



International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2020; 6(1): 616-621
© 2020 IJOS
www.orthopaper.com
Received: 24-11-2019
Accepted: 28-12-2019

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Functional and radiological outcome of schatzker type II, III, VI fractures treated via subchondral RAFT system combined with locking compression plate

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DOI: <https://doi.org/10.22271/ortho.2020.v6.i1k.1936>

Abstract

Need for the study: Treatment of proximal tibia fracture is difficult especially when intraarticular and metaphyseal comminution present. The tibial plateau involves weight bearing so restoration of joint congruity is important to preserve normal function of knee. Subchondral raft construction is one popular method under investigation for this purpose where subchondral screws support the bone pieces along with cartilage and prevent it to depress again.

Aim: to evaluate clinical and radiological results of Schatzker type II, III, VI fractures treated using open reduction and internal fixation with subchondral RAFT system combined with lateral plateau locking compression plates.

Methods: 30 patients of proximal tibial plateau split fracture and depression, including men and women aged >18 years who came to department of orthopaedics GMCH between 2017 to 2019 were enrolled in the study. Diagnosis made by x-rays and computerized tomography. In all patients, the depressed joint line was elevated and fixed with subchondral RAFT screws through the locking compression plate. At the last follow up, clinical and radiological data were recorded.

Results: The mean ROM was 110.5⁰ (range 90⁰- 125⁰), Mean KSS was 90.2 (range 65-100), Mean Rasmussen radio score was 15.6(range 10-18). All 30 patients showed signs of fracture healing on follow up x-rays and on final follow up complete bone union. Two patients developed superficial infection and one patient had screw backout on 2nd follow up. none encountered major intra or post-operative complications.

Conclusion: Subchondral RAFT combined with locking compression plate helps surgeon to maintain the anatomical reduction of depressed intraarticular fragment with satisfactory functional and radiological outcome.

Keywords: Proximal tibia fracture (Schatzker type II, III, VI), RAFT system, knee society score

1. Introduction

Knee joint is a complex joint and is the commonly injured joint because of increased vehicular trauma and sports related injuries. Being superficial joint and more exposed to external forces, this joint easily gets injured [1]. Tibial plateau fractures are one of the most common intra articular fractures. They Result from indirect coronal or direct axial compressive forces. This makes about 1% of all fractures and 8% of fractures in elderly. Most injuries affect lateral tibial condyle which is 55 to 70% and isolated medial condyle fractures occur in 10 to 23% cases whereas the involvement of bicondylar lesions is found in 10-30% of the reported series [2]. These fractures encompass many and varied fracture configurations, Schatzker classification gives 6 types of proximal tibia plateau fractures. Out of these type 2, 3, 6 includes tibial Lateral plateau split fracture and depression, Lateral plateau depression and tibial plateau bicondylar fracture with metaphyseal involvement [3]. Proximal tibia fracture is difficult to treat especially when intraarticular [4]. Over the past three decades many surgical techniques to treat this injury have been published including minimally invasive methods, arthroscopic techniques and C-armed fluoroscopy assisted osteosynthesis even traditional methods have been successfully used by many surgeons [5, 8]. Subchondral raft construction is method under investigation for this purpose where this construct in the subchondral bone

through a locking plate provides support to the articular surface of the lateral and medial condyles of the proximal tibia along with cartilage, irrespective of bone quality and the type of fixation. This approach prevents collapse, even in the absence of bone grafts or bone substitutes^[9-14].

In this study we aim of achieving a stable, well aligned, mobile joint with minimum articular irregularities and to evaluate clinical and radiological results of Schatzker type II, III, VI fractures treated using open reduction to elevate the depressed fragment with subchondral RAFT system combined with anatomical lateral plateau locking compression plates.

2. Material and Methods

This was a prospective interventional observational study undertaken at Orthopaedics department of Geetanjali Medical College and Hospital, Udaipur after approval by the Ethics committee of the hospital.

The source of the data was 30 patients both men and women (age 18 to 75 years) sustaining proximal tibia intraarticular fracture with or without metaphyseal involvement (Schatzker type II, III, VI) who came to department of Orthopaedics GMCH between 2017 to 2019. Patients with Floating knee (both distal femur and proximal tibia intraarticular fractures), Open fracture, Pathological fracture, Proximal tibia fracture with plateau depression <3mm, Previous knee joint surgery were excluded. Diagnosis was made with history, clinical examination and radiologically with xray knee anteroposterior and lateral views.

2.1 Preoperative management

On admission patients were started on an i.v. fluids and antibiotics infused. Analgesics were given. The injured limb was temporarily immobilized in splint. Assessment of primary

care of fracture started with limb elevation and anti-inflammatory treatment given. Close observation of compartment syndrome done. Those presenting with severe soft tissue edema or blisters were taken up for surgery only after the appearance of—wrinkle sign. Routine preoperative investigations were done and preanesthetic check-up and fitness were taken for all the patients. Preoperative CT scan (3D CT) done according to requirement in all patients to assess the fracture pattern and determine the location of articular comminution and depression. Part prepare was done of affected knee and iliac crest in case of planned bone grafting.

2.2 Surgical procedure

Surgery was done under spinal or general anaesthesia. All patients were given IV antibiotics preoperatively as routine prophylaxis. Patient was placed in supine position, with bolster under knee to allow knee flexion. Tourniquet was applied and inflated at the time of incision. Scrubbing, painting and draping was done of affected limb. Bony landmarks were drawn on the incision site. Anterolateral approach to proximal tibia is used for incision and surgical dissection. Sub meniscal arthrotomy was done to evaluate intraarticular damage. For articular depression window was made in the metaphyseal area,

1. Approach from below through the fracture
2. Cortical window in the metaphysis region from the same side or opposite side

Periosteal elevator or blunt osteotome inserted beneath the depressed articular fragments, and by slow and meticulous pressure articular fragments elevated.



Fig: Intraoperative C arm images of reduction of plateau depression

The metaphyseal defect which resulted when the articular fragments were reduced, filled with cancellous autografts or corticocancellous block to support the elevated fragments whenever required. Once the articular fragments open reduction was achieved and metaphyseal defect bone grafted, the lateral condylar fragment reduced with the help of large reduction clamp.

Locking compression plate combined with subchondral RAFT system applied on the anterolateral surface of tibia and temporarily fixed with k wires. Plate position checked under c-arm both in anteroposterior and lateral plane. Plate fixed with distal fragment of bone with one 3.5 mm cortical screw. Then articular fragments were kept reduced and fixed with 4, 3.5 mm locking cancellous screws (RAFT system). All screws inserted under fluoroscopic guidance to avoid intraarticular placement and injury. Temporary k wires were removed and reduction checked again under c arm. One or two long 3.5 mm metaphyseal locking cancellous screws also inserted

depending on fracture pattern. Distally 2 or 3 locking screws of 3.5 mm inserted to fix the plate to the distal fragment. Repair and close the sub meniscal arthrotomy. Close the ilio-tibial band and cover the plate with same. Drain in situ. Soft tissues closed in layers. Skin closed and sterile dressing done. Tourniquet released, distal pulsation checked and splintage applied immediate postoperatively.

2.3 Postoperatively

Close monitoring of operated limb for compartment syndrome, Analgesics and antibiotics given according to protocol, Postoperative x-ray knee (upto midleg) both AP and lateral view done.

Drain removal and dressing done after 24 hours, Static quadriceps exercises and passive range of motion was started on day 1, Unless there were other injuries or complications, mobilization performed on post op day 1. Patient was discharged on day 3-5.

2.4 Follow up

First follow up on day 15, local site examined for wound healing, wound dehiscence and infection. Patients are followed up at monthly interval and every month pain, range of knee motion and angular deformity was measured. Non weight bearing walking with crutches or walker allowed for 6 to 8 weeks. Partial weight bearing started at 8 (range 6–10) weeks. Full weight bearing when bridging bone trabeculae was seen on radiographs range 12-16 weeks. Radiographs were taken on 4 weeks, 8 weeks, 12 weeks. The

integrity of the articular surface and fracture healing assessed using radiographs

2.5 Assesment

Functional assessment was done using Knee Society Score [26] developed by the hospital for special surgery. Rasmussen radiological score [27] used for radiological outcome.

2.6 Case



Postoperative Xray 20/11/2017

Preoperative CT Scan 18/11/2017



1 Month Followup 1/1/2018

3 Months Followup 3/3/2018

Final Followup 16/11/2019



Injured Knee Showing Flexion 135*



Knee Extension 0*

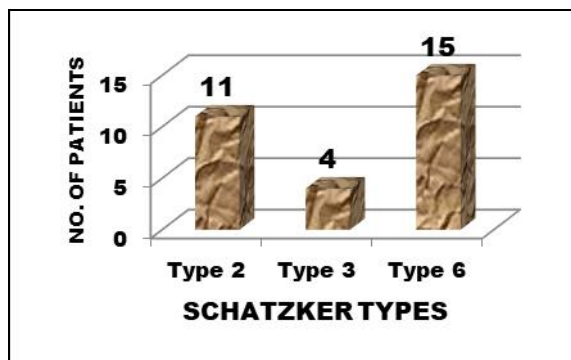


Cross Leg Sitting

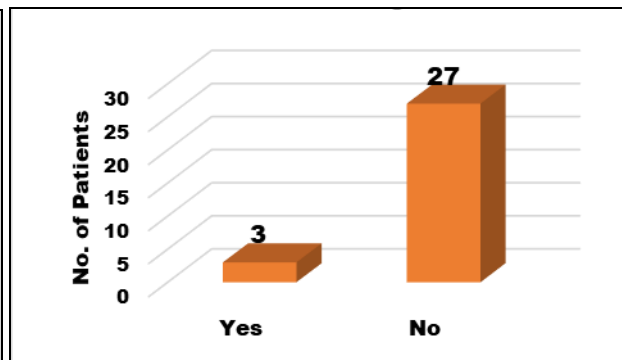
3. Results

Age of patient ranges from 21-60 years. Mean age was 40.96 years. Maximum patients were in the age group of 31-45 years. All patients were from young and middle adulthood. Number of Ratio of male to female is 4:1. Among 30 patients, injury on right side (16 patients) > left side (14 patients). 25 patients got injury due to road traffic accidents, in that fall from bike was the most common reason of injury. Other than these 5 patients had injury due to trivial trauma.

Out of schatzker type 2,3,6 most common type of fracture was bicondylar fracture with metaphyseal diaphyseal separation (type 6) seen in 15 patients, 2nd most common was lateral plateau split and depression fracture(type 2) seen in 11 patients and least common was depression fracture of lateral plateau (type 3)seen in 4 patients. Average preoperative time was 2.93 days. Bone grafting was done in 3 patients out of 30. [10%].



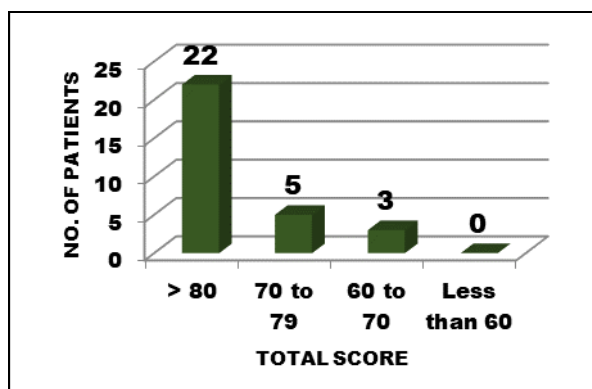
Proximal Tibia Fracture Types



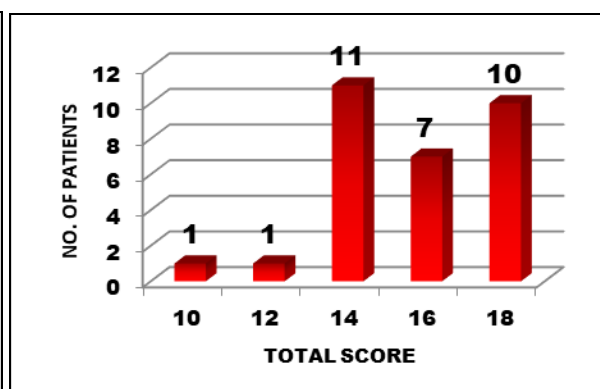
Bone Grafting

All patients kept non weight bearing for at least 6 weeks Partial weight bearing started from 6-8 weeks in majority of patients except 5 in which it is from 10-12 weeks. Full weight bearing started from 12-14 weeks in majority of patients except 6 in which it is in range from 16-22 weeks. All patients had complete extension of operated knee except 1 which showed 10 degrees of extension lag. The mean ROM was 110.50 (range 90- 1250). Mean KSS was 90.2 (range 65-100). According to KSS 22 patients had excellent outcome

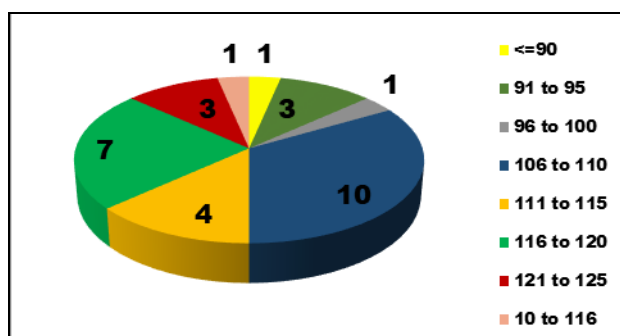
(score >80), 5 patients had good outcome (score 70-80), fair outcome in 3 patients (score 60-70) and none had poor (score <60) outcome. Mean Rasmussen radio score was 15.6(range 10-18). All patients had Rasmussen score of >14 (excellent and good outcome) except 2 patients which had significant preoperative comminution. All 30 patients showed signs of fracture healing on follow up x-rays and on final follow up complete bone union. None had delayed or non-union.



Knee Society Score



Rasmussen Radiological Score



Knee Range of Motion (degrees)

Two patient developed infection and delay in wound healing which was resolved by debridement, intravenous antibiotics based on culture and sensitivity within 1-2 weeks.

One patient had screw backout after 2nd follow up. As whole implant and fixation was stable only single screw removal was done.

None of the patients had any intraoperative complications, osteoarthritis, implant failure, peroneal paralysis.

4. Discussion

Treatment of tibial plateau fractures is a very challenging entity for the surgeon. Road traffic accidents are increasing day by day resulting in high energy injuries. These contribute

to the rising incidence of complex proximal tibial fractures presenting to the healthcare provider. Elderly patients with osteoporotic bones sustain complex tibial plateau fractures due to low energy injuries such as domestic falls.

Indications of surgery

The aim of the treatment is to provide the patient a painless, mobile joint and it needs a very strong technical knowledge and surgical expertise. Good surgical techniques and implants are essential for accurate articular reduction.

Gur, Akman [15] studied 41 tibial plateau fractures and gave the indication for surgery. It was defined as the presence of depression, displacement and instability being greater than

4mm, 10mm and 10 degrees respectively. He also evaluated the effect of surgical treatment on the outcome. Clinical results were assessed using Rasmussen criteria. Successful results accounts for 86.8%.

All 30 patients of current study had schatzker type 2, 3, 6 closed proximal tibia fractures with > 5 mm of depression.

Investigation

Moore and Harvey^[16] also studied tibial plateau fractures and demonstrated the use of tibial plateau view with central ray directed at angle of 105° to the tibial crest which helped in more accurate assessment of the initial depression of the articular surface.

CT scanning for evaluation of the degree of comminution, for classifying and measuring the displacement of fracture was recommended by J. J. Dias^[17].

Approach

18 Tibial plateau fractures were treated with extensile meniscal detachment approach by Thomas G, Padanilam and Nabil A^[18]. They concluded that for patients with significant comminution and depression of lateral tibial plateau - this was a safe and effective method for excellent exposure and accurate reduction. For reduction and fixation in all 30 patients anterolateral approach was used and to reduce intra articular depression and to confirm reduction submeniscal arthrotomy was done.

Articular surface reduction

Restoration of a depressed tibial condyle fracture is important to maintain articular congruity and stable fixation, as it involves weight bearing.

In present study all patients with schatzker type 2, 3, 6 depressed tibia fracture articular depression was corrected intraoperatively and then fracture was fixed.

Sir Robert Jones^[19] also gave the importance of realigning the intra articular fractures of proximal tibia by open reduction and fixation by bone pegs and long screws. He also mentioned the need for elevating the depressed fragments from the tibial shaft.

Porter B.B²⁰ gave study of 68 cases, both non-surgical and surgical methods observed good results in 96% of cases by conservative methods with depression < 10mm, 47% in depression > 10 mm and 80% in surgical methods. They advocated good anatomical reduction for best results.

278 cases of tibial plateau of fractures with an average follow up of 2.5 years, all treated by surgical methods. Burri G^[21] concluded the prognosis improves with the experience and with accurate reconstruction of articular surface.

60 tibial plateau fractures 38 of these fractures were treated by open reduction and internal fixation and 22 treated by closed methods. Blokker^[22] considered that the single most important factor in predicting the outcome in a patient with tibial plateau fracture was adequacy of reduction. The method of achieving the reduction and the length of immobilization period of the knee was not crucial.

RAFT plating for depressed fracture and outcome

Biomechanical characteristics of four different fixation constructs for split depression fractures of the lateral tibial plateau (OTA classification 41B3.1) studied by Karunakar MA, Egol KA^[12]. Tibias were instrumented with an L-buttruss plate, four 3.5-millimeter subchondral raft screws with an antilide plate, an L-buttruss plate with cancellous allograft, or four 3.5-millimeter subchondral raft screws

placed through a periarticular plate. Fixation constructs with a raft of subchondral screws were more resistant to local depression loads. This supports the use of a raft construct when a central depression is a significant component of the overall fracture pattern.

Inside out rafting technique and it's outcome studied by Yoon YC, Oh JK, Oh CW^[14].

Similar study on 24 patients done by Camil Kayali *et al.*^[23]. subchondral raft construction with locking plates applied for the treatment of schatzker type II fractures. At the last follow-up, clinical and radiological data were recorded. The mean follow-up period was 21.4 months (12–39). The mean Knee Society Score (KSS) and Rasmussen clinical scores were 91.5 (range, 77-100) and 16.75(range, 14-18), respectively. The mean Rasmussen radiological score was 27.9 (range, 24-30) during the follow-up. There was no statistically significant difference between injured and non-injured sides with respect to the mechanical axis, the proximal medial tibial angle, and tibial slope. In addition, arthritis showed no difference on the non-injured side, although follow-up was short.

Sunil G Kulkarni *et al*^[24] conducted study on 38 patients who underwent open reduction and internal fixation using a periarticular raft construct through a locking plate for split-depression (>5 mm) proximal tibial plateau fractures (Schatzker type II or AO/OTA type 4.1 B3) were reviewed. The integrity of the articular surface was assessed using radiographs. The Rasmussen radiological score and clinical score, the Lysholm knee score, and the Tegner activity score were also assessed. All patients achieved bone union after a mean of 13.2 (range, 8–26) weeks. The mean range of motion was 118° (range, 100°–130°). The Rasmussen radiological score was excellent in 27 patients, good in 9, and fair in 2. The Rasmussen clinical score was excellent in 15 patients, good in 21, and fair in 2. The Lysholm knee score was excellent in 26 patients, good in 8, and fair in 4. 32 of the 38 patients recovered to their preoperative Tegner activity scores. Only one patient with severe comminution had loss of reduction after full weight bearing. In current study all 30 patients RAFT construct was applied after anatomical reduction of fracture and articular surface. immediate postoperatively knee rom, SLR and quads exercises started. Bed side sitting and non-weight bearing mobilization was also started as soon as possible. Knee society score and Rasmussen radiological score used to evaluate functional and radiological outcome respectively.

All patients had complete extension except one who had 10° lag in extension. The mean ROM was 110.5°(range 90°- 125°) in 30 patients. Mean KSS was 90.2 (range 65-100). According to KSS 22 patients had excellent outcome (score >80), 5 patients had good outcome (score 70-80), fair outcome in 3 patients (score 60-70) and none had poor (score <60) outcome. Patient with good and fair outcome had complaint of moderate/mild pain while walking and stairs climbing.

At the end of final follow up x-ray both knee AP and operated knee lateral views done. Operated knees were checked for bone union, implant failure, plateau depression, condylar widening and angulation. On the basis of that Rasmussen radiological score was also calculated. Mean Rasmussen radio score was 15.6(range 10-18). All patients had Rasmussen score of >14 (excellent and good outcome) except 2 patients which had fair outcome because of significant preoperative comminution. All patients had complete bone union without implant failure.

Post traumatic Osteoarthritis

Burri G^[21] did study of 278 cases of tibial plateau of fractures with an average follow up of 2.5 years, all treated by surgical methods. They concluded that posttraumatic osteoarthritis was directly proportional to the amount of displacement.

Augusto Sermiento^[25] evaluated fracture of the proximal end of the tibia, particularly intra-articular ones, are considered to be difficult management problems because of the malalignment, incongruity and instability that frequently result from their surgical or nonsurgical treatment. They concluded that loss of articular congruity leads to the degenerative arthritis and is less likely to produce so if joint function is maintained.

None of the patients of current study had clinical or radiological changes of osteoarthritis. It may be due to short follow up period.

5. Conclusion

Our study concludes that fixation using a subchondral raft system combined with Locking Compression Plate with or without bone graft for Schatzker type II, III, VI fractures give good functional and radiological outcome without any major complications.

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