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Dr. Imran Jan
Registrar, Department of Orthopaedics, Rajawadi Muncipal General Hospital, Mumbai, Maharashtra, India

Dr. Mariya Shafiki
Resident, Department of Pathology, Govt. Medical College, Srinagar, Jammu and Kashmir, India

Dr. Aijaz Ahmad Ganai
Resident, Department of Orthopaedics, Teerthankar Mahavir University, Moradabad, Uttar Pradesh, India

Corresponding Author:
Dr. Aijaz Ahmad Ganai
Resident, Department of Orthopaedics, Teerthankar Mahavir University, Moradabad, Uttar Pradesh, India

A comparative study of Elevation of depressed tibial plateau fracture (Schazer type 2 and 3) by Autograft and synthetic bone substitute

Dr. Imran Jan, Dr. Mariya Shafiki and Dr. Aijaz Ahmad Ganai

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Abstract

Introduction: There is no unanimous opinion for the use of grafting agent in the reconstruction of depressed tibial condyle fracture. Autograft is most commonly used filling agent for elvation of depressed tibial condyle fracture. However there are certain limitations which led to a recent attraction toward synthetic bone substitute like crystalline hydroxyl apatite granules and blocks.

In this study, we have compared the functional outcome and complications of autograft and bone graft substitute in reconstruction of depressed tibial condyle fractures.

Materials and Methods: A total of 40 patients with acute tibial condyle fracture were studied. Bone graft substitute and autograft were applied in 20 and 20 cases, respectively. The age of the patients was between 20 to 50 years, and the minimum followup period of patients was 12 months and maximum was 18 months .The Radiological and functional assessment was done using the modified Rasmussen clinical criteria.

Results: A total of two infections were observed, which occurred in patients with Bone graft substitute. Articular surface collapse was seen in three patients, with two bone graft substitute and one autograft patients. The mean clinical score was 18.50 and 18.55 in autograft and allograft received patients, respectively ($p = 0.09$). The mean radiological score was 15.50 and 15.60 in autograft and bone graft substitute received patients ($p = 0.3$). In bone graft substitute there was no graft doner site morbity.

Conclusion: While comparing the complication rate, functional and radiological outcome of bone graft substitute versus Autograft reconstruction of TPF, hydroxy apatite allograft could be used as a good alternative of autograft as well.

Keywords: Trauma, tibia plateau fracture, autologous bone grafting, synthetic bone grafting, bone grafting

Introduction

The incidences of tibial plateau fractures are common in this modern world due to high speed motor vehicle road traffic accidents. Tibia is the major weight bearing bone of the leg .The degree of articular depression is one of the most important determining factor in the prognosis of these fractures. Bone grafting after elevation of depressed articular surface is an important aspect of the treatment of depressed tibial condyle fractures, followed by plate and screws. It is well established that optimal knee function depends on anatomical reduction of articular surface and stable fixation.

Reconstruction of skeletal defects is a challenging problem in orthopaedic and trauma surgery [1–3]. Especially tibial plateau fractures can result in various degrees of tibial plateau depression. The resulting bone defects have to be reconstructed to restore the leg axis and regain the original function of the knee joint [4]. A variety of structural grafts such as biologic and synthetic grafts could serve this purpose. Biologic bone grafts are subdivided into autologous and allogenic bone grafts, each having its own advantages and disadvantages. In these defects, human bone allografts and synthetic bone graft substitutes can be used as filling material for elvation of depressed tibial condyle fracture [5, 6]. It has osteoinductive, osteogenic and osteoconductive properties. Bone allografts, as compared to synthetic bone grafts, have the advantage of possessing an osteoinductive (ability to induce new bone formation) and an

Osteoconductive (ability to facilitate new bone formation) potential [7]. Further, bone grafts can also be used as antibiotic carriers preventing bacterial infections directly at the surgical site [8, 9]. Bone grafting aims to restore the original anatomical conditions such as stability alignment, support an early range of motion and mobilization, and lower post-traumatic osteoarthritis risk [10–13]. Autograft bone, routinely obtained from the iliac crest, is commonly used to fill bone defects while facing the problem of restricted availability and the risk of infection, fracture, nerve injury, donor site pain, and hematoma [5, 10, 14–17].
However bone graft substitutes lack osteo-inductive properties are poor in vascularization, have increased chances of disease transmission and immune rejection. However, bone graft substitutes had some advantages as well.It could be stored for many years and be utilized for urgent occasions. There are few reports on patient outcome and bone union following tibial plateau fractures treated with bone allografts [4, 16, 18–20]. Moreover, it could be provided in unlimited quantities, and the complications of autologous harvesting would be avoided.

Materials and Methods

The prospective study was carried out in department of orthopaedics, Rajawadi municipal general hospital Mumbai from August 2015 to December 2017. Exclusion criteria include patients with non-depressed fractures or fractures with less than 10mm depression, patients with age less than 20 years or more than 50 years, open fractures, non-acute fractures and a follow-up period of at least 1 year. Preoperative protocol includes radiological assessment using AP, Lateral and Oblique views. CT scan was done to determine location, the amount of fragment separation and depression. MRI was conducted in order to detect any concomitant severe soft tissue ligamentous injuries. In that case, the patients were excluded from the study as severe soft tissue ligamentous injuries could significantly affect the outcome of the reconstruction. Types V and VI Schatzker were also excluded from the study because they require open reduction plus extensive soft tissue exposure which might affect the clinical outcome. 40 patients who sustained a depressed tibial condyle fracture (Schatker type 2 and 3) requiring grafting were included. Fractures were classified according to the Schatzker Classification and the AO/OTA Classification (Arbeitsgemeinschaft für Osteosynthesefragen und Orthopedic Trauma, Association Committee for Coding and Classification) based on the preoperative radiographs [21-23]. In 20 (50%) patients, hydroxy apatite blocks (G-bone) and in another 20 patients (50%) autologous graft was used to fill the cavity and elevate the articular surface.
The age of the patients was ranging from 20 to 50 years. The mean follow-up of patients was 12 months to 18 months. Clinical and radiological assessment of the outcome was performed employing the modified Rasmussen clinical criteria. In this regard, clinical evaluation includes factors such as pain, walking capacity, range of motion and stability. Accordingly, a score of 0 to 20 could be given to each patient. A score of <13 is considered as poor outcome, while 13–15, 16–18 and 18–20 is regarded as fair, good and excellent, respectively. In terms of radiological outcome, a score of <10 is considered as poor outcome, while 15–16, 13–14 and 10–12 is regarded as excellent, good and fair, respectively. In order to assess these scores, factors such as articular depression, varus/valgus, condylar widening and osteoarthrosis would be considered (Table 2).

Table 1: Modified Rasmussen clinical criteria

Parameters	Score	Outcome
Clinical evaluation	<13	Poor
	13-15	Fair
	16-18	Good
	19-20	Excellent
Radiological outcome	<10	Poor
	10-12	Fair
	13-14	Good
	15-16	Excellent

Surgical technique

All the patients wetre operated under regional anesthesia in supine position on a standard oiperative table with tourniquet. All patients were operated by antero lateral approach. The reduction of intraarticular fragments was confirmed by image intensifier and a sub meniscle arthrotomy .the depressed tibial plateau surface was assessed either by perforating the adjacent cortex or by opening the fractured cortex. After elvation of the articular surface G-bone (hydorxy apatite blocks) or autografts were used to fill the bone defect and support the articular surface.
Buttress plate was then applied on the anterolateral aspect of tibial condyle using appropriate cancellous screws proximally and corticle screws distally to the shaft of tibia. After fixation stability of knee was checked.

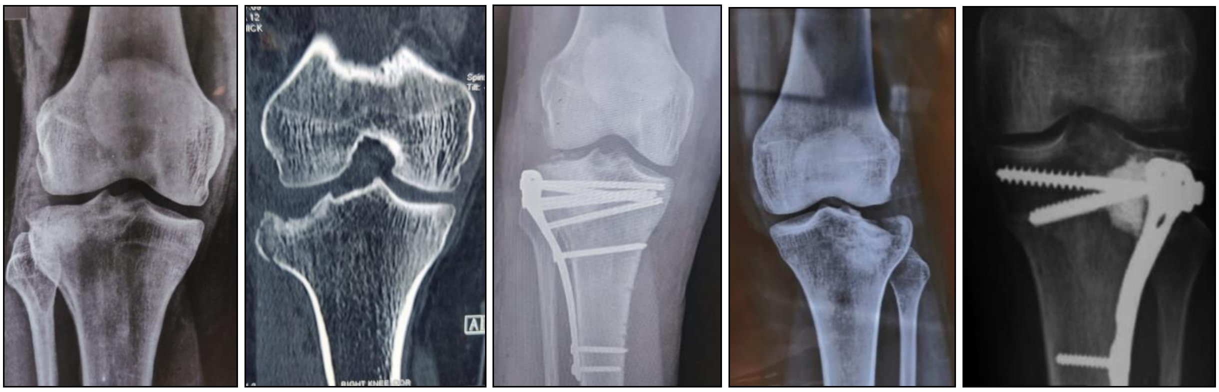

Fig 1: Radiographs

Post-operative protocol

In post-operative protocol the limb was elevated and placed in long knee brace. During first post- operative week quadriceps exercises and gentle active assisted exercises were started. Patients were maintained on non-weight bearing for 16 weeks. Partial weight bearing was started after 6 weeks. Full weight

bearing was allowed after radiological evidence of fracture union preferably at 12 to 14 weeks post-operative period.
Follow up for all patients was every 3 months in the first 12 months, and every 6 months thereafter. In each follow up, radiographs of the surgical site were obtained and routine clinical examinations were conducted. All complications were recorded. Radiologic and clinical assessment of outcome was carried out at the final follow-up session.

Statistical analysis
Statistical tests such as independent sample t test, Chisquare and correlation coefficient test were used for statistical analysis of the result. The level of statistical significance was set at $p < 0.05$

Results
The clinical score ranged from 16 to 20 and radiological score ranged from 15 to 16. A significant positive correlation was observed between clinical and radiological scores of the patients ($r = 0.756$, $p<0.001$).
The final functional outcome and complications were compared in autograft and bone graft substitute cases. The complete union was observed in all patients.
Mean time of union was 12 weeks in both the allograft and autograft received groups, ranging from 12 to 14 weeks. Most common complication was infection, which was observed in 2 patients, both in bone graft substitute patients.
The infections were local and mild and were successfully treated with prolonged antibiotic administration. Articular surface collapse was seen in 3 patients with 2 bone graft substitute and 1 autograft patient. No other graft-related complication was observed.
A total of 26 patients with excellent, 8 patients with good and 6 patients with fair clinical outcome was observed, while no poor clinical outcome was identified. Distribution of this classification in allograft and autograft received patients is shown in Table 3. This distribution was not statistically different regarding the graft type ($p = 0.21$).
The mean clinical score was 18.20 in autograft received patients and 18.00 in bone graft substitute received patients. This difference was not statistically significant ($p = 0.09$).
In terms of radiological outcome, 36 patients had excellent, 5 had good radiologic outcome, while none had fair radiologic outcome. Distribution of this classification did not show statistically significant difference between bone graft substitute and autograft received patients, as well ($p = 0.26$) (Table 3).
The mean radiological score was 15.6 in autograft received patients and 15.4 in bone graft substitute received patients. This difference was not statistically significant as well ($p = 0.3$).

Discussion
While it is widely accepted that open reduction and internal fixation of complex tibial plateau fractures is the gold standard for management, it is often assumed that the presence of a metaphyseal void mandates immediate surgical intervention with void filler [24-32]. However, biomechanical studies do not replicate the evolving scenario seen with fracture healing, and there remain no quality in vivo experiments that replicate the biomechanics of a bipedal plateau void [33]. Historically, ABG has been considered the preferred defect void filler, given its proposed satisfaction of ideal biological, mechanical, and economic criteria for bone grafts [10, 13, 34-37].
However, harvesting ABGs imparts additional morbidity. Furthermore, a recent systematic review concluded that, despite ongoing research, there is currently insufficient evidence to elucidate the utility of biologically active bone grafts in fracture healing [38]. Indeed, consensus indicates that synthetic bone grafts may provide viable alternative void filler in the setting of tibial plateau fractures [5, 10, 30, 34, 39-44].
The most important findings of our study were that patients had clinically successful results as shown by patient reported outcomes score. Therefore, participants achieved better clinical outcomes and lower bone mineral densities with longer follow-up times. In our study 26 (65%) patients with excellent, 8 (20%) patients with good and 6 (15%) patients with fair clinical outcome was observed, while no poor clinical outcome was identified. Only few previous studies have investigated the patient reported outcome of bone allografting after tibial plateau fractures [4, 16, 20, 45]. Gausden et al. [12] retrospectively reviewed 61 patients with a mean age of 59.3 years and a mean follow-up of 59 months. In contrast to this study, only 64% (n = 39) patients were treated with bone void filler. Like our study, most of the fractures were classified as Schatzker II tibial plateau fractures. Age was negatively correlated with BMD measurements in healthy tissue. Schatzker et al. [24] mentioned poor bone quality as a significant obstacle for rigid fixation in tibial plateau fractures.
Another study that compared clinical and radiological outcomes of tibial plateau fractures was performed by Bagherifard et al. [4] In that study, 58 patients were treated with bone allograft and achieved a Rasmussen clinical score of 18.45, which indicates good results, similar to our study. A positive correlation between patients' clinical and radiological scores was observed. However, Bagherifard et al. [4] used Rasmussen radiological criteria in their study, namely articular depression, varus/valgus, and condylar widening factors.
Previous research shows only poor correlations between bone mineral density and patient-reported outcomes. While some authors of studies in which patients were treated without the use of bone allografts have reported an association between fracture pattern [46] or lower bone mineral density in non-injured bone-tissue [47-50] and poor clinical outcome, other recent literature show that bone graft can address poor osseous integrity. The use of appropriate bone grafting and fixation technique can therefore mitigate the impact of poor bone quality on patient outcome and the influence of fracture severity. The previous studies show promising results in radiological and patient-reported outcomes of tibial plateau fractures treated with human bone allograft. Those results are highly congruent with the current study's findings. There were some limitations of our study as small sample size, the patients were operated on by a variety of surgeons at our institution and smaller follow-up examinations. A strength of our study is the fact that all patients were assessed with clinically validated patient-reported outcomes. These questionnaires were compared with the CT scan measurement of the bone mineral density of the allograft bone.

Conclusion
While comparing the complication rate, functional and radiological outcome of bone graft substitute versus Autograft reconstruction of TPF, hydroxy apatite allograft could be used as a good alternative of autograft as well.

Conflict of Interest
Not available

Financial Support
Not available

References
1. Coraca-Huber DC, Hausdorfer J, Fille M, Nogler M. Effect

of storage temperature on gentamicin release from antibioticcoated bone chips. Cell Tissue Bank. 2013;14(3):395–400.
2. Hinsenkamp M, Muylle L, Eastlund T, Fehily D, Noel L, Strong DM. Adverse reactions and events related to musculoskeletal allografts: reviewed by the World Health Organisation Project NOTIFY. Int Orthop. 2012;36(3):633–641.
3. Lewis CS, Katz J, Baker MI, Supronowicz PR, Gill E, Cobb RR. Local antibiotic delivery with bovine cancellous chips. J Biomater Appl; c2011.
4. Bagherifard A, Ghandhari H, Jabalameli M, Rahbar M, Hadi H, Moayedfar M, *et al*. Autograft versus allograft reconstruction of acute tibial plateau fractures: A comparative study of complications and outcome. Eur J Orthop Surg Traumatol. 2017;27(5):665–671.
5. Hofmann A, Gorbulev S, Guehring T, Schulz AP, Schupfner R, Raschke M, *et al*. Autologous iliac bone graft compared with biphasic hydroxyapatite and calcium sulfate cement for the treatment of bone defects in tibial plateau fractures: A prospective, randomized, open-label, multicenter study. J Bone Joint Surg Am. 2020;102(3):179–193.
6. Ong JC, Kennedy MT, Mitra A, Harty JA. Fixation of tibial plateau fractures with synthetic bone graft versus natural bone graft: a comparison study. Ir J Med Sci. 2012;181(2):247–252.
7. Wurm A, Steiger R, Ammann CG, Putzer D, Liebensteiner MC, Nogler M, *et al*. Changes in the chemical quality of bone grafts during clinical preparation detected by Raman spectroscopy. Biopreserv Biobank. 2016;14(4):319-323.
8. Bormann N, Pruss A, Schmidmaier G, Wildemann B. *In vitro* testing of the osteoinductive potential of different bony allograft preparations. Arch Orthop Trauma Surg. 2010;130(1):143-149.
9. Mathijssen NM, Hannink G, Pilot P, Schreurs BW, Bloem RM, Buma P. Impregnation of bone chips with alendronate and cefazolin, combined with demineralized bone matrix: a bone chamber study in goats. BMC Musculoskelet Disord. 2012;13:44.
10. Goff T, Kanakaris NK, Giannoudis PV. Use of bone graft substitutes in the management of tibial plateau fractures. Injury. 2013;44(Suppl 1):S86-94.
11. Müller ME, Allgöwer M, Schneider R, Willenegger H. Manual of internal fixation, vol 1, 3rd edn. Springer, New York; c1995.
12. Gausden E, Garner MR, Fabricant PD, Warner SJ, Shaffer AD, Lorich DG. Do clinical outcomes correlate with bone density after open reduction and internal fixation of tibial plateaufractures. Arch Orthop Trauma Surg; c2017.
13. Koval KJ, Helfet DL. Tibial plateau fractures: evaluation and treatment. J Am Acad Orthop Surg. 1995;3(2):86-94.
14. Larsson S, Hannink G. Injectable bone-graft substitutes: current products, their characteristics and indications, and new developments. Injury. 2011;42(Suppl 2):S30-34.
15. Veitch SW, Stroud RM, Toms AD. Compaction bone grafting in tibial plateau fracture fixation. J Trauma. 2010;68(4):980-983.
16. Feng W, Fu L, Liu J, Li D, Qi X. The use of deep frozen and irradiated bone allografts in the reconstruction of tibial plateau fractures. Cell Tissue Banking. 2013;14(3):375–380.
17. Khan SN, Cammisa FP Jr, Sandhu HS, Diwan AD, Girardi FP, Lane JM. The biology of bone grafting. J Am Acad Orthop Surg. 2005;13(1):77–86
18. Wang JY, Cheng CY, Chen AC, Chan YS. Arthroscopyassisted corrective osteotomy, reduction, internal fixation and strut allograft augmentation for tibial plateau malunion or nonunion. J Clin Med; c2020.
19. Berkes MB, Little MT, Schottel PC, Pardee NC, Zuiderbaan A, Lazaro LE, *et al*. Outcomes of Schatzker II tibial plateau fracture open reduction internal fixation using structural bone allograft. J Orthop Trauma. 2014;28(2):97-102.
20. Lasanianos N, Mouzopoulos G, Garnavos C. The use of freeze-dried cancelous allograft in the management of impacted tibial plateau fractures. Injury. 2008;39(10):1106-1112.
21. Brunner A, Horisberger M, Ulmar B, Hoffmann A, Babst R. Classification systems for tibial plateau fractures; does computed tomography scanning improve their reliability? Injury. 2010;41(2):173–178.
22. Zhu Y, Hu CF, Yang G, Cheng D, Luo CF. Inter-observer reliability assessment of the Schatzker, AO/OTA and three-column classification of tibial plateau fractures. J Trauma Manag Outcomes. 2013;7(1):7.
23. Kfuri M, Schatzker J. Revisiting the Schatzker classification of tibial plateau fractures. Injury. 2018;49(12):2252-2263.
24. Schatzker J, McBroom R, Bruce D. The tibial plateau fracture. The Toronto experience 1968-1975. Clin Orthop Relat Res. 1979;138:94–104.
25. Gardner MJ, Yacoubian S, Geller D, *et al*. Prediction of soft-tissue injuries in Schatzker II tibial plateau fractures based on measurements of plain radiographs. J Trauma. 2006;60(2):319-323.
26. Azi ML, Aprato A, Santi I, Kfuri M, Masse A, Joeris A. Autologous bone graft in the treatment of post-traumatic bone defects: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2016;17(1):465.
27. Tscherne H, Lobenhoffer P. Tibial plateau fractures: management and expected results. Clin Orthop Relat Res. 1993;292:87-100.
28. Shaw KA, Griffith MS, Shaw VM, Devine JG, Gloystein DM. Harvesting autogenous cancellous bone graft from the anterior iliac crest. JBJS Essent Surg Tech. 2018;8(3):e20.
29. Younger EM, Chapman MW. Morbidity at bone graft donor sites. J Orthop Trauma. 1989;3(3):192–195.
30. Russell TA, Leighton RK, Alpha-BSM Tibial Plateau Fracture Study Group. Comparison of autogenous bone graft and endothermic calcium phosphate cement for defect augmentation in tibial plateau fractures. A multicenter, prospective, randomized study. J Bone Joint Surg Am. 2008;90-A(10):2057–2061.
31. Blokker CP, Rorabeck CH, Bourne RB. Tibial plateau fractures. An analysis of the results of treatment in 60 patients. Clin Orthop Relat Res. 1984;182:193–199.
32. Waddell JP, Johnston DW, Neidre A. Fractures of the tibial plateau: a review of ninety-five patients and comparison of treatment methods. J Trauma. 1981;21(5):376–381.
33. Li Y, Chen S-K, Li L, Qin L, Wang X-L, Lai Y-X. Bone defect animal models for testing efficacy of bone substitute biomaterials. J Orthop Translat. 2015;3(3):95–104.
34. Bucholz RW, Carlton A, Holmes R. Interporous hydroxyapatite as a bone graft substitute in tibial plateau fractures. Clin Orthop Relat Res. 1989;240:53–62.
35. Schmidt AH. Autologous bone graft: is it still the gold standard? Injury. 2021;52 Suppl 2:S18–S22.
36. Greenwald AS, Boden SD, Goldberg VM, et al. Bone-graft substitutes: facts, fictions, and applications. J Bone Joint

Surg Am. 2001;83-A Suppl 2 Pt 2:98–103.
37. Giannoudis PV, Einhorn TA, Marsh D. Fracture healing: the diamond concept. Injury. 2007;38(Suppl 4):S3-6.
38. Mott A, Mitchell A, McDaid C, *et al*. Systematic review assessing the evidence for the use of stem cells in fracture healing. Bone Jt Open. 2020;1(10):628–638.
39. Heikkilä JT, Kukkonen J, Aho AJ, Moisander S, Kyyrönen T, Mattila K. Bioactive glass granules: a suitable bone substitute material in the operative treatment of depressed lateral tibial plateau fractures: a prospective, randomized 1 year follow-up study. J Mater Sci Mater Med. 2011;22(4):1073–1080.
40. Pernaa K, Koski I, Mattila K, et al. Bioactive glass S53P4 and autograft bone in treatment of depressed tibial plateau fractures - a prospective randomized 11-year follow-up. J Long Term Eff Med Implants. 2011;21(2):139–148.
41. Jónsson BY, Mjöberg B. Porous titanium granules are better than autograft bone as a bone void filler in lateral tibial plateau fractures: A randomised trial. Bone Joint J. 2015;97B(6):836–841.
42. Simpson D, Keating JF. Outcome of tibial plateau fractures managed with calcium phosphate cement. Injury. 2004;35(9):913–918.
43. Drosos GI, Ververidis A, Babourda EC, Kakagia D, Verettas D-A. Calcium sulfate cement in contained traumatic metaphyseal bone defects. Surg Technol Int. 2012;22:313–319.
44. Iundusi R, Gasbarra E, D'Arienzo M, Piccioli A, Tarantino U. Three year follow-up from a prospective study. BMC Musculoskelet Disord. 2015;16:115.
45. Ong JC, Kennedy MT, Mitra A, Harty JA. Fixation of tibial plateau fractures with synthetic bone graft versus natural bone graft: a comparison study. Ir J Med Sci. 2012;181(2):247–252.
46. Kim CW, Lee CR, An KC, Gwak HC, Kim JH, Wang L, *et al*. Predictors of reduction loss in tibial plateau fracture surgery: focusing on posterior coronal fractures. Injury. 2016;47(7):1483– 1487.
47. Stevens DG, Beharry R, McKee MD, Waddell JP, Schemitsch EH. The long-term functional outcome of operatively treated tibial plateau fractures. J Orthop Trauma. 2001;15(5):312 320.
48. Ali AM, El-Shafie M, Willett KM. Failure of fixation of tibial plateau fractures. J Orthop Trauma. 2002;16(5):323–329
49. Ali AM, Saleh M, Eastell R, Wigderowitz CA, Rigby AS, Yang L. Influence of bone quality on the strength of internal and external fixation of tibial plateau fractures. J Orthop Res. 2006;24(11):2080–2086.
50. Ali AM, Burton M, Hashmi M, Saleh M. Treatment of displaced bicondylar tibial plateau fractures (OTA-41C2&3) in patients older than 60 years of age. J Orthop Trauma. 2003;17(5):346-352.

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