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Use of a raft construct through a locking plate without bone grafting for split-depression tibial plateau fractures

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ABSTRACT

Purpose. To review the outcome after open reduction and internal fixation using a periarticular raft construct through a locking plate without bone grafting for split-depression tibial plateau fractures.
Methods. Records of 38 knees in 31 men and 7 women aged 25 to 75 (mean, 42.7) years who underwent open reduction and internal fixation using a periarticular raft construct through a locking plate without use of a bone graft or bone substitute 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.
Results. The mean follow-up period was 22.8 (range, 6–36) months. All patients achieved bone union after a mean of 13.2 (range, 8–26) weeks. The mean range of motion was 118º (range, 100º–130º). 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 weightbearing.
Conclusion. Fixation using a periarticular raft construct through a locking plate without use of a bone graft or bone substitute for split-depression proximal tibial plateau fractures is a viable option.

Key words: *bone substitutes; fracture fixation, internal; tibial fractures; weight-bearing*

INTRODUCTION

Treatment for proximal tibial plateau fractures is difficult, especially when metaphyseal comminution is associated with osteoporosis[1] and soft tissue injury.[2] The tibial plateau involves weightbearing, and restoration of joint congruity is important to preserve the normal function of the knee. Schatzker

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type II fractures[3] with severe depression of the articular surface require open reduction to elevate the depressed fragment with a bone tamp through a cortical window in the metaphysis, followed by rigid internal fixation. To maintain the reduction, the subchondral void is usually filled with cancellous autografts, allografts, or bone substitutes.[4] Autografting is associated with donor-site morbidity, risk of infection, increased surgical time and blood loss,[5] whereas allografting is associated with the risk of disease transmission, low initial stability in the metaphyseal defects, and inadequate incorporation of the graft to host bone.[6] The use of a raft screw construct in the subchondral bone through a locking plate can avoid these potential problems and provide support to the articular surface of the lateral and medial condyles of the proximal tibia, irrespective of bone quality and the type of fixation. This approach prevents collapse, even in the absence of bone grafts or bone substitutes. This study reviewed the outcome after open reduction and internal fixation using a periarticular raft construct through a locking plate without use of a bone graft or bone substitute for split-depression tibial plateau fractures (Fig. 1).

Figure 1 A Schatzker type II tibial fracture with an articular depression.

MATERIALS AND METHODS

Records of 38 knees in 31 men and 7 women aged 25 to 75 (mean, 42.7) years who underwent open reduction and internal fixation using a periarticular raft construct through a 3.5-mm locking plate without use of a bone graft or bone substitute for split-depression (>5 mm) proximal tibial plateau fractures (Schatzker type II or AO/OTA type 4.1 B3) between January 2011 and March 2014 were reviewed. Patients with open fractures, previous knee joint surgery, other fractures of the lower limb, pelvis or spine, or tibial plateau depression of <5 mm were excluded, as were those with conservative treatment or insufficient follow-up.

The causes of injury included road traffic accident (n=28), motorcycle skid (n=2), and fall from a height (n=8). Soft tissue damage was graded according to the Tscherne classification.[7] Associated injuries included fractures of the fibula (n=17), forearm bones (n=2), distal radius (n=3), multiple ribs (n=2), contralateral tibial shaft (n=1), and head injury (n=3).

Injured legs were elevated to decrease local swelling; surgery was performed within one week of injury. Perioperative intravenous antibiotics were administered. Patients were placed in a supine position under combined spinal epidural anaesthesia, and a high thigh tourniquet was used. An anterolateral incision was made. The menisci were tagged and conserved. The depressed fragment was elevated with the help of a bone tamp through a cortical window, and the articular surface was reduced anatomically. Reduction was maintained using Kirschner wires. The articular surface congruency was checked under fluoroscopy before definitive fixation using 3.5-mm locking subchondral screws (raft technique) through a 3.5-mm locking plate.

Postoperatively, continuous passive motion with the assistance of a physiotherapist was allowed at day 1 to 2. Non-weightbearing walking with crutches or walker was allowed for 6 to 8 weeks. Partial weightbearing was started in 8 (range, 6–14) weeks and progressed to full weightbearing when bridging bone trabeculae were seen on radiographs.

The integrity of the articular surface was assessed using radiographs. The Rasmussen radiological score (Table) and clinical score,[8] the Lysholm knee score,[9] and the Tegner activity score[9] were also assessed.

Table
The Rasmussen radiological scoring system[8]

Parameter	Score
Depression (mm)	
None	6 (excellent)
<6	4 (good)
6–10	2 (fair)
>10	0 (poor)
Condylar widening (mm)	
None	6 (excellent)
<6	4 (good)
6–10	2 (fair)
>10	0 (poor)
Angulation (valgus/varus)	
None	6 (excellent)
<10°	4 (good)
10–20°	2 (fair)
>20°	0 (poor)

Figure 2 At 6 months, bone density in the subchondral defect area is equivalent to that surrounding the metaphyseal bone.

The paired *t* test was used to compare the Tegner activity scores before and after the operation. A value of $p<0.05$ was considered statistically significant.

RESULTS

The mean follow-up period was 22.8 (range, 6–36) months. All patients achieved bone union after a mean of 13.2 (range, 8–26) weeks (Fig. 3). The mean range of motion was 118º (range, 100º–130º). At 6 months, bone density in the subchondral defect area was equivalent to the surrounding metaphyseal bone in all patients (Fig. 2).

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. The pre- and post-operative Tegner activity scores of the 38 patients were comparable (4.14±0.64 vs. 4.08±0.68, p=0.164). The Tegner activity scores were comparable for women

Figure 3 Restoration of the depressed articular surface and subchondral void.

and men preoperatively (4.10±0.70 vs. 4.14±0.69) and postoperatively (4.04±0.66 vs. 4.11±0.63).

Only one patient with severe comminution had loss of reduction after full weightbearing. Two patients underwent implant removal. Two patients developed superficial infection and delay in wound healing (within one week), which was resolved by debridement, insertion of antibiotic-impregnated beads for 4 weeks, and intravenous antibiotics. None had any intra-operative complication, frank infection, osteomyelitis, osteoarthritis, implant failure, breakage, or screw backout.

DISCUSSION

The goal of treatment for intra-articular fractures is to restore joint mobility, joint stability, articular surface congruence, and axial alignment, and to avoid post-traumatic osteoarthritis.[10] Restoration of a depressed tibial lateral condyle fracture is important to maintain articular congruity and stable fixation, as it involves weightbearing.[11,12] Treatment is difficult in elderly patients with weak subchondral cancellous bone and soft tissue damage.[13–15] The use of a raft construct through a locking plate provides adequate stability to the subchondral bone without filling the metaphyseal void with a bone graft or bone substitute, and achieves radiological union after a mean of 8 (6–14) weeks, which is similar to other techniques with bone grafting.[16,17]

Complications after bone grafting have been reported. In patients with iliac crest bone grafting, up to 3% developed infection necessitating readmission, up to 22% developed minor complications such as persistant discomfort, cutaneous nerve damage, local wound complications (superficial wound infection, seroma, and haematoma), and up to 38% had pain after 6 months and in some cases beyond 2 years.[5] In addition, donor-site morbidity after iliac crest bone grafting includes arterial injury, ureteral injury, herniation, chronic pain, nerve injury, infection, fracture, pelvic instability, cosmetic defects, haematoma, and tumour transplantation.[18–21] Cancellous bone grafts have very low mechanical strength and hence can lead to collapse of the articular surface.[6]

Allografts are associated with transmission of viral infections, histological incompatibility, and low union rates.[22,23] Full weightbearing is delayed in most patients with allografting.[6] Disease screening for allografts is expensive, and bone banks are not commonly available.[24] Bone substitutes provide minimal structural support, are expensive, and have potential immunogenic reactions.[25] Synthetic bone substitutes such as injectable calcium phosphate cement have problems associated with mechanical strength, bone remodelling, graft resorption, and long-term preservation of articular congruency.[26]

The use of a periarticular raft plate in anatomically reduced split-depression tibial plateau fractures provides sufficient ridgity and prevents collapse, irrespective of the underlying bone quality.[26,27] After trauma, there is immediate loss of proteoglycans due to decreased synthesis or increased destruction, even before cartilage changes occur, leading to increased permeability of fluid into the bone causing damage to the chondrocytes. If damage is not irreversible, the remaining chondrocytes restore the damaged matrix and mechanical stability.[28] The use of a periarticular raft construct through a locking plate prevents further damage to the chondrocytes by maintaining the anatomic reduction, and enables bone healing without the need for a bone graft or substitute, which decreases operating time and morbidity.

The use of small-fragment screws for fixation of tibial plateau fractures is recommended, as the pullout strength of 6.5-mm, 4.5-mm, and 3.5-mm screws is comparable.[29,30] The 3.5-mm small fragment screws and T-plate decrease the bulk of hardware and improve fixation for small fragments.[31] The antiglide screw or buttress plate has no additional advantage over lag screw fixation alone.[32] The buttress plate has greater stiffness than lag screws alone.[33] Fixation with a raft using 3.5-mm subchondral screws is more resistant to local depression loads than a buttress plate with or without a bone graft.[34] Fixation with screws through (rather than outside) the plate enables more stability against plateau displacement.[35]

CONCLUSION

Fixation using a periarticular raft construct through a locking plate without use of a bone graft or bone substitute for split-depression proximal tibial plateau fractures is a viable option.

DISCLOSURE

No conflicts of interest were declared by the authors.

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