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Dual locked plating of unstable bicondylar tibial plateau fractures

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ABSTRACT

The operative treatment of displaced bicondylar tibial plateau fractures is challenging. The displaced condyles must be reduced, depressed plateaus must be elevated and adequately supported and early rehabilitation must be encouraged in order to obtain good clinical results. This retrospective study was designed to evaluate the clinical outcomes of patients with bicondylar tibial plateau fractures treated with dual locked plates using raft screws with MIPO technique and autologous bone grafting. We hypothesized that in this group of patients dual locked plating reduces the complication rates by avoiding loss of reduction due to the accomplished rigid fixation. Twenty-two consecutive patients with bicondylar tibial plateau fractures (AO Type C) were included in this study. The mean follow up was 26 months. Bone healing was achieved in all patients with 3 cases of superficial and 1 case of deep infection. Secondary loss of reduction, secondary loss of alignment, early post-traumatic arthritis were not observed in this study. The Lysholm knee score showed an average of 80.5 points (range: 61.5–90) at the final follow up assessment. Optimal fixation of the fracture with dual locked plating which allows immediate motion and partial weight bearing may be an alternative concept to prevent secondary loss of reduction to obtain a good clinical outcome.

Introduction

The operative treatment of displaced bicondylar tibial plateau fractures is challenging [1–5]. Metaphyseal and articular comminution of the fractures and soft tissue problems following high energy trauma lead to a significant number of complications, such as malunion, nonunion, compartment syndrome delayed wound healing, infection and early/late post-traumatic arthritis [6–10]. Since stiffness following prolonged immobilization may be another potential reason for patient dissatisfaction, early osseous restoration of the plateau with sufficient biomechanical stability allowing immediate mobilisation is vital to obtain painless full range of knee motion [11,12].

Various treatment modalities can be used for the treatment of displaced bicondylar tibial plateau fractures. Conventional plate fixation with a single incision requires invasive exposure of the fracture zone, which may endanger the soft tissues, leading to unaccetably high rates of complications [6]. External fixators have also been advocated to reduce the soft-tissue complications and deep infections, however, problems of nonunion and pin track infections are common [13–15]. Recent developments in the techniques of internal fixation, including the development of locked plating with raft screws and minimal invasive techniques have dramatically decreased the complication rates observed [16–20]. Dual plating in combination with buttress plates and locked plates have also been described, but loss of reduction remains as a potential problem [21–23].

Our goal in this retrospective study was to evaluate the clinical outcomes of patients with bicondylar tibial plateau fractures treated with dual locked plates using raft screws with MIPO technique and either autologous or allograft bone grafting, and to investigate the effectiveness of dual locked plating in avoiding loss of reduction.

Patients and methods

A total of 108 tibial plateau fractures were managed in our hospital between 2005 and 2010. The fractures were classified according to the AO/OTA classification [24]; there were 22 patients with AO Type A, 58 patients with AO Type B and 28 patients with AO Type C fractures. Only C type fractures were evaluated retrospectively from the chart review, and 22 patients were included in this study; one patient with a pathological fracture, one patient with open growth plates, and 4 patients with inadequate follow up or documentation were excluded from the study. The mean age of the patients was 41 years (range 25–65). Sixteen of the patients were male, and six were

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female. This study was approved by the hospital Ethics Committee.

The mechanism of injury was road traffic accidents ($n = 11$ patients), falls from varying heights ($n = 8$ patients), sporting activities ($n = 2$ bicycling, and $n = 1$ snow-skiing). Four patients suffered from additional limb fractures, head, chest or abdominal injury. All fractures were closed, but with varying degrees of soft tissue injury, which were graded by the Tscherne scale [25]. Preoperatively, there was partial neurologic deficit of the deep peroneal nerve which resolved spontaneously after 2 months in one patient. There was no preoperative or iatrogenic vascular injury in this study.

All patients had preoperative antero-posterior (AP) and lateral view X-rays and computed tomography (CT) scans. CT images were reviewed for fracture gap and articular depression. Postoperatively, both AP and lateral views were performed.

The mean interval between injury and operation was 4.2 days (range 0–10 days). Fourteen of the patients had surgery performed within 48 h with Tscherne grade 0 and Tscherne grade I injuries. A staged protocol for soft tissue management was used in the other eight patients with Tscherne grade II injuries; the fracture was initially stabilized using an AO type ex fix which was converted to ORIF with locked plates after the skin wrinkle sign was observed as described by Egol et al. [10] Dual locked plate osteosynthesis was performed through medial and lateral minimally invasive incisions; a lateral arthrotomy was performed in all patients to obtain anatomic reduction. In 10 patients, autologous bone graft was used due to impaction of the plateau harvested from the anterior iliac crest.

Surgical technique

Patients were given a single dose of cefazolin sodium (50 mg/kg) preoperatively. Tourniquet was routinely used in these procedures.

All patients were operated by two surgeons (U.O. and A.S.P.). The patient was in the supine position, with the injured leg in semiflexion with a pillow under the proximal fragment. Freeman et al. had demonstrated that biomechanically the medial column forms the fixed hinge of the knee, and due to its specific anatomic form, it usually dislocates posterodistally [26]. Therefore, medial column restoration was performed first with a medial incision beginning 1–2 cm posterior to the posteromedial border of the tibial metaphysis. The interval between the pes anserinus tendons and the medial head of the gastrocnemius was identified and dissected allowing exposure of the fracture zone. The medial gastrocnemius from the tibial periosteum was elevated, and the distal dislocation of the posterior fragment was identified. The knee is then flexed and externally rotated allowing better exposure of the posteromedial aspect of the tibia. The medial collateral ligament was not dissected and the fracture is reduced using reduction forceps under fluoroscopic guidance. The fracture of the medial condyle was not comminuted in most of our patients; so, open visualisation of the medial articular zone was not routinely necessary. Following temporary fixation of the fragment with K wires, a posteromedial or medial hybrid locked plate was used to buttress the posteromedial/medial fragment with only 1 screw approximately 3 cm distal to the posteromedial or medial fragment. Then the knee is extended and proximal locking screws were used to fix the fragment.

The anterolateral incision was started 1–2 cm lateral to the patella and extended distally over Gerdy's tubercle and 1–2 cm lateral to the crest of the tibia with minimal subperiosteal dissection. To observe the articular surface and perform a direct reduction, a transverse submeniscal arthrotomy was performed. With the knee flexed in varus and internally rotation, the menisci and cruciate ligaments were examined, and soft tissue injuries were repaired if possible. Depressed fragments were elevated and, when necessary, supported with autograft harvested from iliac crest or allograft. Because lateral compression fractures tend to broaden the compartment, a large compression clamp or interfragmentary lag screws were used to obtain anatomic reduction. Following temporary fixation with K wires, a hybrid locked plate with raft screws was used to fix the lateral column.

All patients had a similar postoperative regimen. Active knee motion was encouraged on the 3rd day after surgery. Touch-down weight bearing with crutches was allowed immediately. The patients were discharged after an average 90 degrees of range of motion was obtained. All patients were seen in an out-patient department 14 days after surgery for the removal of the stitches. Subsequently, the patients were seen at monthly intervals in the first 3 months and then in every 3 months up to 1 year. They were maintained on touch-down weight bearing with crutches for the first 2 months. Weight bearing is gradually increased until radiological evidence of complete fracture healing was observed.

Plain radiographs were taken to verify adequate articular reduction and implant placement. An intra-articular step-off of at least 5 mm measured on radiographs was defined as malreduction. The tibial plateau angle on anteroposterior radiographs and the posterior slope angle on lateral radiographs were measured; tibial plateau angle $\geqslant 90^\circ$ or $\leqslant 80^\circ$ or posterior slope angle $\geqslant 15^\circ$ or $\leqslant -5^\circ$ was defined as malalignment. An increase of 2 mm of intra-articular step-off was defined as secondary loss of reduction. An increase of 3° malalignment when compared with the first postoperative radiograph was defined as secondary loss of alignment. Cortical union of at least 3 cortices was defined as bony union and no clinical or radiological evidence of bone healing after 9 months was defined as nonunion.

The mean follow up was 26 months (range: 13–40 months). At their final follow up, a functional assessment using the Lysholm score was performed [27].

Results

Three cases with high energy fractures developed superficial infections, which delayed the wound healing, and were managed with a course of oral antibiotics for a week. In one other patient with high energy fracture, deep infection with persistent wound drainage occurred 4 months after surgery which was treated with debridement, plate removal, and cast brace. Although bony union was achieved radiologically and clinically, this patient developed significant postoperative stiffness due to the deep infection. Prolonged intensive physiotherapy was ineffective; he had 5° of flexion contracture and 95° of knee flexion 24 months after surgery.

There were no cases of nonunion or thromboembolic complications in this series.

The ACL was intact in all of the cases, however, direct inspection during surgery revealed lateral meniscal tears in 6 cases. Four menisci were partially resected and the others were sutured intraoperatively.

The immediate post-operative radiographs of two patients revealed nonanatomic gap or step more than 5 mm. At their final follow up assessment, no radiological evidence of degenerative changes in the articular surface was observed. One patient with nonanatomic coronal alignment had a varus angulation of 6° and one other had a valgus angulation of 5°. No secondary loss of reduction or secondary loss of alignment was observed. The posterior proximal tibial angle and the condylar width was anatomic in all patients. In the radiographic assessment, all fractures were healed at 12 weeks (range 10–14) (Figs. 1–4).

The Lysholm knee score showed an average of 80.5 points (range: 61.5–90) at the final follow up assessment.