RESEARCH PAPER

Prospective Analysis of Radiological, Clinical and Functional Outcomes of Proximal Tibial Fractures Managed with Locking Compression Plate Fixation

Saumikkumar Pravinkumar Raval[1], Anamika Uikey[2]

[1] Department of Orthopedics, Param Multispecialty Hospital, Palitana, Gujarat, India.

[2] Department of Orthopedics, Chhindwara Institute of Medical Sciences, Chhindwara, Madhya Pradesh, India.

Email: anamika7000u@gmail.com

ABSTRACT

Objective

Maximum incidences of Tibial plateau fractures are secondary to high-speed velocity accidents and fall from heights, result fractures from direct axial compression usually with valgus more common then varus and indirect shear force. The aim of surgical treatment was to restore congruent articular surface of the tibial condyles maintaining the mechanical axis and restore ligament stability in the mean while time achieve functional painless and good range of motion on the knee joint of proximal tibial fracture. With the advancement of Locking compression plate as a preferred technique for surgical fixation and maintaining the mechanical axis with restoration of ligament stability occur from direct axial compression of proximal tibial plateau.

Aim

To study the Radiological, Clinical and Functional outcome in Proximal Tibial Fractures treated with locking compression plate.

Methodology

A prospective observational study was conducted on 30 consenting patients diagnosed with Proximal Tibial Fractures who were admitted to Unique Hospital and Research Centre between 31 May 2018 and 01 June 2020. Patients were selected based on predefined inclusion and exclusion criteria. The study included adult patients aged 18 years and above of either sex presenting with proximal tibial fractures classified as Schatzker type III to VI. Only closed fractures were included. Patients who were medically unfit for surgery, managed conservatively, had open fractures, pathological fractures (other than osteoporosis), extra-articular fractures, peri-prosthetic fractures, or were below 18 years of age were excluded from the study. All patients underwent detailed clinical evaluation and routine investigations. Patients were managed either by Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) technique or by Open Reduction and Internal Fixation (ORIF) using locking compression plate depending on fracture configuration and soft tissue condition. Patients were followed at 6 weeks, 3 months, and 6 months postoperatively. Clinical examination and application of the method Rasmussen Scoring radiological evaluation using anteroposterior and lateral X-rays of the knee joint with proximal two-thirds of the leg were performed.

Result

Among 30 patients, Bony results as per Rasmussen score were excellent in 56.7% (n=17), good in 23.3% (n=7), fair in 13.3% (n=4), and poor in 6.7% (n=2). Fracture union was achieved in 7 (23.3%) patients within 12–14 weeks, in 12 (40.0%) patients within 15–17 weeks, and in 11 (36.7%) patients within 18–20 weeks. The mean fracture union time was 16.40 ± 1.91 weeks. Majority of the patients had achieved their fracture union by 17 weeks postoperatively.

Conclusion

Majority of the patients in our study had excellent final outcome according to Rasmussen Scoring system. Only a few of our patients are having poor to fair final outcome. Overall Locking Compression plate proved to be surgical choice of treatment, in cases of the proximal Tibial fracture definite maintaining the mechanical axis with restoration of ligament stability occur from direct axial compression.

Keywords: Rasmussen Scoring, LCP, Schatzker Classification, MIPPO, ORIF

Prospective Analysis of Radiological, Clinical and Functional Outcomes of Proximal Tibial Fractures Managed with Locking Compression Plate Fixation

How to cite this article: Raval S P, Uikey A. Prospective Analysis of Radiological, Clinical and Functional Outcomes of Proximal Tibial Fractures Managed with Locking Compression Plate Fixation. Int J Drug Deliv Technol. 2026;16(37s): 949-957. DOI: 10.25258/ijddt.16.37s.120

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Broad spectrum of injuries involving one of the principal weight bearing joints of the lower extremity that is Knee joint and its represent Proximal Tibial fractures. Proximal Tibial fracture are the most common intra articular injuries encountered in orthopedic practice[1].They are broadly categorized into low and high energy trauma, Valgus and varus stress and shear force with axial compression cause complex fracture[2].In elder individuals with osteopenic bone, where minimal trauma may lead to depression type fractures because of reduced subchondral bone strength. Extra-articular proximal tibial fractures maximally occur due to the bending forces acting on the metaphyseal-diaphyseal region[3].

The initial goal in the surgical treatment of proximal tibial fractures is anatomical restoration of the articular surface, limb alignment and mechanical axis maintenance, ligamentous stability preservation and achieve a painless, functional knee joint with satisfactory range of motion with early mobilization[4].Techniques such as Traditional plating provide rigid fixation, associated with complications such as periosteal stripping, vascular supply disruption, delayed union, implant failure and secondary displacement mainly in osteoporotic bone[5].These limitations led to the evolution of biological fixation principles, emphasizing minimal soft tissue disruption and preservation of blood supply[6].

Development of minimally invasive plate osteosynthesis (MIPO) and internal fixator transformative changes in fracture management[7].Thereafter the emerging of AO locking compression plate combining the advantages of conventional compression plating and locked plating technology[8].Compatibility with minimally invasive techniques, enhanced fixation in metaphyseal and osteoporotic bone, reduced plate-to-bone contact Provided by LCP.Its design allows both lag screw application and locking screw fixation, facilitating stable internal fixation while preserving vascularity.

In managing Proximal tibial fractures, these advantages, locking compression plate fixation has gained widespread acceptance[9]. Systematic evaluation of the radiological healing, clinical recovery, and the functional outcomes remains essential to determine its overall efficacy. Therefore, this study aims to conduct a prospective analysis of radiological, clinical, and functional outcomes of proximal tibial fractures managed with locking compression plate fixation, thereby contributing to evidence-based orthopedic practice[10].

AIM

To prospectively analyze the radiological, clinical, and functional outcomes of proximal tibial fractures managed with locking compression plate fixation, and to evaluate the duration and pattern of fracture union following surgical treatment.

METHODOLOGY

Prospective observational study was conducted on 30 consenting patients diagnosed with the proximal tibial fractures and they admitted to Unique Hospital and Research Centre in between 31 May 2018 and 01 June 2020. The study was designed to evaluate the clinical and functional outcomes of proximal tibial fractures managed surgically with locking compression plate (LCP) using either minimally invasive percutaneous plate osteosynthesis (MIPPO) or open reduction and internal fixation (ORIF) techniques. Institutional ethical approval was obtained prior to the commencement of the study. All participants were informed in detail about the nature of the study, surgical procedures, possible risks, benefits, and follow-up protocol, and written informed consent was obtained from each patient.

Study Population

The study included the skeletally mature patients aged more than 18 years of either sex presenting with proximal tibial fractures classified as the Schatzker Type III to Type VI. Patients were selected according to the predefined inclusion and exclusion criteria. Inclusion criteria comprised of the closed proximal tibial fractures of Schatzker Type III to VI in patients medically fit for surgery. Exclusion criteria included patients younger than 18 years, those unfit for anesthesia or surgery, patients managed conservatively due to associated medical comorbidities, all open fractures of the proximal tibia, pathological fractures other than those secondary to osteoporosis, extra-articular proximal tibial fractures, and periprosthetic fractures.

Preoperative Evaluation

Radiological assessment and clinical examination of all the patient. Anteroposterior and lateral views of proximal two thirds of the leg were obtained. To assist in surgical planning, Computed tomography (CT) scan was performed in selected cases to better delineate fracture morphology. Medical routine preoperative investigation included complete blood count, bleeding time, clotting time, urine examination (albumin, sugar, and microscopy), random blood sugar, blood urea, serum creatinine, HIV and HBsAg screening, blood grouping and Rh typing, electrocardiogram, and chest radiograph (postero-anterior view). Patients were optimized medically prior to surgery.

Operative Procedure

All surgeries were performed under spinal or epidural anesthesia with the use of a thigh tourniquet. Procedures were carried out under fluoroscopic guidance using an image intensifier. In MIPPO technique, the patient was positioned supine on the operating table with the affected limb placed over a knee frame to allow at least 110° of knee flexion. A rolled blanket was placed under the ipsilateral buttock to maintain the rotational alignment. To avoid pressure over the popliteal neurovascular structures highly care was taken. After standard aseptic preparation and draping, fracture reduction was achieved by manual traction and closed manipulation. Small (3–4 cm) proximal and distal incisions were made, and a subcutaneous extra periosteal tunnel was created. A pre-contoured 4.5 mm anatomical locking plate was inserted and positioned along the anteromedial or anterolateral aspect of the tibia. Temporary fixation was achieved with Kirschner wires. Locking screws were inserted in the metaphyseal and diaphyseal segments, while non-locking screws were used for interfragmentary compression where necessary.

For ORIF, an anterolateral parapatellar approach was commonly employed. S-shaped incision was made starting proximal to the joint line and extending distally over Gerdy's tubercle with the knee flexed to 30°. Fracture fragments were visualized directly, reduced anatomically, and temporarily were stabilized using Kirschner wires and reduction clamps. Depressed articular fragments were elevated and supported with autogenous iliac crest bone graft where required. A contoured buttress plate or locking compression plate was applied to the anterolateral tibial condyle and fixed with cancellous and cortical/locking screws. Stability was assessed intraoperatively under fluoroscopy before wound closure over a suction drain.

Postoperative Management and Follow-Up

Postoperatively, the operated limb was elevated, and intravenous antibiotics were administered for five days followed by oral antibiotics. Suction drains were removed after the 48 hours. Check radiographs were obtained on the third postoperative day. In the 48 hours Quadriceps strengthening exercises and ankle mobilization were initiated. On the second or third postoperative day depending on fixation stability, Knee range of motion exercises and toe-touch ambulation with walker support were started. Sutures were removed on the 14th postoperative day.

Progressive weight bearing was permitted based on clinical and radiological evidence of union, with the full weight bearing allowed only after confirmed union. Patients were continuously followed up at 6 weeks, 3 months, and 6 months postoperatively.At each visit, clinical assessment and radiological evaluation with anteroposterior and lateral radiographs of the knee joint including proximal two-thirds of the leg were performed to the assess fracture healing and functional recovery.

Fig 1: Male, 41 years old, Injury due to Road Traffic Accident

Preoperative X-ray

Immediate Postoperative

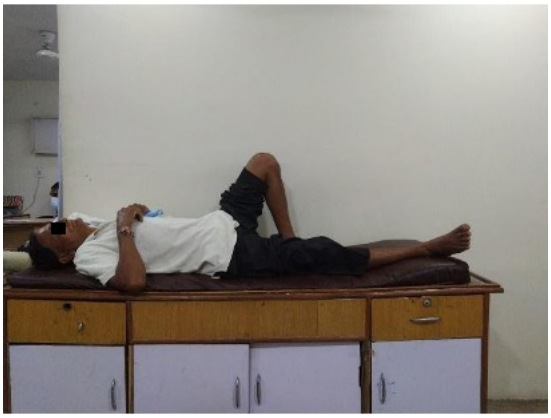
6 weeks follow-up

3 months follow-up

6 months follow-up

Fig 2: Male, 41 years old, Injury due to Road Traffic Accident

Full Weightbearing



Extension

Flexion

OBSERVATION AND RESULT

Table 1
Distribution of patients according to Age

Age Group	Number	Percentage
20-40 years	14	46.7
41-60 years	14	46.7
61-78 years	2	6.6
Total	30	100.0

The above table illustrates the distribution of patients according to age group. Out of the total 30 participants, the majority were in the 20–40 years and 41–60 years age groups, each comprising 46.7% (n=14) of the study population. A smaller proportion of patients, 6.6% (n=2), belonged to the 61–78 years age group. Overall, the study population was predominantly composed of the individuals between 20 and 60 years of age.

Table 2
Distribution of patients according to sex

Sex	Number	Percentage
Female	4	13.3
Male	26	86.7
Total	30	100.0

The above table shows the distribution of patients according to sex.

The sex-wise distribution of the study participants showed that the majority were male. Out of 30 patients included in the study, 26 (86.7%) were males and 4 (13.3%) were females. This indicates a clear male predominance in this study population.

Table 3
Distribution of patients according to mode of injury

Mode of Injury	Number	Percentage
Fall	7	23.3
Road Traffic Accident	23	76.7

Total	30	100.0

The distribution of patients according to mode of injury showed that the majority of cases were due to road traffic accidents. Out of the total 30 patients, 23 patients (76.7%) sustained injury following a road traffic accident, whereas 7 patients (23.3%) sustained injury due to a fall. This indicates that road traffic accidents were the predominant cause of injury in the present study of population

Table 4
Distribution of patients according to side involved

Side Involved	Number	Percentage
Left side	12	40.0
Right side	18	60.0
Total	30	100.0

The distribution of patients according to the side involved showed that the right side was more commonly affected, accounting for 60.0% (n = 18) of cases, whereas the left side was involved in 40.0% (n = 12) of patients. The total sample size comprised 30 patients (100%).

Table 5
Fracture Classification according to Schatzker Classification

Fracture Classification	Number	Percentage
Type 3	10	33.3
Type 4	10	33.3
Type 5	6	20.0
Type 6	4	13.3
Total	30	100.0

The distribution of fractures according to classification revealed that Type 3 and Type 4 fractures were the most common, each accounting for 33.3% (n = 10) of the total cases. Type 5 fractures constituted 20.0% (n = 6), while Type 6 fractures were the least frequent, representing 13.3% (n
= 4) of the study population. Overall, a total of 30 cases were included in the analysis (100%).

Table 6
Distribution of patients according to surgical approach

Surgical Approach	Number	Percentage
Antero-lateral approach	14	46.7
Antero-medial approach	10	33.3
Midline approach	6	20.0
Total	30	100.0

The distribution of surgical approaches among the 30 patients is presented in the table. The anterolateral approach was the most commonly utilized technique, performed in 46.7% (n = 14) of cases. This was followed by the anteromedial approach in 33.3% (n = 10) of patients. The midline approach was employed in 20.0% (n = 6) of cases. Overall, the anterolateral approach constituted nearly half of the surgical interventions in the study population.

Table 7
Distribution of patients according to surgical procedure

Surgical Procedure	Number	Percentage
MIPPO	3	10.0
ORIF	27	90.0
Total	30	100.0

Among the total 30 patients included in the study, the majority underwent ORIF (Open Reduction and Internal Fixation), accounting for 90.0% (n = 27) of cases, whereas 10.0% (n = 3) were treated with MIPPO (Minimally Invasive Percutaneous Plate Osteosynthesis). This indicates that ORIF was the predominantly performed surgical procedure in the study population

Table 8
Distribution of patients according to Union Time

Union Time	Number	Percentage
12-14 weeks	7	23.3
15-17 weeks	12	40.0
18-20 weeks	11	36.7
Total	30	100.0

Among the 30 patients studied, the majority achieved fracture union between 15–17 weeks, accounting for 40.0% (n = 12). Union within 18–20 weeks was observed in 36.7% (n = 11) of patients, while 23.3% (n = 7) demonstrated union between 12–14 weeks. Overall, most patients experienced radiological union within 15–20 weeks of treatment.

Table 9
Distribution of patients according to final outcome

Final Outcome	Number	Percentage
Excellent	17	56.7
Good	7	23.3
Fair	4	13.3
Poor	2	6.7
Total	30	100.0

Among the 30 patients evaluated for final outcome, the majority demonstrated an excellent result in 56.7% (n = 17) of cases. Good outcomes were observed in 23.3% (n = 7) of patients, while 13.3% (n = 4) had fair results. Poor outcomes were recorded in 6.7% (n = 2) of the cases. Overall, the findings indicate that most patients achieved satisfactory to excellent final outcomes following treatment.

DISCUSSION

The present study evaluated the demographic profile, surgical management, clinical characteristics and final outcomes of proximal tibial fractures treated with locking compression plate (LCP), and the findings were compared with previously published literature. The discussion highlights important similarities and differences with earlier studies and attempts to interpret the observed trends.

With respect to demographic distribution, the majority of the patients in our study, belonged to the age groups of 20–40 years and 41–60 years, each constituting 46.7% of the total sample, with a mean age of 41.57 ± 12.21 years. This suggests that proximal tibial fractures predominantly affect the active and economically productive population. The mean age in our study is the consistent with the findings of Jain et al. (2012), who reported a median age of 42 years in patients treated with periarticular locking plates[10], and Liu et al. (2009), who documented an average age of 49 years among patients with proximal tibial fractures[11]. The similarity in age distribution across studies indicates that high-energy trauma in middle-aged individuals remains a major contributing factor to such injuries. The involvement of this age group has significant socioeconomic implications, as these individuals are often primary earners, and prolonged disability can adversely affect their quality of life and productivity.

Gender distribution in the present study showed a clear male preponderance. This observation is comparable to the findings of Tang Xin et al. (2012), who reported that 30 out of 42 patients were male[12]. The higher incidence among males may be attributed to greater exposure to outdoor activities, occupational hazards, and road traffic accidents. In developing countries especially, males are more frequently involved in vehicular travel and high-risk physical activities, which increases their susceptibility to high-energy trauma leading to tibial plateau fractures.

Regarding the mode of injury, the majority of patients in our study sustained fractures following road traffic accidents (RTAs). This finding aligns with the observations of Tang Xin et al., who also identified RTAs as the most common cause of proximal tibial fractures. The predominance of RTAs reflects the increasing vehicular density, inadequate road safety measures, and non-compliance with traffic regulations. High-energy trauma from RTAs often results in complex intra-

articular fractures, which require meticulous surgical planning and stable fixation to restore joint congruity and prevent long-term complications such as post-traumatic osteoarthritis.

In terms of side involvement, right-sided fractures were more common in our study. However, since most of the reviewed literature did not analyze side predilection, a direct comparison could not be established. The predominance of right-sided injuries may be incidental or related to dominant limb use, but further large-scale studies would be required to draw definitive conclusions.

Analysis of fracture type revealed that Schatzker Type III and Type IV fractures were most commonly encountered in our study. This finding contrasts with the study by Tang et al. (2012), where Type V fractures were most prevalent, followed by Type VI fractures. The discrepancy may be explained by differences in the mechanism and severity of trauma, referral patterns, and sample size variations. High-energy trauma tends to produce bicondylar fractures (Type V and VI), whereas relatively lower-energy mechanisms may result in split or depression-type fractures (Type III and IV). Therefore, the fracture pattern in any study population largely depends on the demographic and trauma profile of that region.

Concerning the surgical approach, the anterolateral approach was most commonly utilized in our study, followed by the anteromedial approach, while the midline approach was used in only a few cases. Chen et al. (2015) reported favorable outcomes using the extended anterolateral approach for posterolateral tibial plateau fractures, emphasizing improved visualization and fixation[13]. Similarly, Prasad et al. (2013) treated Schatzker Type V and VI fractures using various approaches, including anterolateral, medial minimally invasive, and posteromedial approaches, and observed comparable outcomes among them[14]. These findings suggest that the choice of surgical approach should be individualized based on fracture morphology, soft tissue condition, and surgeon expertise. The predominance of the anterolateral approach in our study reflects its versatility and adequate exposure for lateral plateau fractures.

In the present study, the majority of patients were managed with open reduction and internal fixation (ORIF), while minimally invasive percutaneous plate osteosynthesis (MIPPO) was employed in selected cases. Tscherne et al. (1993) advocated ORIF as the preferred treatment modality for displaced and unstable tibial plateau fractures to achieve anatomical reduction and stable fixation[15]. On the other hand, Kim J-W et al. (2012) demonstrated that MIPO could be an acceptable option in open fractures provided adequate soft tissue management is ensured. Our preference for ORIF in most cases may be attributed to the need for direct visualization and accurate restoration of the articular surface, especially in complex fractures[16]. Nevertheless, MIPPO remains a valuable technique in selected cases with favorable soft tissue conditions.

Fracture union in our study occurred predominantly between 15–17 weeks, with a mean union time of 16.40 ± 1.91 weeks. This is comparable to Apostolou et al. (2005), who reported a mean union time of 15.5 weeks for tibial fractures[17], and Jain et al. (2012), who observed an average union time of 17.6 weeks. Prasad et al. also reported a mean union time of 14 weeks (range 8–22 weeks). The consistency of union times across studies indicates that locking compression plates provide adequate stability to facilitate timely bone healing. Radiological and clinical assessments in our study confirmed satisfactory progression toward union without significant delay in most cases.

Finally, assessment of functional outcome using the Rasmussen Scoring System demonstrated that the majority of patients achieved excellent results, with only a few reporting fair to poor outcomes. These findings are in agreement with Tang et al. (2012) and Prasad et al., who also reported predominantly excellent functional outcomes following LCP fixation. The favorable outcomes observed in our study can be attributed to stable fixation, early mobilization, proper postoperative rehabilitation, and careful patient selection.

CONCLUSION

Displaced tibial plateau fractures require meticulous management to restore the joint congruity and preserve long-term knee function. The findings of the present study reinforce that operative intervention remains the treatment of choice for displaced fractures. Achievement of optimal functional outcomes is closely associated with the accurate anatomical reduction, stable internal fixation, and the initiation of early controlled mobilization to regain a satisfactory functional arc of motion.

Minimally displaced fractures with limited metaphyseal bone defects can be effectively managed with percutaneous fixation techniques, thereby minimizing soft tissue disruption. However, in cases of the

comminuted or significantly displaced fractures, open reduction and internal fixation is essential to the restore articular alignment and ensure the mechanical stability. Strict adherence to post-operative rehabilitation protocols, including appropriate periods of non-weight bearing followed by progressive mobilization, plays a critical role in achieving favorable clinical and functional results.

In the present study, the use of proximal tibial locking compression plates demonstrated reliable fracture union and allowed early mobilization, contributing to improved knee function. Based on these outcomes, locking plate fixation can be considered a safe and effective modality for the management of proximal tibial plateau fractures, offering satisfactory radiological union and encouraging functional recovery when combined with the structured rehabilitation.

REFERENCES:

1. Schulak DJ, Gunn DR. Fracture of the tibial plateaus. Clin Orthop 1975;109:166-77.
2. Koval KJ, Helfet DL. Tibial plateau fracture: evaluation and treatment. J Am Acad Orthop Surg 1995;3(2):86-94.
3. Biyani A, Reddy NS, Chaudhary DR. The results of surgical management of displaced tibial plateau fractures in the elderly. Injury 1995;26(5):291-7.
4. Wagner M. General principles for the clinical use of the locking compression plate (LCP). Injury 2003;34(Suppl 2):B31-42.
5. Egol KA, Koval KJ. Fractures of proximal tibia. In: Rockwood CA, Green DP, editors. Rockwood and Green's Fractures in Adults. 6th ed. Philadelphia: Lippincott Williams and Wilkins; 2006. p. 2.
6. Dendrinos GK, Kontos S, Katsenis D, Dalas K. Treatment of high-energy tibial plateau fractures by the Ilizarov circular external fixator. J Bone Joint Surg Br 1996;78(5):710-7.
7. Brown GA, Sprague BL. Cast brace treatment for plateau and bicondylar fractures of the tibia. Clin Orthop 1976;119:84-93.
8. Schultz M, Südkamp NP. Revolution in plate osteosynthesis: new internal fixator systems. J Orthop Sci 2003;8:252-8.
9. Sommer C, Gautier E, Müller M, Helfet DL, Wagner M. First clinical results of the locking compression plate (LCP). Injury 2003;34(Suppl 2):B43-54.
10. Jain D, Selhi HS, Mahindra P, Kohli S, Yamin M. Results of proximal tibial fractures managed with periarticular locking plates: a series of 34 cases. IJRRMS 2012;2:1-5.
11. Liu F, Tao R, Cao Y, Wang Y, Zhou Z, Wang H, et al. The role of LISS (less invasive stabilisation system) in the treatment of peri-knee fractures. Injury 2009;40:1187-94. doi: 10.1016/j.injury.2009.06.195, PMID 19692139.
12. Tang X, Liu L, Tu CQ, Yang TF, Wang GL, Fang Y, Li J, Li Q, Pei FX. Timing of internal fixation and effect on Schatzker IV–VI tibial plateau fractures. Chin J Traumatol 2012;15:81–5.
13. Chen HW, Zhou SH, Liu GD, Zhao X. An extended anterolateral approach for posterolateral tibial plateau fractures. Knee Surg Sports Traumatol Arthrosc 2015;23:3750-5.
14. Prasad GT, Kumar TS, Kumar RK, Murthy GK, Sundaram N. Functional outcome of Schatzker type V and VI tibial plateau fractures treated with dual plates. Indian J Orthop 2013;47:188-94. doi: 10.4103/0019-5413.108915. PMID 23682179.
15. Tscherne H, Lobenhoffer P. Tibial plateau fractures. Management and expected results. Clin Orthop Relat Res 1993;292:87-100.
16. Kim JW, Oh CW, Jung WJ, Kim JS. Minimally invasive plate osteosynthesis for open fractures of the proximal tibia. Clin Orthop Surg 2012;4:313-20. doi: 10.4055/cios.2012.4.4.313, PMID: 23205259.
17. Apostolou CD, Papavasiliou AV, Aslam N, Handley RC, Willett KM. Preliminary results and technical aspects following stabilisation of fractures around the knee with LISS. Injury Extra 2005;36:529-36.