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Original Research Article

Plating as an operative management of intra articular fractures of the upper end of tibia: a prospective clinical study

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ABSTRACT

Background: Tibial plateau fracture management is challenging because of the severe displacement of the bony fragments, the concomitant depression and impaction of the cancellous subchondral bone, and the inevitable associated cartilage injury.
Methods: A prospective cohort study of 25 patients who suffered high energy intra-articular fractures of proximal tibia was done and they were diagnosed and classified according to Schatzker's classification. The study was done to study the outcomes of surgical management of high energy tibial plateau fractures with buttress plate, to achieve anatomical reduction and absolute stable internal fixation to prevent malunion, to achieve early mobilisation, to prevent post-operative knee stiffness and also to determine timing of operation after trauma and sequence of fixation of bicondylar fractures. All patients were treated with open reduction and internal fixation with a buttress plate either a lateral, medial or bicondylar plating.
Results: Average radio-graphic bony union time was 12 weeks. Average full weight bearing time was 13 weeks. Knee stiffness improved with physiotherapy and full range was achieved on an average in 8 weeks, mean range of movement 0-124.5º was achieved. 4 patients (16%) developed infection.
Conclusions: Fractures of upper end of tibia can be treated with the plating technique, to achieve anatomical reduction and stable internal fixation with 82% good functional outcome. The plating technique facilitates early mobilisation of injured joint and attains good range of movements. Minimal mal reduction does not seem to vitiate the results. The infection rate of 16% is of concern with this procedure, but responds well to antibiotics and surgical debridement.

Keywords: Proximal tibia, Buttress plating, Three column classification system

INTRODUCTION

Tibial plateau fracture involves the proximal tibia in its articular and meta-epiphyseal segments. Their management is challenging because of the severe displacement of the bony fragments, the concomitant depression and impaction of the cancellous subchondral bone, and the inevitable associated cartilage injury. It often associated with complications, i.e. compartment syndrome, cartilage destruction, meniscal injuries, soft tissue damage, infection, knee instability or stiffness.[1-3] Early and late post-traumatic arthritis are devastating.[4]

Tibial plateau fractures have a controversial management. Excellent to good results have been published in both groups. Most of the tibial plateau fractures 85% can be managed by conservative treatment.[5,6] Some say that every tibial plateau even undisplaced fractures should be operated upon to achieve anatomical reduction and rigid

internal fixation, so that early mobilization of knee is possible.[7]

Currently, open reduction and internal fixation with the plate and screws is considered to be the gold standard of treatment. Modern locking plate systems, providing increased angular stability, low implant failure, improved design that matches periarticular bone surface, as well as compatible with the minimal invasive techniques MIPPO (Minimally Invasive Percutaneous Plate Osteosynthesis) are nowadays the mainstay of treatment.[8]

Arthroscopic assisted reduction is recommended by some pure depression fractures. In these patients there is a risk of development of compartment syndrome due to the drainage of irrigation fluids into the tibial compartments.[9,10]

The use of ring fixators offers a reliable alternative method of treatment for the high energy tibial plateau fractures with gross intra-articular comminution (AO/OTA type C3) associated with severe soft-tissue damage.[11]

METHODS

Our study was prospective in nature and was conducted at Govt. Medical College and hospital, Miraj between April 2012 to April 2014. 25 patientswho suffered high energy intra-articular fractures of proximal tibia were diagnosed and classified according to Schatzker's Classification, and treated with open reduction and internal fixation with plate and screws and followed –up for a period of 2years patients were observed for minimum period of 9 months.

On arrival to the hospital APand lateral Xrays & stress radiographs were taken if ligament injury suspected. Injured knee supported in Thomas splint. CT scan was done once the patient was stable. The type of fracture, degree of depression and displacement of the fracture determined the line of treatment. The general condition of the patient is the factor that affected the treatment. Insall knee scoring system used for clinical and functional assessment of surgery on regular follow-up.

Inclusion criteria

Inclusion criteria were all high energy tibial plateau fractures i.e. all such fracture incurred in motor vehicle accident, motor cycle crash, fall from a significant height etc; patient age above 18 years.

Exclusion criteria

Exclusion criteria were patients above 60 years of age; patients with severe arthritic changes involving the knee; pathological fractures.

Statistical tests

Descriptive statistics were used to determine the range, mean, and standard deviation. One-way analysis of variance and Student t test were used

Investigations

Pre-surgical investigations and appropriate radiological investigations were carried out for every patient before surgical intervention.

Imaging techniques

Radiographic evaluation includes the standard knee trauma series of an anterior posterior (AP), lateral, and both oblique views.[12-13] Because of the 10 to 15 degrees posterior slope of the tibia's articular surface, these views may not be accurate in determining articular depression.[14] Therefore, a 10 to 15 degrees caudally tilted plateau views used to assess articular step-off.[15] A physician assisted traction view is often helpful in higher energy fractureswith severe impaction and meta-diaphyseal dissociation. The ligamento-taxis offered by gentle in line traction often reduces the split components and can give the treating physician added information about the fracture pattern prior to computed tomography (CT) scan. In addition to providing an assessment of the fracture patterns, radiographs often provide evidence of associated ligamentous injury. Avulsion of the fibular head and the segond fracture (lateral capsular avulsion) are the signs of associated ligamentous injury, whereas the Pellegrini-Stieda lesion (calcification along the insertion of the medial collateral ligament) was seen late and represents injury to the medial collateral ligament (Figure 1).[16,17]

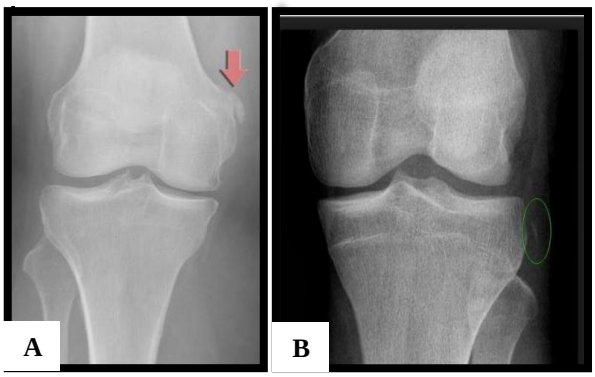

Figure 1: Radiograph of knee AP view showing. A: Pellegrini-Stieda lesion, B: Segond fracture.

Computerized axial tomography (CAT)

CT Scanning with sagittal reconstruction has increased the diagnostic accuracy in tibial plateau fractures and is indicated in cases of articular depression (Figure 2).[18,19] Furthermore, these studies are excellent in determining

the fracture configuration and planning of implant and surgical incision placement.

Figure 2: CT scan of the knee lateral and axial sagittal section.

Magnetic resonance imaging (MRI)

MRI have been suggested as a non-invasive method for evaluating proximal tibia fractures.[20,21]

Figure 3: Plane radiograph of the knee and MRI of same patient.

Classification

There is numerous classification systems proposed to describe the tibial plateau fractures. The majority of these systems are very similar, and each one recognizes wedge, compression, and bicondylar types.

1. Schatzker's classification.[22]
2. Three column classification system.[23]

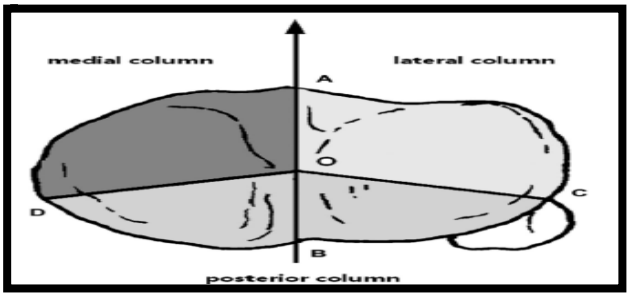

Figure 4: Three column classification.

The tibial plateau is divided into three areas, which are as the lateral column, the medial column and the posterior column. These three columns are separated by three connecting lines, namely OA, OC and OD (Figure 4).

Surgical treatment

Timing of surgery

Fractures that occur in conjunction with multiple injuries as a result of blunt trauma should be stabilized as soon as the patient's overall condition permits. If extensive soft tissue injury an external fixator or traction can be used (Figure 5 and 6).

Figure 5: A-supramalleolar pin for skeletal traction with blebs with blood stained fluid on skin.

Figure 6: Temporary two pin joint spanning external fixator.

The timing of surgery for these injuries depends primarily on the soft tissue status. If a delay of more than 1 or 2 days is necessary, the leg should be immobilized (Especially for type I, II, III) and minimal displacement. It does not prevent shortening and collapse of the fracture and therefore makes subsequent reduction more difficult. For those complex, high-energy fractures, it is best to place the leg in skeletal traction or external fixation, as previously described (Figure 6), until the soft tissues have recovered and the operative procedure can be safely carried out.

Preoperative planning

The surgical procedure must be planned carefully, especially for Schatzker's type IV, V and VI. Often, traction radiographs help determine the surgical tactic by indicating which fragments may be reduced by a ligamentotaxis, thereby helping to limit the overall extent of the incision. In addition, they identify the components of the fracture that cannot be reduced by ligamentotaxis alone and therefore require a direct operative treatment. Stress radiographs, CT & MRI play important role in planning the surgery. It is helpful to obtain radiographs of the opposite knee, which can serve as a template. It is possible through the use of preoperative drawings to make a detailed plan of all the steps in the surgical tactic.

Surgical exposures

The surgical approach should provide adequate articular visualization, combined with preservation of all vital structures and minimal soft tissue and osseous devitalization. Skin incisions for tibial plateau fracture should be longitudinal and as close to the midline as possible. Variations of the skin incision include a lazy S or inverted L shape centred over the proximal lateral tibia.

Because the majority of plateau fractures involve the lateral column, a lateral parapatellar incision and arthrotomy is often used. For medial fractures use either a medial Parapatellar approach or a posteromedial approach. In either case, the incision should be planned so that implants do not lie directly below the skin incision.[23,24,26]

Reduction techniques

Reduction of tibial plateau fractures can be attained either by direct or indirect means. Direct reduction of the articular surface and tibial metaphysis can be performed either open reduction by flexion-external rotation for plating the medial column, and extension internal rotation for fixation of the lateral compartment or by semi-open means indirect reduction techniques have been utilized. These methods take advantage of ligamentous and capsular attachments to the fracture fragments to indirectly reduce the joint surface and align the tibial shaft. Indirect reduction techniques have the advantage of minimal soft tissue stripping and fragment devitalization. Ligamentotaxis will not work on centrally depressed articular fragments. If segments of articular surface remain depressed following attempted indirect reduction or in a pure depression fracture, a cortical window can be made in the metaphysis, the site of which depends on the depression's location. The entire osteochondral segment should be elevated enmasse using bone tamps and punches. Following articular surface elevation, the void left by impacted cancellous bone should be filled with autogenous bone graft, allograft, or bone graft substitute. Check radiographs were taken in the operation table and stability of ligaments should be checked. Intra- substance full-thickness tears of ACL and PCL we retreated secondarily once fracture was united and full range of knee movements achieved.[23,24]

Implants

4.5 mm hockey plate for lateral condyle and T plates for medial tibial condyle.

Post-operative protocol

Post-operative treatment consists of elevation of the operated limb in long knee brace Intravenous antibiotics for 48 hr then oral for 10 days, if superficial infection occurs then antibiotic duration increased and change of antibiotic considered according to culture and sensitivity reports. If deep infection was present debridement under anaesthesia and antibiotic impregnated beads were kept into wound. Analgesics considered as needed. Static quadriceps and ankle exercises started as pain subsides. If the patient had no ligamental injury Gentle knee bending exercise was started after 72 hours while vigorous knee bending exercise and crutch walking with non-weight bearing was allowed after removal of stitches. An acute collateral ligament injury also involved then long leg cast maintained for 2 weeks until the sutures are removed, Then cast brace was worn for 4 weeks. When the cast is removed, then active exercises started. When the ligament has been repaired and the condylar fracture fixed, the knee was immobilized in a long leg plaster cast with the knee flexed 45 degrees for 4 weeks then active exercises started. Non weight bearing walking continues till 12 weeks from surgery. Follow-up radiographs were taken on 3rd, 6th, 9th months after surgery to assess union and any delayed secondary collapse and radiological evaluation. On every follow- up functional improvement checked by Insall scoring system.

Post operation imaging

Immediate postoperative orthogonal plain radiographs of the proximal tibia, Injury films and Full-length standing films which were not used for evaluating axial alignment were taken.

Each parameter was scored as satisfactory if within the following endpoint.

1. Articular reduction (2 mm step/gap)
2. Coronal alignment (medial proximal tibial angle 87±5°)
3. Sagittal alignment (posteriorproximal tibial angle 9±5°)
4. Condylar width (0–5 mm,)
5. Anatomical Femoro-tibial angle

Radiographic magnification was accounted for during assessment of the articular surface. Reductions outside of these parameters were considered to be unsatisfactory.

Operated case sample

Figure 7: Preoperative radiograph.

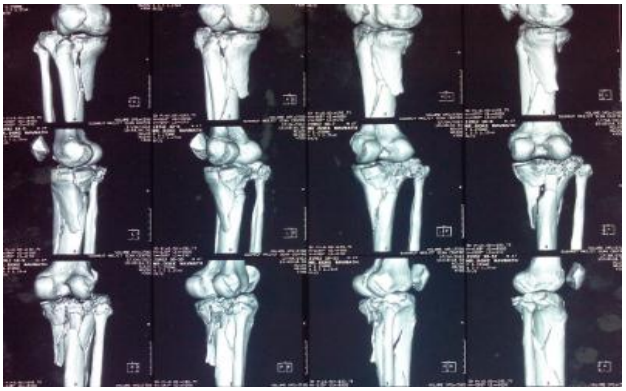

Figure 8: 3D CT scan.

Figure 9: Postoperative day 1.

Figure 10: 9 months follow up radiograph.

Figure 11: Range of movements extension.

Figure 12: Range of movements flexion.

RESULTS

Between April 2012 to April 2014, 25 patients of tibial plateau fractures were operated in our centre. Most common cause of injury in our study was the fall from motor vehicle. Among those fractures, 2 were type I, 5 were type II, 1was type III, 2were type IV, 6were type V, and 9 were type VI. There were 2women and 23men with average of 37.8 years (S.D -9.6) (range 20–60 years). 18fractures were on right side and 7on left. Out of 25 patients, 23 fractures in this study were closed, 2 were compound fractures (grade II and grade IIIA), one patient had post traumatic peroneal palsy, one had compartment syndrome, 1popliteal artery injury. 2 patients had ligament injuries, one patient had ACL injury &1had MCL injury. The mean time from trauma to surgery was 5 days (range 2-10 days). 1 patient had compartment syndrome with popliteal artery injury was immediately treated by fasciotomy and internal fixation with lateral condylar plate followed by vascular repair with saphenous vein graft, after 5 days skin grafting done on fasciotomy wound. The mean follow-up time was 12 months (S.D -2.7) (range 9-18 months).

Average radio-graphic bony union time was 12 weeks (S.D -1.15) (range 11- 14 weeks) Average full weight bearing time was 13 weeks (S.D-0.59) (range 12 – 16 weeks). One patient (No. 3) had screw loosening postoperatively but no revision operation was required No secondary varus and valgus collapse occurred in our

study. 6 patients (24%) had infection, of these two patients (No. 4 and No. 19) had superficial infection, this was managed by antibiotics administration as indicated by culture and sensitivity test. Four patients (No. 9, 18, 21, 25) had deep infection for which debridement under anaesthesia was done followed by insertion of vancomycin impregnated beads into the wound. In two patients) not responding to antibiotics progressed to chronic stage, for which implant were removed once fracture was united after 12 months of index surgery. No patient with deep infection developed septic arthritis of knee joint.

Knee stiffness improved with physiotherapy and full range was achieved on an average in 8 weeks, mean range of movement 0-124.5º was achieved. Three patients (No.- 2,9,19) were developed persistent knee stiffness for which manipulation of the knee under anaesthesia helped them to regain the range of movements. One patient(No. 9) developed DVT same patient also had preoperative peroneal palsy and post-operative knee stiffness.one patient developed (4%) (No. 18) post-operative lateral popliteal palsy.

All patients (100%) demonstrated satisfactory articular reduction (<2 mm). No patient had articular malreduction (>5 mm). All patients (100%) had demonstrated satisfactory coronal alignment or medial proximal tibial plateau angle (mPTA 87°±5), no varus and valgus mal-alignment found. 18 patients (72%) demonstrate satisfactory sagittal alignment or posterior proximal tibial plateau angle (pPTA 9°±4), 1 patients (4%) demonstrated pPTA>13° which is considered as flexion or procurvatum deformity, 6 patients (24%) demonstrated pPTA<5 and is considered as extension or recurvatum deformity. Maximum pPTA angle was 18° and minimum was -8°.All patients had satisfactory reduction of condylar width and anatomical femorotibial angle (aFTA). 18 patients (72%) had got satisfactory reduction of all five parameters. The average insall score at the 9th monthspostindexsurgerywas185.5 (S.D-16.7) (range 134-200) minimum score being 134 and maximum score of 200.

Table 1: Results of study.

Results	Insall's score	No. of patients	Percentage (%)
Excellent	>190	13	52
Good	170-190	8	32
Fair	140-170	3	12
Poor	<140	1	4

DISCUSSION

Common modes of injury in this study were vehicle accidents (48%) and fall from height (32%).

The average age was 37.8 years and was more common in men than in female which corresponds to most studies.

In our study Schatzker's classification system was used. 3column system of classification by Cong-FengLuo et al depends on CT scan.[23]

In our study fractures of Schatzker'stype VI (36%) and type V (24%) were more common. 23 fractures were close and 2 were open fractures. Frequency of involvement of right knee was more than the left knee, in our study it was 18:7. In Cong-FengLuo et al series of 2 9 patient 16 fractures were on right side and 13 were on the left side.[23] Long-term results after open reduction and internal fixation of tibial plateau fractures gives satisfactory functional outcomes, particularly in young patients. High energy, complex bicondylar tibial plateau fractures, typically present with an associated severe soft-tissue injury. Extensive dissection through the tenuous soft-tissue envelope to achieve reduction and apply stabilizing implants, particularly through a midline incision, may significantly increase postoperative infection consequently, the combination of traumatic and surgical soft tissue injury has a high complication rate, especially regarding infections. After medial and lateral plating of high-energy bicondylar tibial plateau fractures, independent reports by Moore et al quoted deep infection rates of 73%, 87.5%, respectively.[25] In our study infection rate was found to be 16%. Barei et al reports 8.3% deep infection rate in his study and shows that infection rate can be reduced by performing surgery after soft tissue swelling subside, and use of joint spaning two pin external fixator.[26]

In patients with deep infection debridement was done under anaesthesia followed by installation of vancomycin impregnated beads with intravenous antibiotics for 3 weeks as indicated by culture and sensitivity of organism.

In this study, 20 patients (80%) had full range of movements, 3 patients (12%) were terminal restriction of movements, 2 patients suffering from significant restriction of movements (90°-100°) even after knee manipulation under anaesthesia, of these patients one 4% had DVT. Average range of flexion achieved in this series was 124º.5, no patient developed extension lag at the knee joint. In Cong-fengluo et al series average range of the affected knee was 2.7º to 123.4º.[24] In Eggli et al 7% patients had developed DVT and Barei et al series there was 2% patients had DVT.[24,26] No patient in our series had developed decubitus ulcer. In our study ligament injuries occurred in 8% of patients, 4% had ACL injury and while same percentage suffered MCL injury.No patient had meniscal injury in this study. Bareiet al found 38.6% meniscal injuries in a series of 83 bicondylar fractures but did not report about ligamental injuries; Chan et al described a high association of ACL tears with a posteromedial avulsion fragment.[26,28]

In this study, 88% patients showed satisfactory anatomical reduction of articular surface and all patients had satisfactory coronal alignment. Bhattacharyya et al

observed a significant correlation between functional outcome and accuracy of articular reduction.[27]

All patients (100%) demonstrated satisfactory articular reduction (<2 mm). No patient had articular malreduction (>5 mm). All patients (100%) had demonstrated satisfactory coronal alignment or medial proximal tibial plateau angle (mPTA 87°±5), no varus and valgus mal alignment found. 18 patients (72%) demonstrate satisfactory sagittal alignment or posterior proximal tibial plateau angle (pPTA 9°±4). All patients had satisfactory reduction of condylar width and anatomical femoro tibialangle (aFTA), which are comparable to the results of Barie et al series in which 62% of patients demonstrated satisfactory articular reductions, 91% demonstrated satisfactory coronal alignment, 72% demonstrated satisfactory sagittal alignment, and 98% demonstrated satisfactory condylar width with no secondary collapse noted. In our series no secondary collapsefound.[26]

Arthroscopic assisted reduction and internal fixation is recommended by Buchko and Johnson, Caspari forthe knees with pure depression fractures.[9,10]

In our study partial weight bearing was started between 12 to 16 weeks. This corresponds to Eggliet al series.[24]

We did not have a post op CT. which was our limitation. Similarly, long-leg standing films were not obtained on these patients and may be a source of error in determining the adequacy of coronal alignment.

CONCLUSION

Our study demonstrates that the high energy intra articular fractures of upper end of tibia can be treated with the plating technique, to achieve anatomical reduction and stable internal fixation with 82% good functional outcome. The plating technique facilitates early mobilisation of injured joint to quickly attain good range of movement and achieve satisfactory outcome. Minimal mal reduction does not seem to vitiate the results. The deep infection rate of 16% is of concern with this procedure, but responds well to surgical debridement and antibiotics.

Recommendations

1. Close reduction is advised in those patients who are physically unfit forsurgery and hairline fractures of tibial plateau.
2. Preoperative planning is necessary according to fracture patterns for optimum results. CT scan gives better orientation of fracture pattern and must be done in all fractures whenever possible. Posteromedial fragment should be fixed first followed by lateral fragment.
3. To reduce infection rate wait till the soft tissue recovers from the closed degloving injury, joint spaning external fixator or supramalleolar skeletal traction is applied temporary in this patient for early recovery.
4. Near anatomical reduction of articular surface and medial tibial plateau angle is necessary for excellent results.
5. Ligament injury must be assessed intraoperatively under anaesthesia and managed accordingly.
6. Post-operative weight bearing will be decided on case to case basis. Early ROM to be started to prevent stiffness& to achieve optimal outcome.

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REFERENCES

1. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the knee society clinical rating system. Clin Orthop Relat Res. 1989;(248):13-4.
2. Bennett WF, Browner B. Tibial plateau fractures: a studyof associated soft tissue injury. J Orthop Trauma. 1994;8:183.
3. Young MJ, Barrack RL. Complications in internal fixation of tibial plateau fractures. Orthop Rev. 1994;23(2):149-54.:
4. Volpin G, Dowd GS, Stein H, Bentley G. Degenerative arthritis after intra-articular fractures of the knee: long-term results. J Bone Joint Surg. 1990;72B:634.
5. Fyshe TG. Fractures of the condyles of the tibia immobilized by the Stander splint. Can Med Ass J. 1952;67:103-7.
6. Dobelle M. A new method closed reduction of fractures of the lateral condyle of the tibia. Amer J Surg. 1941;53:460-2.
7. Honkonen SE. Indications for surgical treatment of tibial condyle fractures. Clin Orthop. 1994;(302):199-205.
8. Biggi F, Di Fabio S, D'Antimo C, Trevisani S. Tibial plateau fractures ;Internal fixation with locking plates and MIPO technique. Int J Care Injured. 2010;41:1178–82.
9. Buchko GM, Johnson DH. Arthroscopy assisted operative management of tibial plateau fractures. Clin Orthop Relat Res 1996;332:29.
10. Caspari RB, Hutton PM, Whipple TL, Meyers JF. The role of arthroscopy in the management of tibial plateau fractures. Arthroscopy. 1985;1:76.
11. Stamer DT, Schenk R, Staggers B, Aurori K, Aurori B, Behrens FF. Bicondylar Tibial plateau fractures treated with a hybrid ring external fixator: aPreliminary study. J Orthop Trauma. 1994;8:455.

12. Martin J, Marsh JL, Nepola JV, Dirschl DR, Hurwitz S, DeCoster TA. Radiographic fracture assessments: which ones can we reliably make? J Orthop Trauma. 2000;14(6):379-85.
13. Lugo-Olivieri CH, Scott WW Jr, Zerhouni EA. Fluid-fluid levels in injured knees: do they always represent lipohemarthrosis? Radiology. 1996;198(2):499-502.
14. Jensen DB, Bjerg-Nielsen A, Laursen N. Conventional radiographic examination in the evaluation of sequelae after tibial plateau fractures. Skeletal Radiol. 1988;17(5):330-2.
15. Moore TM, Harvey JP Jr. Roentgenographic measurement of tibial plateau depression due to fracture. J Bone Joint Surg Am. 1974;56:155-60.
16. Goldman AB, Pavlov H, Rubenstein D. The Segond fracture of the proximal tibia: a small avulsion that reflects major ligamentous damage. Am J Roentgenol. 1988;151(6):1163-7.
17. Hohl M, Larson R. Fractures and dislocations of the knee- Fractures Vol. 2 by Rockwood & Green : J.B. Lippincott and Co; 1975: 1158-1178.
18. Chan PS, Klimkiewicz JJ, Luchetti WT, Esterhai JL, Kneeland JB, Dalinka MK, et al. Impact of CT scan on treatment plan and fracture classification of tibial plateau fractures. J Orthop Trauma. 1997;11(7):484-9.
19. Fanucci E. Computerized tomography assessment of bone damage following injury of the anterior cruciate ligament. Radiol Med (Torino) 1995;89(5):608-12.
20. Yacoubian SV, Nevins RT, Sallis JG, Potter HG, Lorich DG. Impact of MRI on treatment plan and fracture classification oftibial plateau fractures. J Orthop Trauma. 2002;16(9):632-7.
21. Kode L, Lieberman JM, Motta AO, Wilber JH, Vasen A, Yagan R. Evaluation of tibial plateau fractures: efficacy of MR imaging compared with CT. Am J Roentgenol. 1994;163(1):141-7.
22. Schatzker J, McBroom R, Bruce D. The tibial plateau fracture: the Toronto experience 1968“1975. Clin Orthop. 1979;138:94-104.
23. Cong-Feng Lu. Fixation for Complex Tibial Plateau Fractures. J Orthop Trauma. 2010;24:683–92.
24. Eggli S, Hartel MJ, Kohl S, Haupt U, Exadaktylos AK, Roder C. Unstable bicondylar tibial plateau fractures: a clinical investigation. J Orthop Trauma 2008;22:673–9.
25. Moore TM, Patzakis MJ, Harvey JP. Tibial plateau fractures: definition, demographics, treatment rationale, and long-term results of closed traction management or operative reduction. J Orthop Trauma. 1987;1(2):97-119.
26. David P, Barei DP, Nork SE, Mills WJ. Complications associated with internal fixation of high-energy bicondylar tibial plateau fractures utilizing a two-incision technique. J Orthop Trauma. 2004;18:649.
27. Bhattacharyya T, McCarty LP 3rd, Harris MB, Morrison SM, Wixted JJ, Vrahas MS, et al. The posterior shearing tibial plateau fracture: treatment and results via a posterior approach. J Orthop Trauma. 2005;19:305-10.
28. Chan KK, Resnick D, Goodwin D, Seeger LL. Posteromedial tibial plateau injury including avulsion fracture of the semimembranosus tendon insertion site: ancillary sign of anterior cruciate ligament tear at MR imaging. Radiology. 1999;211:7.

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