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Mid- to long-term functional outcome after open reduction and internal fixation of tibial plateau fractures

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ABSTRACT

Background: Tibial plateau fractures account for approximately 1% of all fractures. They usually occur after a direct high-energy trauma. Despite adequate treatment, these fractures can result in malalignment and secondary osteoarthritis (OA). Research concerning long-term functional outcome is limited. The primary aim of this study was to evaluate mid- to long-term functional outcome of surgically treated tibial plateau fractures. The secondary aim was to investigate whether radiological characteristics of OA one year after surgery are predictive of functional outcome at follow-up.
Methods: All consecutive patients with fractures of the proximal tibia, which were surgically treated in our level-2 trauma centre between 2004 and 2010, were included in this study. Initial trauma radiographs were analysed for fracture classification, using both the Schatzker and AO/OTA classification systems, by three different raters. Immediate postoperative and 1-year postoperative radiographs were analysed for osteoarthritis by an experienced radiologist, using the Kellgren and Lawrence scale. Functional outcome of the included patients was measured using the Dutch version of the Knee injury and Osteoarthritis Outcome Score (KOOS) questionnaire.
Results: Seventy one patients out of a group of 96 included patients completed the survey. Median KOOS scores are 89.8% for pain, 91.1% for 'other symptoms', 89.7% for daily function, 72.5% for sports and recreation and 75.0% for quality of life. Median KOOS overall score is 82.99%. We did not find a correlation between the KOOS scores and the absolute age for any of the subscales. There was no significant relationship between radiological characteristics of osteoarthritis and functional outcome.
Conclusions: This is the first study to describe mid- to long-term functional outcome after ORIF for all types of tibial plateau fractures, with the use of the KOOS. Patients should be informed about the likelihood of lower functional outcome in the long-term. This study shows that radiological characteristics of osteoarthritis are not related with lower functional outcomes in the mid- to long-term.

Introduction

Tibial plateau fractures account for approximately 1% of all fractures [1]. These fractures usually result from direct high-energy trauma, i.e. a direct blow to the side of the knee or a fall from a height. In the elderly these fractures may also occur due to a simple fall. The anatomical valgus angulation in the knee joint causes the lateral femoral condyle to press into the lateral tibial plateau. Relatively minor forces cause a fracture in the lateral tibial plateau. More force, especially in line with the knee joint, results in medial or bicondylar fractures. The medial condyle is not supported by the fibula and therefore shifts down easily, while the lateral condyle is more often multi-fragmented [2]. Tibial plateau fractures are often associated with extensive soft tissue injury, including meniscal tear disruption and ligament disruption [4].

Treatment of tibial plateau fractures is challenging and focuses on restoring a stable joint to avoid posttraumatic morbidity. According to the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification systems, simple, undisplaced, stable fractures may be treated non-operatively. More complex fractures are treated with surgical reduction and fixation [3].

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Despite adequate treatment, these fractures often result in malalignment and secondary osteoarthritis (OA) [1,5,6]. Incidences of OA after tibial plateau fractures vary in literature between 10% and 58% [7–13]. Patients often present with limb-specific and general health deficits at follow-up [5]. Associations between the presence of osteoarthritis and pain [12] and between the presence of osteoarthritis and lower functional outcome [14] have been reported. Whether radiological characteristics of OA at short-term follow-up are predictive of lower patient-reported functional outcome in the long-term remains elusive [15]. Most studies concerning tibial plateau fractures investigate short- to medium-term results [12,16–18], while there are relatively few studies exploring long-term functional outcome [15,19]. The data regarding prognosis after surgery are poor and need further examination [3].

The primary aim of this study was to evaluate the mid- to long-term functional outcome of surgically treated tibial plateau fractures. The secondary aim was to investigate whether radiological characteristics of OA one year after surgery are predictive of lower functional outcome at follow-up.

Our local ethics committee approved this retrospective cohort study.

Patients and methods

Study population and database

All consecutive patients with fractures of the proximal tibia, which were surgically treated in our level-2 trauma centre between 2004 and 2010, were retrospectively identified and analyzed using the hospital database. Patients under the age of 18 or with other types of fractures than tibial plateau fractures were excluded. Patient characteristics, fracture type and type of treatment were obtained by evaluating hospital charts, clinical notes, surgery reports and pre- and postoperative radiographs.

Initial trauma radiographs were analysed for fracture classification, using both the Schatzker [20] and AO/OTA [3] classification systems. Three different raters independently assessed classification of fractures. When two or more of the raters agreed, this was accepted as the final classification. When the first assessment was inconclusive – when there were three different classifications, when there were interobserver differences between AO/OTA types A and B or when there were interobserver differences between Schatzker classification $\leq$3 and $\geq$4 – cases were discussed until consensus was reached. Immediate postoperative and 1-year postoperative radiographs, when available, were analysed for osteoarthritis by a senior radiologist, using the Kellgren and Lawrence scale [21].

Surgical techniques

All patients were surgically treated with open reduction and internal fixation (ORIF). Relatively stable split and split depression type fractures were treated with screws alone, while all other fractures were treated with plates and screws. Bicondylar fractures were treated with locking plates. During surgery, image intensifier was used to ascertain proper fracture reduction and alignment. Full weight bearing was not allowed for 10–12 weeks. Physiotherapy was initiated the day after surgery to stimulate range of motion.

Outcome measures

Functional outcome in the included patients was measured using the Dutch version of the Knee injury and Osteoarthritis Outcome Score (KOOS) questionnaire [22,23]. KOOS is developed as an extension of The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [24] to assess both short- and long-term symptoms and function in subjects with knee injury and osteoarthritis. The KOOS questionnaire is extensively validated for different populations with varying diseases and durations and at varying ages and activity levels [25]. It has been used for the evaluation of functional outcome after tibia plateau fractures before [11], and is widely used for the evaluation of functional outcome after other knee-related problems, including total knee arthroplasty [14] and anterior cruciate ligament [25]. By scoring 42 items in five categories, detailed patient-reported functional outcome is gathered. The five categories include the following: pain, other symptoms, function in daily living (ADL), function in sports and recreation (Sport/Rec), and knee related quality of life (QoL). Questionnaires are scored 0–100 (worst–best) [22]. All questions from the WOMAC Osteoarthritis Index are included in the KOOS questionnaire. In addition, we added 14 questions to the questionnaire, concerning the type of work and sports patients were engaged in, the time it took to return to work or sports activities and the level patients returned to. The questionnaire was sent to the patients by mail, together with a form for written informed consent. After one month, patients who had not responded were contacted by telephone and kindly asked to participate in the study.

Statistical analysis

We collected the following preoperative data: age, sex, cause of injury and type of fracture according to the Schatzker and the AO classification. Since the KOOS scores do not follow a normal distribution, median KOOS scores and subscores are presented for the total cohort and for various subgroups based on sex, age group, Schatzker classification, AO classification (partial/complete articular fracture), osteoarthritis one year postoperative (present/absent) and treatment (screws alone/plates and screws). However, for comparing our results with the scarce literature on evaluating tibial plateau fractures we also calculated mean KOOS scores. Comparisons of the scores between subgroups was performed using Mann–Whitney U and Kruskall–Wallis tests. Patients with a total knee arthroplasty (TKA) after their tibial plateau fracture were excluded from these analyses. To investigate the relation between age and the KOOS scores in more detail, we additionally calculated Spearman's correlation coefficients with 95% confidence intervals. For all analyses, the null hypothesis was rejected at p values less than 0.05. The statistical analyses were performed using SPSS Statistics 19 (SPSS Inc., Chicago, IL, USA).

Results

Patients

Between 2004 and 2010, 133 patients were surgically treated for proximal tibial fractures in our institution (Fig. 1). Six patients were deceased at the start of this study. Twenty-nine patients were excluded because they did not suffer a tibial plateau fracture: two isolated epiphysiolysis fractures, 10 tuberositas tibiae fractures, 11 eminentia fractures and five crural shaft fractures. One patient had a total knee arthroplasty without signs of a tibial plateau fracture. The preoperative images of two patients were untraceable.

A final group of 96 patients, consisting of 37 (38.5%) males and 59 (61.5%) females, was sent a KOOS questionnaire. Age, injury cause and type of fracture are shown in Table 1. Initially, 60 patients returned the questionnaire. After contacting non-responders, a total of 71 (74%) completed the survey. Median follow-up of these patients was 6.17 years (range 2.94–9.84 years).

Eighty-four of sixty-nine (87.5%) reductions were anatomic (step-off or gap $<$1 mm). There was no difference in functional outcome (KOOS subscores or total score) after anatomical and