 10/16 patients showed anatomic postoperative reduction (0 mm step-off) of the articular surface and 6/16 patients showed acceptable reduction (< 2 mm step-off). All fractures healed within 6 months without secondary displacement. In contrast with our results the study by He et al., [11] reported that There were no significant differences in FTA, TPA and PA on the radiographs immediately postoperatively and 24 months postoperatively. As regard Kellgren and Lawrence system at different follow up points among the participants, our results revealed that there is statistically significant difference between immediate post-operative Kellgren and Lawrence score and scores after 6 weeks, after 3 months and after 5 months. We also found that the mean Lysholm score immediate post-operative was 89.1± 5.5, after 6 weeks was 91.0± 3.8, after 3 months was 92.8± 3.1 and after 5 months was 95.6± 3.0.

In addition regarding Tegner score at different follow up points, we found that the mean score immediate after operation was 6.5 ± 0.9, after 6 weeks was 5.6± 0.8, after 3 months was 4.4± 0.7 and after 5 months was 2.6± 0.9. While the study by Qiu et al., [9] reported that the outcome scores were finally measured by SF-36 (94.2 range, 80–100) and HSS (96.1 range, 80–100) at 12 months follow-up. On the other hand, FTA, TPA or PA values showed statistically no difference on day 1- and 12-months photographs postoperatively. ($P < 0.05$) While the study by Sebaie et al., [10] involved 6 patients with fracture type IV, 4 of them (66.6%) had excellent score and 2 of them (33.4%) had good score. The other 9 patients had fracture type V, 4 of them (44.4%) had excellent score while 5 of them (55.6%) had good results. Yin et al., [13] utilized HSS score to assess the outcome and they found that the average HSS score was 94.7 ± 4.1 (range: 84–100).

As regard Early complications among the participants, we found that there was 75% of the participants had no complications while 25% had early complications among them 8.3% had infection, 4.2% had DVT, 8.3% had neural palsy and 4.2% had non-union.

Stahel and Mauffrey, [15] in their study with more than 50 patients, postoperative complications included one patient with a postoperative wound infection that required an unplanned surgical debridement and washout of the surgical wound. Three patients had excessively long posterior apex screws that required early plate removal after fracture union. One case with osteoporotic bone had a displacement of the fracture after 3 weeks from the injury. While He et al., [11] reported that none of the complications such as infection, necrosis of the skin incision or the loosening and breakage of the internal fixator occurred.

Lin et al., [12] reported that No cases of deep infection were observed. One case had an acute superficial surgical site infection, treated by oral antibiotics. One patient had a superficial dehiscence postoperatively that healed without further treatment. One patient had wound-edge skin necrosis, successfully treated by surgical debridement. Whereas in a study conducted by Chiu et al., [16] the correlation of the results to the type of the fracture (types IV, V, and VI) were not statistically significant.

The fixation does not expedite the fracture healing, but rehabilitation and patient-related scores are significantly better. Posterior approaches demand technical expertise and have certain minor complications, prolong operative time, more blood loss, and hospital stay which are its potential disadvantages. We recommend it as a routine approach for the treatment of the tibial plateau fractures involving the posterior column.

Conclusion

Posterior tibial plateau fracture is relatively rare in tibial plateau fractures. Once fracture occurred, medial and lateral parts of the plateau unevenly stood force, resulting in osteoarthritis and various pathological changes. Tibial plateau fracture could be caused by indirect violence or direct violence. Posterior tibial plateau fracture (PTPF) is a relatively uncommon injury, with an incidence of 28.8%. This kind of fracture appears confusing on initial radiographs because of the small displacement, so it is a special injury pattern that is not sufficiently included in any type of the classification systems. Our study highlights the importance of posterior tibial plateau fracture which was deemed unimportant in the past. Our results highlight the importance of fixation of PTPF and achieving an early and satisfactory functional outcome at follow up. The fixation does not expedite the fracture healing, but rehabilitation and patient-related scores are significantly better. Posterior approaches demand technical expertise and have certain minor complications, prolong operative time, more blood loss, and hospital stay which are its potential disadvantages.

Conflict of interest: no conflicts of interest.

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