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Predictors of osteoarthritis following operative treatment of medial tibial plateau fractures☆

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ABSTRACT

Purpose: To determine factors influencing the development of posttraumatic osteoarthritis (OA) following medial tibial plateau fractures and to evaluate concomitant injuries associated with these fractures.

Materials and methods: A chart review of patients with operatively treated medial tibial plateau fractures admitted to our Level I trauma centre from 2002 to 2008 was performed. Of 63 patients, 41 participated in a clinical and radiographic examination. The mean age was 47 years (range 16–78) and the mean follow-up time was 7.6 (range 4.7–11.7) years. All patients had preoperative computed tomography (CT) scans and postoperative radiographs. At the end of follow-up, standing radiographs, mechanical axis, and CT scans were evaluated.

Results: Of the 41 patients, 24 had no or mild (Kellgren-Lawrence grade 0–2) OA and 17 had severe (grade 3–4) OA. Initial articular depression measured from preoperative CT scans was a significant predictor of OA (median 1.8 mm vs 4.5 mm, $p = 0.009$). Fracture line extension to the lateral plateau ($p = 0.68$) or fracture comminution ($p = 0.21$) had no effect on the development of posttraumatic OA, nor did articular depression at the end of follow-up ($p = 0.68$) measured from CT scans. Mechanical axis $>4°$ of varus and ≥ 2 mm articular depression or step-off were associated with worse WOMAC pain scores, but did not affect other functional outcome scores. Six patients (10%) had permanent peroneal nerve dysfunction. Ten patients (16%) required LCL reconstruction and nine (14%) ACL avulsions were treated at the time of fracture stabilisation.

Conclusions: The amount of articular depression measured from preoperative CT scans seems to predict the development of posttraumatic OA, probably reflecting the severity of chondral injury at the time of fracture. Restoration of mechanical axis and articular congruence are important in achieving a good clinical outcome.

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Introduction

Fractures of the medial tibial plateau are rare. Even though these fractures comprise only 10–20% of all proximal tibial fractures, they generally have the worst prognosis [1]. These fractures are usually a consequence of varus stress of the knee along with axial loading [2]. The medial plateau carries about 60% of the bodyweight and consequently has, as compared to the lateral plateau, a denser subchondral bone [3]. This structural difference, combined with the anatomical valgus axis of the knee and natural tendency of external impact laterally, makes the lateral side more prone to fractures. Medial plateau fractures thus usually are thought to result from a high-energy trauma, unlike more common lateral plateau fractures [1,4]. However, in one recent study half of the medial plateau fractures were caused by low-energy trauma [5].

Medial plateau fractures have a high prevalence of concomitant injuries. Of these, lateral collateral ligament (LCL) and anterior cruciate ligament (ACL) injuries are the most common, as are peroneal nerve injuries [6,7]. Many authors recommend operative

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treatment of medial plateau fractures if there is any displacement in the fracture [4,8–10]. The premise is that since the medial plateau carries a higher proportion of the knee's load than the lateral side, it might cause these fractures to dislocate more easily. Especially, posterior shearing fractures of the plateau are prone to dislocate. There is still little data on the medium and long-term outcomes following operative treatment of these fractures. Some evidence indicates that the quality of the medial plateau fracture reduction, measured from plain x-rays, affects the resulting functional outcome [9].

The primary objective of this study was to determine fracture- and surgery-related factors that could influence the development of posttraumatic osteoarthritis (OA). Our hypothesis was that residual articular incongruence is related to the development of OA. The secondary objective was to evaluate functional outcome and the type of concomitant injuries associated with these fractures. The local Ethical Committee approved the study and we obtained informed consent from each patient.

Materials and methods

We performed a chart review of all patients with operatively treated tibial plateau fractures who were admitted to our Level I trauma centre between 1 January 2002 and 31 December 2008. A total of 389 patients with proximal tibia fractures were identified in the hospital database. We reviewed knee radiographs and routine multi-detector computed tomography (CT) scans with axial, sagittal, and coronal reformations and classified fractures according to the AO/OTA [11] classification system. From this cohort, we identified 63 patients with AO/OTA type 41-B1.2, B1.3, B3.2, and B3.3 medial plateau fractures (Fig. 1). All but one patient had preoperative CT scans for accurate evaluation of fracture morphology. Fourteen of these 63 patients also had a preoperative MRI examination. The indication for operative treatment at our institution was any displacement of the medial tibial plateau fracture. We reviewed hospital records, including operative reports and clinical notes, and determined the nature of the injuries and complications of either the fracture or its treatment.

The most common mechanisms of injury were same-level falls in 28 patients and road traffic accidents in 14 patients. Other frequent injury mechanisms included the following: bicycle accident in 9 patients, sports-related injury in 8 patients, automobile collision with a pedestrian in 2 patients, and falls from a height greater than 1 m in 2 patients.

Operative technique

All patients were treated using the standard techniques of exposure, open reduction, and stable internal fixation. Twenty-two patients had a temporary external fixation until swelling was reduced and the remainder had a splint while awaiting surgery. The most common approach for fracture reduction was posteromedial (52 patients, 83%) and 13 of these patients also had an additional anterolateral approach performed [12]. Eight patients were operated from an anterior approach, two patients were operated from an anterolateral approach only, and one was treated using a percutaneous technique. Ten patients had an additional lateral approach used for lateral collateral ligament (LCL) reconstruction. Thirty-four fractures were stabilized using angular stable plates and 22 using traditional buttress plates. Seven patients had only screw fixation. The postoperative management protocol included early mobilization using a hinged knee brace. All patients were instructed to be non-weight bearing for the first six to ten weeks, followed by partial weight bearing for a further two to six weeks depending on the operating surgeon's intraoperative assessment of fracture comminution and stability.

Clinical and functional evaluation

Of the 63 patients, 41 were able to participate in a follow-up visit. The patient characteristics are summarized in Table 1. Two patients underwent total knee arthroplasty and thus were not included in the clinical and functional evaluations. Seven patients completed functional evaluation information forms, but were unable to attend the follow-up visit. Fifteen patients were excluded from the study due to no follow-up data (Fig. 2). The mean follow-up time was 7.6 (range 4.7–11.7) years.

One orthopaedic surgeon (MP) examined patients at the follow-up visit. Valgus and varus laxity were evaluated using manual testing in extension and in 30° of flexion. To assess anterior laxity, the Lachman, anterior drawer, and pivot shift tests were used. Posterior laxity was evaluated using the posterior drawer test. Range of motion was measured using a goniometer. Results were compared to the uninjured contralateral knee. Patients completed two validated functional outcome measurement tools; the Modified Lysholm knee score and the Western Ontario and McMaster Universities Osteoarthritis index (WOMAC) [13,14].

Radiological analysis

For the current study, weight-bearing knee radiographs were obtained at the follow-up visit to evaluate the stage of posttraumatic OA according to the Kellgren-Lawrence classification (grade 0 to 4) [15]. Radiographs were obtained with the knees in (neutral) extension and the tibias in neutral rotation. Full-lenght radiographs of the lower extremities were taken to evaluate the mechanical axis. Computed tomography (CT) (GE Discovery CT750 HD, General Electric Medical Systems, Milwaukee, WI, USA) of the injured knee was obtained at the end of follow-up to measure the depression of the joint surface. Axial 1.25-mm thick reconstructions and 2-mm sagittal and coronal reformation were used for the analysis. The residual depression of the joint surface was also measured from the first postoperative conventional non-weight bearing radiographs. The images were independently evaluated on clinical PACS workstations (IMPAX DS 3000, version 4.5, Agfa-

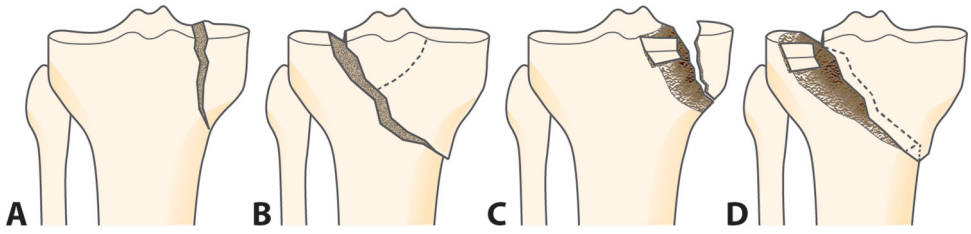

Fig. 1. Medial tibial plateau fracture subtypes (A = B1.2, B = B1.3, C = B3.2, and D = B3.3) according to AO/OTA classification.

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