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"Surgical Management of Tibial Plateau Fractures with Raft Construct – A Prospective Study"

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Abstract:
Introduction*: Tibial plateau fractures are one of the commonest intra-articular fractures resulting from indirect coronal or direct axial compressive forces. Fractures of tibial plateau constitute 1% of all fractures and 8% fractures in the elderly. Medial condyle (10-23%), lateral condyle (55-70%) and both (11-30%) with differing degrees of articular depression and displacement. Improper restoration of the plateau surface and the axis of the leg could lead to development of posttraumatic early osteoarthritis. Various modalities of treatment have been recommended for particular type of fracture pattern(Schatzker classification).In case of unstable type I and other fractures, open reduction and internal fixation with elevation of depressed fragment with bone grafting/substitute for metaphysial void and rigid fixation with buttress plating is indicated. In order to avoid bone grafting/substitute and their complications, a newer method called Raft construct with variable angle locking compression plate is gaining popularity.* ***Objective*** *is to assess the functional outcome of surgical management of split and/or depressed tibial plateau fractures with variable angle locking compression plate using raft construct.* ***Materials And Methods****: A prospective study conducted on 30 patients with tibial plateau fractures(I,II,III) above age of 18 years admitted to Chigateri General Hospital and Bapuji Hospital attached to J.J.M Medical College, Davangere in the period from October 2016 to October 2019 by obtaining an informed written consent and were assessed using Rasmussen clinical and radiological criteria.* ***Results:*** *bone union was achieved at mean of 12.4 weeks, average range of movement 120^0 , Rasmussen scores were excellent in 17,good in 9, fair in 4 and no poor outcome.* ***Conclusion****: Fixation using a Raft construct through a locking plate without use of a bone graft/substitute for split-depression tibial plateau fractures is a viable option.*
Key Words: *Tibial plateau, Raft construct, Raft screw, Rasmussen criteria. Schatzker classification.*

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I. Introduction:

Tibial plateau fractures are one of the commonest intra-articular fractures resulting from indirect coronal or direct axial compressive forces. Fractures of tibial plateau constitute 1% of all fractures and 8% fractures in the elderly[1] . These fractures encompass presents with varied fracture configurations that involve the medial condyle (10-23%), lateral condyle (55-70%) or both (11-30%) with differing degrees of articular depression and displacement. In case of improper restoration of the plateau surface and the axis of the leg, these fractures could lead to development of premature osteoarthritis, ligaments and meniscal injuries as well, with lifelong pain and disability [2][3]. Schatzker Type II[4] (lateral split depression) tibial plateau fractures tend to occur in elderly patients with osteopenic bone. Because these are intra-articular fractures with a significant depressed fragment, the depressed portion must be elevated and the joint line restored anatomically. Unfortunately, these fractures can be very difficult to treat, and in one study 100% of tibial plateau fractures in osteopenic bone had hardware failure[5]. The aim is to study the surgical management of tibial plateau fractures(Schatzker type I ,II,III) using Raft construct to obtain a stable, pain-free, mobile joint, to prevent the development of premature osteoarthritis without using bone graft or substitute and to correlate the radiological findings with the type of fracture and the functional end result.

Patients and methods:

This is a prospective study which was carried out between October 2016 and October 2019, 30 cases of tibial plateau fractures admitted in Chigateri general hospital and Bapuji hospital affiliated to JJM medical college, Davangere-577004.

Inclusion criteria:

1. Patients above 18 years old who are diagnosed to have Tibial plateau fracture(schatzker type I,II,III)
2. Patients with osteoporosis.
3. Patients who have given their informed written consent for the procedure.
4. Patients who are fit for surgery.

Exclusion Criteria

1. Age less than 18 years.
2. Massive soft tissue envelop loss.
3. Schatzker type IV,V.VI.
4. Patients medically unfit for surgery.
5. Patient not willing for surgery.

II. Operative technique:

Patients were thoroughly investigated, affected limb is prepared for surgery. Under spinal anaesthesia surgery was carried out. All patients were given inj. Ceftriaxone 1gm i.v and inj TT i.m pre-operatively as routine prophylaxis.

Position the patient supine on a radiolucent operating table. The leg should be freely movable. The contralateral leg can be placed in an obstetric leg holder. Visualization of the proximal tibia under fluoroscopy in both the AP and Lateral view is necessary.

Support the knee with towel to get 30^0 flexion. tourniquet applied, femoral distracter is used when required.

Using Anterolateral Approach(figure 1) , with the knee in 30^o flexion , a slightly curved incision is performed, beginning in the area of the epicondyle and ending between the fibula and Gerdy's tubercle. This incision can be expanded proximally and distally if more exposure is needed. The deep dissection involves splitting the fibers of iliotibial tract. Care should be taken not to dissect the other structures that may be displaced, such as meniscus, etc. The menisci is then palpated and the knee joint may be opened below the meniscus to visualize the articular fragments or arthroscopy can be used.

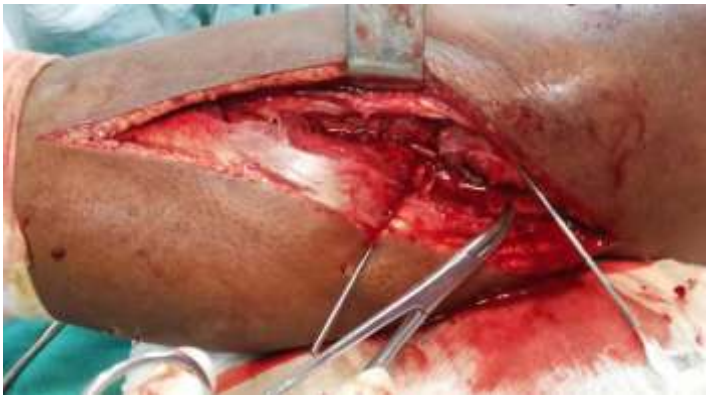


Figure 1 anterolateral incision with reduction and k-wire fixation

The fracture fragments were mobilized with chisel and reduced directly under vision. Once reduction is achieved 1.5mm K-wire is passed through fracture fragments(figure 1) and confirmed under fluoroscopy. In case of depressed fractures, through cortical window fragments were elevated and fixed with 1.5mm K-wires(figure 2).in our study we haven't put bone graft or bone substitutes. Plate templates are used to know the contour of tibia condyle and shaft for proper placement of 'Raft plate' variable angle locking compression plate(figure 4).

Figure 2 reduction using impactor through cortical window.

Figure 3 applying reduction clamp

Figure 4 positioning of precontured plate.

Once plate is placed 2mm k-wire passed through plate proximally and once plate positioning is confirmed distal k-wire is fixed to plate and the shaft which confirmed under fluoroscopy. Then a 3.5mm raft screws is fixed to plate subchondrally about 2mm beneath articular surface(figure 5). Distally 3.5mm locking cortical screws locked to combi holes. once, plate position is confirmed rest of screws locked to plate bone construct(figure 6).

Figure 5 k-wires and Raft screws through the plate

Figure 6 lateral view

After thorough wash, draine is inserted and wound was compacted, to block the bleeders once tourniquet is loosened. Iliotibial band was closed. Subcutaneous and skin approximated. The draine was removed after 48hrs of surgery according to the protocol.

Injection ceftriaxone 1000mg and amikacin 500mg BD was started on first post-operative day. sitting was allowed and active quadriceps and ankle pump exercises were taught and encouraged within the limits of pain, dressing was changed in 2nd post operative day along with drain removal, sutures removed on 10th post operative day. Complete weight bearing was deferred till the callus bridges the fracture gap on serial follow up according to the protocol.

Patients were followed up every month to assess the range of movements, check x-ray are taken to know the collapse of fragments, signs of union and for angular deformity.Partial weight bearing allowed at 6-8weeks.Complete weight bearing at 10-14weeks depending on rate of union and stability. Functional and radiological assessment made with modified Rasmussen criteria for clinical and radiological assessment at an interval of 1, 3, 6 and 12 months.

Figure 7 showing x-ray of 40yr old male with schatzker

Figure 7a: post-op x-ray showing Raft construct with LCP.

Type II fracture.

Figure 7b Follow up x-ray after 3 months

Figure 7c: Followup x-ray after 6 months

Figure 7d: 1 year followup x-ray showing bone union.

Figure 8: clinical picture showing Extension.

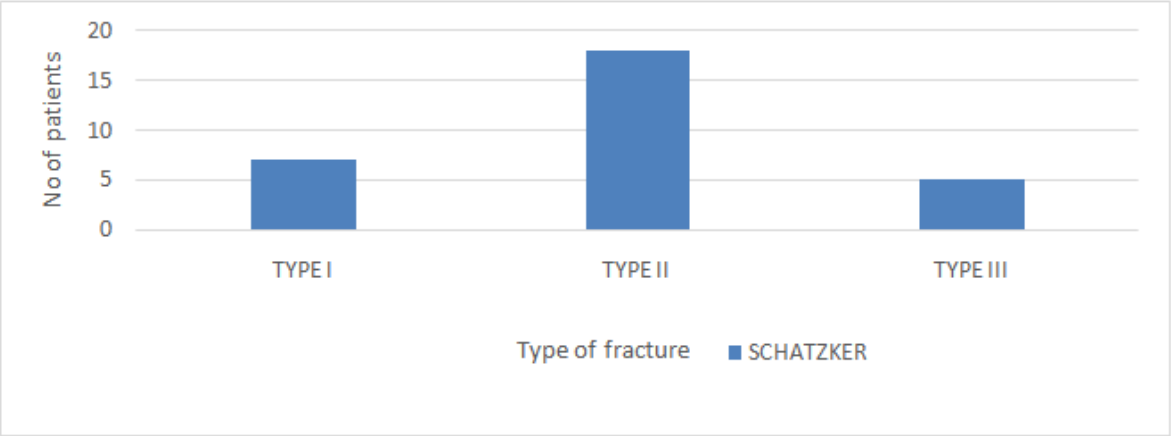
Figure 9: clinical picture showing flexion of knee joint.

Figure 10: clinical picture showing crossed leg sitting.

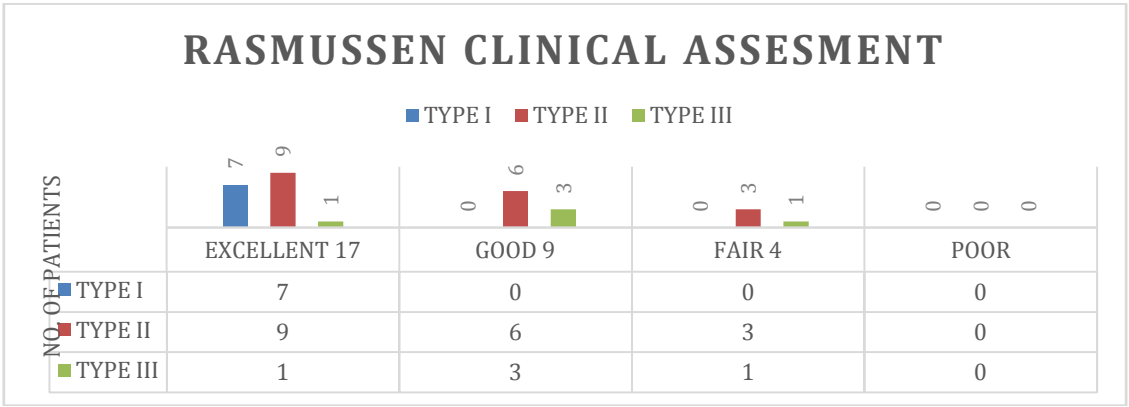
III. Results

Type of fractures

SCHATZKER	PATIENTS	PERCENTAGE(%)
I	7	23
II	18	60
III	5	17

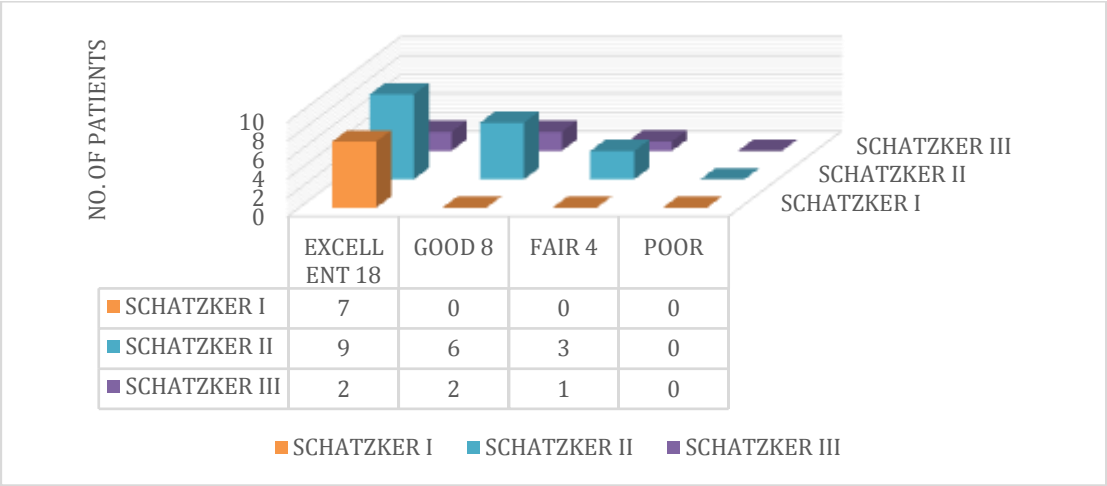


In total of 30 cases males were predominantly affected around 76.7% sustained road traffic accidents. There is no side specificity in our study with a mean follow up period 27.6weeks.
60% of them had schatzker type II, 23.3% type I and 16.7% type III.which proves type II fractures are of common type.
50% of patients aged above 40years are affected with mean age 40.4years.
Mean union rate 12.4weeks ranging from 8-14weeks with a mean ROM 120^0 ranging from 0-100^0 to 0-130^0.
Functional analysis was done using **Rasmussen clinical scoring system**, which is filled by surgeon.



All unstable type I schatzker fracture treated with raft construct had excellent functional outcome without any complications.
Among type II schatzker fracture 9 showed excellent functional outcome, 6 of them showed good and 3 of them fair results. None of patients had poor outcome.
In case of type III schatzker fractures 3 patients showed good outcome and rest of them had excellent and fair results each.
Over all out of 30 patients, 56.7% of them showed excellent clinical outcome. 30% of patients with good and 13.3% had fair outcome. None of patients had poor outcome.

RASMUSSEN RADIOLOGICAL OUTCOME.
Patients radiographs were analysed according to Rasmussen criteria and were graded according to scores.



	EXCELLENT 18	GOOD 8	FAIR 4	POOR
SCHATZKER I	7	0	0	0
SCHATZKER II	9	6	3	0
SCHATZKER III	2	2	1	0

All unstable schatzker type I treated with raft construct showed excellent radiological outcome.
Among type II schatzker fractures 9 showed excellent results. 6 with good and 3 fair results.none of patients had poor outcome.
Among schatzker type III fractures 2 patients had excellent, 2 good and 1 fair results.
Over all out of 30 patients, 60% of them showed excellent clinical outcome. 26.7% of patients with good and 13.3% had fair outcome. None of patients had poor outcome.
Post operative complications in our study were 3 infected,4 wound dehiscence, 2 loss of reduction, knee stiffness and 5 with persisting pain.

IV. Discussion:

The goal of treatment for intra-articular tibial plateau fracture is to restore axial alignment, articular surface congruence, joint stability, joint mobility and to avoid post traumatic early osteoarthritis of knee joint[6]. Around 40% of body weight is loaded on lateral condyle of tibia hence stable fixation with restoration of lateral condyle of tibia is important to maintain articular congruity[7,8]. Treatment is usually difficult as most of tibial plateau fractures are of type II and in eldely, in whom the subchondral bone is weak and soft tissue is damaged[9-11]. Use of raft construct through the plate rather than outside plate give better stability even without filling the metaphyseal void with bone graft / bone substitute, and achieves radiological union after a mean of 12.4 weeks ranging from 8-14 weeks, which is similar to other techniques with bone graft[12,13] and without bone graft/bone substitute[14]. Though there are newer modalities of treatment for minimally depressed fragments which are promising like tibioplasty technique. but, In one study its failed in longitudinal tibial condyle fractures where they recommend open reduction and rigid internal fixation with raft construct.

All the patients were treated with anterolateral approach as described in one of the study. Lateral condyle fractures usually contain more than one fragment because of its convexity towards femur and substantial proportion of cancellous bone. Articular surface depression is widely seen in older patients because of osteoporosis. Consequently, both minimally invasive and conventional approaches are used to treat these fractures[15,16]. Adequate maintainance of reduced fragment is important during post operative period to prevent loss of reduction and to minimise the risk of post traumatic osteoarthritis. The subchondral raft technique is a well known method to resist depression and loss of reduction and can be performed with kirschner wires, lag screws, conventional screws and locking screws either through the plate or individually[14,17]. Cancellous screws provide great resistance to fragment displacement than cortical screws and screws with smaller thread diameter provide great resistance to displacement than screws of the same thread type with a larger diameter[18].

Raft screws which we used have larger core diameter and shallower thread pitch for improved bending and shear strength. The use of small fragment screws for fixation of tibial plateau fractures is recommended, as the pullout strength of 6.5mm, 4.5mm, and 3.5mm screws is comparable[19,20]. The 3.5mm small fragment screws and T-plate decreases the bulk of hardware and improves fixation for small fragments[21]. The antiglide screw or buttress plate has no additional advantage over lag screw fixation alone[22]. The buttress plate has greater stiffness than lag screws alone hence we fixed unstable type I schatzker fractures[23]. Fixation with a raft using 3.5mm subchondral screws is more resistant to local depression loads than a buttress plate with or without bone graft[24]. Fixation with screws through the plate instead of outside plate enables more stability against plateau displacement[25].

The mean age of patients in our study was 40.4years. this is similar to the mean age of 41years in Eggli et al study and 49.1years in the Lee et al[26] study. Most of the patients sustained fracture due to road traffic accident. In our study male out-numbered females as most of males are travelling and more prone for road traffic accidents. The mean follow up period was 27.6weeks. At every follow up, patients were analysed using Rasmussen clinical and radiological criteria.

Out of 30 patients 60% showed excellent Rasmussen clinical scores and 56.7% showed excellent Rasmussen radiological scores. Hence, periarticular raft construct gives better stability even in osteoporotic bone as most of our patients are elderly(>40 years) and achieved bone union at 12.4weeks without bone graft which prevents donor site morbidity(autograft)[27-30], disease transmission(allograft)[31-33] and potential immunogenic reactions(bone substitutes)[34] however metaphyseal fractures are expected to heal much faster even without bone graft.

The use of periarticular raft plate in anatomically reuced split-depression tibial plateau fractures provides rigidity and prevents collapse irrespective of underlying bone quality[35,36].

In patients with good and fair functional scores these patients started early weight bearing which led to collapse of reduced fragment and these patients had constant knee pain leading to restricted ROM and knee stiffness. In our study mean ROM is 120^{o}. 16.7% of patients complained of knee pain this could be because of post traumatic osteoarthritis. After trauma there is immediate loss of proteoglycans due to distruction or decreased synthesis which leads to chondrocyte damage and further osteoarthritis. The use of periarticular raft construct through locking plate prevents further damage to chondrocytes by maintaining the anatomical reduction and enable bone healing without the need for a bone graft or substitute, which decreases operating time and morbidity.

Parkkinen et al, reported that articular congruity and normal mechanical axis predict the postoperative osteoarthritis. They found valgus malalignment $>5^{o}$ and articular depression >2mm lead to severe arthritis[37].

Two points are important to lower the arthritis rate: obtaining the anatomical joint line and normal mechanical axis during surgery and maintaining this reduction throughout the healing period[37,38].Three cases in our study had superficial wound infection managed with intravenous antibiotics and thorough debridement. The relation between time before surgery and chances of infection could not be assessed because of small sample size.

V. Conclusion

3.5mm raft screws placed subchondral region provide adequate construct stiffness and prevent articular depression without using bone graft/ bone substitute. Small fragment plates when placed anterolaterally provide support for posterolateral and posteromedial fragment which reduces the need for separate fixation and wound healing complications.There is no difference in time for union when compared to other method of treatment but there is added advantage of not using bone graft/ bone substitute. Locking plates provide better stability and maintain articular congruence which decreases chances of osteoarthritis, aids in better range of movements and reduces pain during post operative physiotherapy hence giving positive end results.Buttress plating in schatzker type I,II and III fracture to support raft screw fixation is necessary for all tibia plateau fractures with poor bone quality or fragment instability.

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References:

[1]. Jacofsky DJ, Haidukerwych GJ. Tibia plateau fractures. In: Scott WN. Insall & Scott Surgery of the knee. Philadelphia: Churchill Livingstone. 2006. p.113346.
[2]. Wang SQ, Gao YS,1 Wang JQ, Zhang CQ, Mei J, and Rao ZT. Surgical approach for high-energy posterior tibial plateau fractures. Indian J Orthop. 2011 Mar-Apr; 45(2): 125–31.
[3]. Markhardt BK, Gross JM, Monu J. Schatzker Classification of Tibial Plateau Fractures: Use of CT and MR Imaging Improves Assessment. Radio Graphics. March 2009; 29: 585-97.
[4]. Schatzker J, McBroom R, Bruce D. The tibial plateau fracture. The Toronto experience 1968--1975. Clin Orthop Relat Res1979;138:94–104
[5]. Ali AM, El-Shafie M, Willett KM. Failure of Fixation of Tibial Plateau Fractures. JOT. 2002;16:323-329
[6]. Honkonen S.E, Jarvienen M.J,: Classification of fractures of tibial condyles, *JBone Joint Surg 74B: 840, 1992*
[7]. Hohl M, Luck JV. Fractures of the tibial condyle; a clinical and experimental study. J Bone Joint Surg Am 1956;38:1001–18.
[8]. Hohl M. Tibial condylar fractures. J Bone Joint Surg Am 1967;49:1455–67.
[9]. Stannard JP, Wilson TC, Volgas DA, Alonso JE. The less invasive stabilization system in the treatment of complex fractures of the tibial plateau: short-term results. J Orthop Trauma 2004;18:552–8.
[10]. Watson JT, Coufal C. Treatment of complex lateral plateau fractures using Ilizarov techniques. Clin Orthop Relat Res 1998;353:97–106.
[11]. Weigel DP, Marsh JL. High-energy fractures of the tibial plateau. Knee function after longer follow-up. J Bone Joint Surg Am 2002;84:1541–51.

[12]. Singh S, Patel PR, Joshi AK, Naik RN, Nagaraj C, Kumar S. Biological approach to treatment of intra-articular proximal tibial fractures with double osteosynthesis. Int Orthop 2009;33:271–4.
[13]. Yu Z, Zheng L, Zhang Y, Li J, Ma B. Functional and radiological evaluations of high-energy tibial plateau fractures treated with double-buttress plate fixation. Eur J Med Res 2009;14:200–5.
[14]. Sunil G Kulkarni, Ravishanker Tangirala, Shekhar P Malve et al. Use of a raft construct through a locking plate without bone grafting for split-depression tibial plateau fractures. Journal of Orthopaedic Surgery 2015;23(3):331-5
[15]. Zhai Q, Luo C, Zhu Y, Yao L, Hu C, Zeng B, Zhang C. Morphological characteristics of split-depression fractures of the lateral tibial plateau (Schatzker type II): a computer-tomography-based study. Int Orthop. 2013;37(5):911-7.
[16]. Westmoreland GL, McLaurin TM, Hutton WC. Screw pullout strength: abiomechanical comparison of large-fragment and small-fragment fixation in the tibial plateau. J Orthop Trauma. 2002;16(3):178-81.
[17]. Cross WW 3rd, Levy BA, Morgan JA, Armitage BM, Cole PA. Periarticular raft constructs and fracture stability in split-depression tibial plateau fractures. Injury. 2013;44(6):796-801.
[18]. Cooper HJ, Kummer FJ, Egol KA, Koval KJ. The effect of screw type on thefixation of depressed fragments in tibial plateau fractures. Bull Hosp Jt Dis.2001-2002;60(2):72-5.
[19]. Duwelius PJ, Rangitsch MR, Colville MR, Woll TS. Treatment of tibial plateau fractures by limited internal fixation. Clin Orthop Relat Res 1997;339:47–57.
[20]. Westmoreland GL, McLaurin TM, Hutton WC. Screw pullout strength: a biomechanical comparison of large-fragment and small-fragment fixation in the tibial plateau. J Orthop Trauma 2002;16:178–81.
[21]. Benirschke SK, Swiontkowski MF. Knee. In: Hansen S, Swiontkowski MF, editors. Orthopaedic trauma protocols. 1st ed. New York: Raven Press; 1993:313–325.
[22]. Koval KJ, Sanders R, Borrelli J, Helfet D, DiPasquale T, Mast JW. Indirect reduction and percutaneous screw fixation of displaced tibial plateau fractures. J Orthop Trauma 1992;6:340–6.
[23]. Denny LD, Keating EM, Engelhardt JA, Saha S. A comparison of fixation techniques in tibial plateau fractures. Orthop Trans 1984;10:388–9.
[24]. Karunakar MA, Egol KA, Peindl R, Harrow ME, Bosse MJ, Kellam JF. Split depression tibial plateau fractures: a biomechanical study. J Orthop Trauma 2002;16:172–7.
[25]. Cross WW 3rd, Levy BA, Morgan JA, Armitage BM, Cole PA. Periarticular raft constructs and fracture stability in splitdepression tibial plateau fractures. Injury 2013;44:796–801.
[26]. Lee et al.: Comparison of outcome of unilateral locking plate and dual plating in the treatment of bicondylar tibial plateau fractures. *Journal of Orthopaedic Surgery and Research 2014 9:62.*
[27]. Catinella FP, De Laria GA, De Wald RL. False aneurysm of the superior gluteal artery. A complication of iliac crest bone grafting. Spine (Phila Pa 1976) 1990;15:1360–2.
[28]. Cohn BT, Krackow KA. Fracture of the iliac crest following bone grafting. A case report. Orthopedics 1988;11:473–4.
[29]. Guha SC, Poole MD. Stress fracture of the iliac bone with subfascial femoral neuropathy: unusual complications at a bone graft donor site: case report. Br J Plast Surg 1983;36:305–6.
[30]. Kurz LT, Garfin SR, Booth RE Jr. Harvesting autogenous iliac bone grafts. A review of complications and techniques. Spine (Phila Pa 1976) 1989;14:1324–31.
[31]. Palmer SH, Gibbons CL, Athanasou NA. The pathology of bone allograft. J Bone Joint Surg Br 1999;81:333–5.
[32]. Segur JM, Torner P, García S, Combalía A, Suso S, Ramón R. Use of bone allograft in tibial plateau fractures. Arch Orthop Trauma Surg 1998;117:357–9.
[33]. Sugihara S, van Ginkel AD, Jiya TU, van Royen BJ, van Diest PJ, Wuisman PI. Histopathology of retrieved allografts of the femoral head. J Bone Joint Surg Br 1999;81:336–41.
[34]. Welch RD, Zhang H, Bronson DG. Experimental tibial plateau fractures augmented with calcium phosphate cement or autologous bone graft. J Bone Joint Surg Am 2003;85:222–31.
[35]. Barei DP, Nork SE, Mills WJ, Coles CP, Henley MB, Benirschke SK. Functional outcomes of severe bicondylar tibial plateau fractures treated with dual incisions and medial and lateral plates. J Bone Joint Surg Am 2006;88:1713–21.
[36]. Wu CC. Salvage of proximal tibial malunion or nonunion with the use of angled blade plate. Arch Orthop Trauma Surg 2006;126:82–7.
[37]. Parkkinen M, Madanat R, Mustonen A, Koskinen SK, Paavola M, Lindahl J. Factors predicting the development of early osteoarthritis following lateral tibial plateau fractures: mid-term clinical and radiographic outcomes of 73 operatively treated patients. Scand J Surg. 2014;103(4):256-62.
[38]. Rademakers MV, Kerkhoffs GM, Sierevelt IN, Raaymakers EL, Marti RK. Operative treatment of 109 tibial plateau fractures: five – to 27-year follow-up results. J Orthop Trauma. 2007;21(1):5-10.

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