Zagazig University Medical Journal
www.zumj.journals.ekb.eg
https://doi.org/10.21608/zumj.2022.130789.2542 Volume 30, Issue 3, May 2024
**Manuscript ID ZUMJ-2203-2542**
**DOI 10.21608/ZUMJ.2022.130789.2542**
**ORIGINAL ARTICLE**

# Evaluation of Surgical Techniques in Management of Bicondylar Tibial Plateau Fractures

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Submit Date 2022-04-11
Accept Date 2022-04-17

## ABSTRACT

**Background:** Tibial plateau fractures are one of the most common intra-articular fractures caused by coronal or axial compressive forces. This study aimed to compare the functional outcome and the complication rate between double-plate and single lateral locked in patients with bicondylar tibial plateau fractures.

**Methods**: A prospective study was conducted in Zagazig University hospitals, in the period from August 2021 to February 2022, 18 patients complaining of tibial plateau fracture; either Schatzker type V or VI, were Included and divided into two groups: the single lateral plate (SLP) group including nine patients, and the double plate (DP) group including also nine patients. Majority of the patients were males in both groups. The road traffic accidents (RTA) were the leading cause of fracture in SLP group. While fall from height (FFH) was the most common cause of fracture in DP group. Anteroposterior and lateral radiographs of whole tibia from knee to ankle were obtained. CT scans were done for all cases to accurately delineate fracture type and extent, fragment size and location, the degree of articular depression or displacement. The clinical evaluation was based on Rasmussen scoring system with six months follow-up.

**Results**: Rasmussen functional score showed significant improvement from the 1st month till the 6th month. There were no significant differences between the two methods with respect to functional and radiographic outcomes at the final follow-up. Also, both methods had no differences in complication rate.

**Conclusion**: This study concluded that both methods (single lateral plate and double plating) are effective methods for treatment of bicondylar tibial plateau fractures.

**Keywords**: Bicondylar tibial plateau, Fracture, Locking plate fixation

## INTRODUCTION

Tibial plateau fractures are one of the most common intra-articular fractures caused by coronal or axial compressive forces. Tibial plateau fractures account for 1% of all fractures and 8% of fractures in the elderly. These fractures include a wide range of fracture configurations involving the medial condyle (10-23%), lateral condyle (55-70%), or both (11-30%) with varying degrees of articular depression and displacement. If the plateau surface and the axis of the leg are not properly restored, these fractures can lead to the development of premature osteoarthritis, ligament injury, and lifelong pain and disability [(1)].

Tibial plateau fractures are intra-articular knee joint injuries that are frequently difficult to treat and have a high complication rate, including early-onset osteoarthritis. For more complex tibial plateau fractures, surgical fixation is usually used. Furthermore, bone void fillers are frequently used to treat bone defects caused by the injury. There is currently no agreement on the best method of fixation or bone void filler [(2)].

High-energy tibial plateau fractures, which are characterized by joint comminution, meta-diaphyseal disjunction, and soft tissue injury, are difficult to manage. Bicondylar fractures are those that involve both the medial and lateral plateaus. The Schatzker classification system, which divides tibial plateau fractures into six types, is widely used by orthopaedic surgeons for assessing the initial injury, planning management, and predicting prognosis. Each increasing numeric category denotes a greater amount of energy imparted to the bone, thereby increasing the severity of the fracture. Types V and VI are bicondylar, while the first four are unicondylar. The pattern of each fracture in the Schatzker classification assists orthopaedic surgeons in selecting appropriate treatment modalities [(3)].

Bicondylar TPF treatment is still a contentious issue, and it is generally difficult because patients can experience postoperative arthritis and functional disability of the knee joint. In bicondylar TPFs, staged treatment with a temporary external fixator resulted in good clinical and radiological outcomes. Surgeons should use fluoroscopy to assess the reduction status intraoperatively and also refer to the uninjured limb radiologically. To solve soft tissue problems, several fixation methods can be used, including the use of a hybrid external fixator and staged treatment with a temporary external fixator [(4)].

The purpose of this study was to compare the functional outcome and the complication rate between Double-plate and single lateral locked in patients with bicondylar tibial plateau fractures.

## METHODS

This study was prospective study in Zagazig University hospitals in the period from August 2021 to February 2022; included 18 patients complaining of tibial plateau fracture either Schatzker type V or VI. Nine of them were treated by Single lateral plate (SLP) and the other nine were treated with Double plate (DP). The age ranged from 18-60 years for SLP group with mean age 45.6 years. While in the DP group the mean age was 43.7 years; ranging from 20 to 60 years. The majority in both groups were males, as 88.9% and 77.8% in SLP groups and DP groups respectively. The road traffic accidents (RTA) were the leading cause of fracture in SLP group (55.6%), while fall from height (FFH) was the most common cause of fracture in DP group (55.6%). Most of the patients in both groups were Schatzker V as SLP group was (88.9%), and (66.7%) was Schatzker V in DP group. Approval taking Institutional Review Board (IRB) approval and also informed written consent was taken from all patients' parents with explanation of the procedure, possible hazards & follow up protocol. This Work was performed according to the code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

**Inclusion criteria**: age from 18 to 60 years, both genders and patients who presented with bicondylar tibial plateau fractures according to Schatzker classification. **Exclusion criteria:** Patients with deformity, the presence of additional fractures or neurovascular injuries, over the course of 30 days fracture progression, pathological fractures , fractures without clinical indication for the procedure, as well as a lack of adequate radiographic documentation for evaluation, patients with contraindications for surgery and patient's refusal to sign the informed consent form.

**Pre-operative:** all patients underwent full history taking, clinical examination, routine laboratory investigations, (complete blood picture (CBC), coagulation profile, random blood sugar, liver function tests and renal function tests), and chest x-ray as a preoperative assessment were done for all patients. Anteroposterior and lateral radiographs of whole tibia from knee to ankle were obtained in all cases. Radiographs were

analyzed for condylar widening, articular and shaft extension. CT scans were done for all cases to accurately delineate fracture type and extent, fragment size and location, the degree of articular depression or displacement.

**Surgical technique:** Fixation using double or single lateral locked plate was not randomized. The surgical approach was selected according to the degree of displacement of the posterior tibial cortex; fractures with no or minimal displacement of the posterior tibial cortex (usually ≤2 mm) were operated using the anterolateral incision, while fractures with a large displacement (usually > 2 mm) were operated by anterolateral and posteromedial double incisions. The single lateral locked plate was chosen based on indication criteria in the literature: the presence of a large and non-marginal medial fragment, the medial condyle in bone contact, the absence of fractures in the coronal plane, the absence of osteoporosis, and the availability of a lateral locked plate.

The surgical technique involves positioning the patient supine under general or spinal anesthesia. Cases with bicondylar tibial plateau fractures were operated under traction, a good tourniquet high in the thigh, The entire limb and the ipsilateral iliac crest were prepared and draped into the surgical field under complete aseptic technique. A third generation cephalosporin was given intravenously (vial of 1 gm) as a pre-operative antibiotic prophylaxis with induction of anesthesia in all cases. Following proper draping, a short oblique anterolateral incision was made just proximal to the origin of the tibialis anterior muscle distally and up to Gerdy's tubercle just distal to the joint, and the fascia was then released. A periosteal elevator is used to expose the lateral surface of the proximal tibia. Our priority in displaced intraarticular fractures was to reduce the articular surface before applying plates. First, the medial plateau fracture must be reduced and stabilized. Once temporarily reduced, cancellous bone screws were used for compression independently outside the plate or within the locked plate's metaphyseal head. Then, after elevating the depressed articular surface, reduce the articular portion of the lateral plateau in the same manner. A large intercondylar imminence fragment was reduced and fixed. In three cases, an iliac bone graft was used to fill defects.

A posteromedial approach parallel to the posteromedial border of the proximal tibia was used in the double-plate technique, at least 5 cm distal from the anterolateral incision. The distance between the semimembranosus muscles and the gastrocnemius medial head has been determined. Pes anserinus (goosefoot) was disinserted and then moved away from the gastrocnemius after being separated from its structures. The semimembranosus muscle was removed to reveal the posteromedial tibial plateau. Kirschner wires were used to temporarily stabilise smaller fragments. Then For fixation, medial buttress plating was placed in the medial aspect of the proximal tibia. Finally, we confirmed fixation in both the AP and lateral views using C-arm image guidance. The limb was then re-examined for alignment before the wound was closed. In all cases, a suction drain was used. Finally, the subcutaneous and skin layers were closed. Postoperative plain X-ray films (AP and lateral views) were taken for documentation and later assessment of bone healing progress.

**Post-operative follow up:** All patients were followed up clinically and with x-ray immediately at 1, 3 and 6 months postoperatively as a routine part of monitoring. Clinical and radiographic results were assessed and outcome measures are applied at final follow-up. At each visit, the wound was clinically evaluated, range of movement (ROM) was measured, and plain (AP and lateral) X-rays were taken. Deep infection was defined as infection of the wound that required recurring debridement in two patients. The presence of trabeculation crossing the fracture on radiographs of at least three cortices was defined as radiological union in all patients. At regular intervals, Rasmussen knee scores (functional and anatomical) were used. The time it took to return to work after initial surgery was evaluated and compared across different age groups and fracture types.

## STATISTICAL ANALYSIS

Data from the history, basic clinical examination, laboratory investigations, and outcome measures were coded, entered, and analyzed in Microsoft Excel software. The data was then imported into the Statistical Package for the Social Sciences (SPSS version 23.0) software for analysis. According to the type of data, qualitative data was represented as a number and a percentage, while quantitative data was represented as a mean and standard deviation (SD). To test the significance, the following tests were used: difference and association of qualitative variables by Chi square test (X2). Differences between quantitative independent measures by t test and repeated measures for follow-up by ANOVA for repeated measures. The 5% level of significance was chosen as the cutoff (P-value).

## RESULTS

Our study showed that there was no statistically significance difference between the two studied groups regarding age & sex distribution **(Table 1).**

There was statistically significant increase on Rasmussen anatomical score among both groups but the increase on double plate group was statistically significantly higher than the single lateral plate at the end of the follow up period. But regarding 1st and 3rd months, there was no statistically significance difference between both groups. There was also statistically significant increase on Rasmussen functional score among both groups but the increase on double plate group was statistically significantly higher than the single lateral plate at the end of the follow up period. But regarding 1st and 3rd months, there was no statistically significance difference between both groups **(Table 2)**.

There was a statistically significant better outcome among double plate group than the single lateral plate group at the end of the follow up period with no poor results among the double plate group **(Table 3)**.

The range of flexion and extension were higher among double plate group than the single lateral plate group; yet without statistically significant difference **(Table 4)**.

Double plate group had a lesser medial proximal tibial angle (MPTA) than the single lateral plate group but this difference wasn't significant at different times. There was a decrease on the medial proximal tibial angle (MPTA) on both groups but not significant. Double plate group had a lesser Posterior proximal tibial angle (PPTA) than the single lateral plate group but this difference wasn't significant at different times. There was a decrease on the Posterior proximal tibial angle (PPTA) on both groups but not significant **(Table 5)**.

The double plate group had shorter average union time than single lateral plate group (4.1 versus 4.6 months) respectively without any statistically significance difference between the two studied groups **(Table 6)**.

Four cases (44.4%) had complications among the double plate group. Two of them had surgical site infection, one of them had poor wound healing, and the other one had skin irritation. While 3 cases (33.3%) among the single lateral plate group had complications, one with poor wound healing and 22.2% of patients had SSI. The complication rate had no statistical difference between the two groups **(Table 7)**.

## DISCUSSION

Our demographic data were comparable to **Citak et al [5],** with mean age of 51.2 years, rangied from 25 to 83 years for the SLP group while 51.3 years ranged from 34 to 73 years for DP group. The majority in both groups was males (70% and 80% for SLP and DP groups respectively) the RTA was the most common cause of fracture (55%) in both groups followed by FFH (25%).

Also, **Badawy et al [6],** who used single lateral locked plate for treating bicondylar tibial plateau fracture, documented a mean age of 38 years (Range: 24-57 years). Ninety percent of them were males, and only 10% were females, 35% injured due to FFH and the other 35% was because of pedestrian, while the rest was caused by motor vehicle accident (MVA). 50% of

patients were Schatzker V and the other 50% was Schatzker VI.

The union time in our study showed that there was no statistical difference between the two groups as it was 4.1 months for DP group which shorter than 4.6 months for SLP group, the P value was 0.6.

This was comparable with **Citak et al [5].** the average time to radiological Union was 14 weeks (range, 9 to 16 weeks) with no statistical difference between the two groups. Also, **Wang et al [7]** reported that the mean union time for double plating group was 4.6±1.8 months.

**Roy et al [8]** documented that regardless the method of fixation (which either SL plate or the DP), 14 patients (70%) had union time at 12-16 weeks. In 4 patients (20%) the union occurred at 16-20 weeks. The union took more than 20 weeks only in 1 patient.

Regarding the post-operative anatomical score, there was a statistically significant improvement in the anatomical score at the 1st month, 3rd and 6th month in both groups. In the SLP, the score was 12.9 points, improved to 13.71 in third month and finally reach 14.2 in the sixth month (P=0.04). Also, in the DP group the improvement was statistically significant as the score improved from 13.1 in first month reaching 14.69 and 17.1 in the 3rd and 6th months respectively (P=0.02). There was no statistical difference at 1st and 3rd months between the two groups regarding this score (P 0.06 and 0.1 respectively) while at 6th month the double plate group was statistically significantly higher than the single lateral plate at the end of the follow up period.

Also, Rasmussen functional score in our study showed a significant improvement from 23.81 in the 1st month to 26.8 in the 6th month in SLP group (P=0.04). Also, in the DP group the improvement was significant, as in the 1st month the Rasmussen functional score was 24.12 and reached 30.8 by the 6th month (P=0.003). This improvement was statistically significant between the two groups as the double plate group improved more than the SLP group (P=0.02). In the DP group, there was only 1 patient with unsatisfactory outcome while in the SLP group 22.2% (2 patients) had unsatisfactory results. Regarding the excellent outcome, more than three quarters (77.8%) of the DP group were excellent, compared with 55.6% in the SLP group.

This was in contrast with **Citak et al [5]** who documented that the mean score for SLP was 15.2 and reach 15.8 in DP group with no statistical difference between the two groups. Also, regarding the Rasmussen functional score our results was superior to **Citak et al [5]** as the SLP group mean score was 22.9 while for DP group was 24.3 with no statistical difference between the two groups.

Also, **Yao et al [9]** who used double plates in treatment of 74 patients complaining of bicondylar tibial plateau fractures, observed that the Rasmussen anatomic outcome (immediately postoperatively) was excellent in 34, good in 23, and fair in 17 patients. While the mean Rasmussen clinical score was 26.14 (range; 10-29), Rasmussen functional outcome was excellent in 31 patients, good in 25, and fair in 13 patients, while 5 patients missed at the final follow-up. While **Patil et al [10]** who treated 15 patients with intra-articular tibial plateau with single lateral locked plate, found that the mean functional score was 27.7, while the mean anatomical score was 16.8.

On the other hand; our results showed no statistical significant difference regarding range of motion between the two groups, as the mean flexion was 119.5 in SLP group and 123.6 in DP group with non-significant P value. Also, for the extension the mean extension was 4.86 and 5.21 for SLP, DP groups respectively.

According to **Lee et al [11]** who treated bicondylar fractures with single locked plate, the mean flexion was 136.3° ranged from 125° to 145, while the mean extension was 3.9° ranged from 0° to 10°.

**Badawy et al [6]** reported that the mean knee range of motion after post-operative programmed was 3.9°-99.5° ranging from 0°-10° for extension lag to 90°-115° degrees of flexion from extension lag.

The radiological measurements at final follow-up in this study showed no difference between the

two methods of fixation, as the medial proximal tibial angle (MPTA) was 86.13 for SLP group and 82.05 for DP group, while the posterior proximal tibial angle (PPTA) was 7.39 in SLP group and 7.21 for DP group.

This was in agreement with **Citak et al [5],** who documented that the mean MPTA in SLP group was 86.3° (the range 82–91°), while the mean PPTA 5.5° (the range 4°-9°). On the other hand, the DP group patients had the mean MPTA 86.8° (the range 84–89°), and the mean PPTA 5.4° (the range 3-7°) at the last visit. Also, **Arouca et al [12]** reported that the mean MPTA was 89.2° for SLP group, and 88.8° for DP group with no statistical difference. Moreover, the mean PPTA was 6.6° for SLP group and 7.6° for DP group with no statistical difference.

Regarding the complications, four cases (44.4%) had complications among the double plate group. Two of them had surgical site infection (SSI), one of them had poor wound healing, and the other one had skin irritation. On the other hand, 3 cases (33.3%) among the SLP group had complications; one with poor wound healing and 22.2% of patients had SSI. The complication rate had no statistical difference between the two groups.

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% as documented by **Badawy et al. [6]**, who observed in their study that the overall complication rate was 30%. The same as with our study, the most common complication was the wound infection.

**Yao et al [9]** documented low complication rate in their study, they used double plating in treatment of bicondylar fractures in 74 patients, and only 5 patients (6.76%) had complications. Three of them had SSI, while the other two had deep venous thrombosis (DVT).

In the same context, **Oguzkaya et al [13]** observed that the complication rate was 35.6%, the most common complication was the infection either superficial or deep which accounted for 16.6% in the DP group. At the end of the follow-up of their study, they compared the DP group with the Ilizarov external fixations group, and found that the Ilizarov method is more cost-effective and related with lesser complications.

**Roy et al [8]** used locked plate in management of tibial plateau fractures either SLP (in 70% of cases) or DP in 30%, and reported an overall complication rate of 20% .1 patient (5%) had infection, and in 2 patients (10%) plate prominence occurred. In 1patient (5%) delayed union occurred.

## CONCLUSION

This study concluded that both methods (single lateral plate and double plating) are effective methods for treatment of bicondylar tibial plateau fractures. The usage of double plates had slightly better outcome, with more intra-operative bleeding, while the single lateral locking plate had slightly lower complication rate.

We propose a future prospective study to compare the outcome with different types of bicondylar tibial plateau fracture fixations.

## REFERENCES

1- **Ramponi DR, McSwigan T.** Tibial Plateau Fractures. Adv Emerg Nurs J. 2018; 40(3):155-61.

2- **Zhao R, Lin Z, Long H, Zeng M, Cheng L, Zhu Y.** Diagnosis and treatment of hyperextension bicondylar tibial plateau fractures. J Orthop Surg Res. 2019; 14(1):1-8.

3- **Crijns TJ, Mellema JJ, Özkan S, Ring D, Chen NC.** Classification of tibial plateau fractures using 3DCT with and without subtraction of unfractured bones. Injury. 2020; 51(11):2686-91.

4- **Ryu SM, Yang HS, Shon OJ.** Staged Treatment of Bicondylar Tibial Plateau Fracture (Schatzker Type V or VI) Using Temporary External Fixator: Correlation between Clinical and Radiological Outcomes. Knee Surg Relat Res **2018**; 30(3): 261–268.

5- **Citak C, Kayali C, Ozan F, Altay T, Karahan HG, Yamak K.** Lateral locked plating or dual plating: A comparison of two methods in simple bicondylar tibial plateau fractures. CiOS Clin Orthop Surg.

2019;11(2):151–8.

6- **Badawy A, Safwat H, El-Saedi ME-S.** Treatment of Bicondyler Tibial Plateau Fracture by Single Lateral Locked Plate. Egypt J Hosp Med. 2019; 75(5):2942–51.

7- **Wang Y, Luo C, Zhu Y, Zhai Q, Zhan Y, Qiu W, et al.** Updated three- column concept in surgical treatment for tibial plateau fractures—A prospective cohort study of 287 patients. Injury. 2016; 47(7):1488-96.

8- **Roy S, Singh R, Prasad P.** Study of surgical management of tibial plateau fractures using locking compression plate. Int J Orthop Sci. 2021; 7(3):320–3.

9- **Yao Y, Lv H, Zan J, Li J, Zhu N, Jing J.** Functional outcomes of bicondylar tibial plateau fractures treated with dual buttress plates and risk factors: A case series. Injury. 2014; 45(12):1980–4.

10- **Patil DG, Ghosh S, Chaudhuri A, Datta S, De C, Sanyal P.** Comparative study of fixation of proximal tibial fractures by nonlocking buttress versus locking compression plate. Saudi J Sport Med. 2015; 15(2):142.

11- **Lee T-C, Huang H-T, Lin Y-C, Chen C-H, Cheng Y-M, Chen J-C.** Bicondylar tibial plateau fracture treated by open reduction and fixation with unilateral locked plating. Kaohsiung J Med Sci. 2013; 29(10):568–77.

12- **Arouca MM, da Costa GHR, Leonhardt MC, Barbosa D, dos Santos Silva J, Kojima KE.** Comparison of bicondylar tibial plateau fractures with double or single lateral locked plate. Acta Ortop Bras. 2020; 28(4):182–5.

13- **Oguzkaya S, Misir A, Kizkapan TB, Eken G, Ozcamdalli M, Basilgan S.** A comparison of clinical, radiological, and quality-of-life outcomes of double-plate internal and Ilizarov external fixations for Schatzker type 5 and 6 tibia plateau fractures. Eur J Trauma Emerg Surg. 2021; (7):1980–4.

## To Cite :

**Elhadi, A., Amin, A., Zanfaly, A., Shehata, E. Evaluation of Surgical Techniques in Management of Bicondylar Tibial Plateau Fractures. Zagazig University Medical Journal, 2024; (803-812): -. doi: 10.21608/zumj.2022.130789.2542**

**Table (1): Age and sex distribution of the studied groups**

| Variables | Single lateral plate group NO=9 | Double plate group NO=9 | Test | P-value |
|---|---|---|---|---|
| **Age (years)** | | | | |
| Mean ± SD | 45.6±10.7 | 43.7±9.8 | 1.4 | 0.7 |
| (Range) | (18-60) | (20-60) | | |
| **Age (years)** | | | | |
| ≤40 | 5 (55.6%) | 6 (66.7%) | FET | 0.9 |
| >40 | 4 (44.4%) | 3 (33.3%) | | |
| **Sex** | | | | |
| Male | 8 (88.9%) | 7 (77.8%) | FET | 1 |
| Female | 1 (11.1%) | 2 (22.2%) | | |

FET = Fischer – Exact Test.

**Table (2): Postoperative evaluation by Rasmussen anatomical and functional score among the two studied groups**

| | Single lateral plate group NO=9 | Double plate group NO=9 | P-value |
|---|---|---|---|
| **Postoperative anatomical score** | | | |
| **In the 1st month** | | | |
| Mean ± SD | 12.9±1.4 | 13.1±1.9 | |
| (Range) | (10-14) | (11-15) | 0.06 |
| **In the 3rd month** | | | |
| Mean ± SD | 13.71±0.92 | 14.69±1.14 | |
| (Range) | (10-15) | (10-15) | 0.1 |
| **In the 6th month** | | | |
| Mean ± SD | 14.2±1.4 | 16.3±0.8 | |
| (Range) | (12-17) | (14-19) | **0.03*** |
| **P-value#** | **0.04*** | **0.002*** | |
| **Postoperative functional score** | | | |
| **In the 1st month** | | | |
| Mean ± SD | 23.87±3.09 | 24.12±2.07 | 0.7 |
| (Range) | (12-24) | (14-27) | |
| **In the 3rd month** | | | |
| Mean ± SD | 26.0±3.53 | 27.3±2.4 | 0.6 |
| (Range) | (14-27) | (15-29) | |
| **In the 6th month** | | | |
| Mean ± SD | 26.8±2.4 | 30.8±2.35 | **0.02*** |
| (Range) | (17-29) | (17-34) | |
| **P-value#** | **0.04*** | **0.003*** | |

P-value#=p-value for the difference between 1st, 2nd and 3rd month.

* Statistically significant difference (P < 0.05)

**Table (3): The final Rasmussen functional score at the end of the follow up period among the two studied groups**

| Postoperative functional score | Single lateral plate group NO=9 | Double plate group NO=9 | Test | P-value |
|---|---|---|---|---|
| **Excellent** | 5 (55.6%) | 7 (77.8%) | 4.6 | **0.03*** |
| **Good** | 2 (22.2%) | 1 (11.1%) | | |
| **Fair** | 1 (11.1%) | 1 (11.1%) | | |
| **Poor** | 1 (11.1%) | 0 (0.0%) | | |

* Statistically significant difference (P < 0.05)

**Table (4): The range of motion at the end of the follow up period among the two studied groups**

| The range of motion | Single lateral plate group NO=9 | Double plate group NO=9 | Test | P-value |
|---|---|---|---|---|
| **Range of flexion**<br>Mean ± SD<br>(Range) | 119.5±8.2<br>121.0 (91-130) | 123.6±10.4<br>124.0 (95-135) | 1.2 | 0.5 |
| **Range of extension**<br>Mean ± SD<br>(Range) | 4.86±1.15<br>4.0 (2-9) | 5.21±1.13<br>6 (2-10) | 1.9 | 0.3 |

**Table (5): The medial proximal tibial angle (MPTA) and (PPTA) among the two studied groups**

| | Single lateral plate group NO=9 | Double plate group NO=9 | P-value |
|---|---|---|---|
| **Postoperative MPTA** | | | |
| **Immediately**<br>Mean ± SD<br>(Range) | 90.02±2.6<br>(86-97) | 89.03±2.7<br>(85-94) | 0.9 |
| **In the 1st month**<br>Mean ± SD<br>(Range) | 89.88±2.9<br>(84-95) | 88.1±3.1<br>(83-91) | 0.3 |
| **In the 3rd month**<br>Mean ± SD<br>(Range) | 88.25±5.1<br>(83-92) | 87.25±4.1<br>(80-90) | 0.5 |
| **In the 6th month**<br>Mean ± SD<br>(Range) | 86.13±6.3<br>(80-90) | 82.05±4.7<br>(75-89) | 0.7 |
| **p-value#** | 0.1 | 0.2 | |
| **Postoperative PPTA** | | | |
| **Immediately**<br>Mean ± SD<br>(Range) | 9.08±0.83<br>(7.4-10.5) | 8.98±0.45<br>(7-10) | 0.09 |
| **In the 1st month**<br>Mean ± SD<br>(Range) | 8.62±0.92<br>(7.3-9.7) | 8.3±0.87<br>(7-9.7) | 0.5 |
| **In the 3rd month**<br>Mean ± SD<br>(Range) | 7.99±0.56<br>(7.1-9.2) | 7.5±0.16<br>(7-9.4) | 0.7 |
| **In the 6th month**<br>Mean ± SD<br>(Range) | 7.39±0.58<br>(7-9) | 7.21±0.91<br>(7-9) | 0.9 |
| **p-value#** | 0.4 | 0. 3 | |

p-value#= P-value for repeated measurements on the follow up period

**Table (6): The union time among the two studied groups**

| Variable | Single lateral plate group NO=9 | Double plate group NO=9 | P-value |
|---|---|---|---|
| **The union time** (months)<br>Mean ± SD<br>(Range) | <br>4.6±1.1<br>4 (3-10) | <br>4.1±1.02<br>3.5 (2-8) | 0.6 |

**Table (7): Complications among the two studied groups**

| Complications | Single lateral plate group NO=9 | Double plate group NO=9 | Test | P-value |
|---|---|---|---|---|
| Poor wound healing | 1 (11.1%) | 1 (11.1%) | 1.5 | 0.07 |
| Skin irritation | 0 (0.0%) | 1 (11.1%) | | |
| Surgical site infection | 2 (22.2%) | 2 (22.2%) | | |