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Tibial plateau fractures: Internal fixation with locking plates and the MIPO technique

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ABSTRACT

Proximal tibial fractures are difficult lesions to treat because of the involvement of the articular surface, the often occurring comminution, and the precarious condition of the soft tissues, especially following high-energy trauma. Aim of the treatment is to restore the congruence of the articular surface supporting the tibial plateau cartilage which is usually depressed; to fix the fracture with a stable device; to allow early rehabilitation.

We present our treatment strategy, utilising closed or open reduction and internal fixation, angle-stable polyaxial plates, immediate osteointegration, when necessary, with autologous bone graft or other osteoconductive material augmented with autologous platelet gel. Surgery is soft-tissue dependent in terms of timing, and it is usually performed directly or under supervision of an experienced surgeon utilising, whenever possible, a tissue sparing technique.

A cohort of 58 proximal tibial fractures, surgically treated, from January 2004 to June 2007, was retrospectively reviewed. Fractures were classified according the OTA/AO classification. The assessment of the functional outcome with the use of the Rasmussen score identified good to excellent results in 78% of the cohort 12 months post-surgery.

Internal fixation with locking plates, following the principles of MIPO (Minimally Invasive Percutaneous Osteosynthesis), provides satisfactory fracture reduction with good results regarding the mid-term clinical outcome.

Introduction

Tibial plateau fractures involve the proximal tibia in its articular and meta-epiphyseal segments. Their management is challenging because of the severe displacement of the bony fragments, the concomitant depression and impaction of the cancellous subchondral bone, and the inevitable associated cartilage injury.

Often the associated complications, i.e. compartment syndrome, cartilage destruction, soft-tissue envelope damage, post-surgery infection, knee instability/stiffness, early/late post-traumatic arthritis, are devastating.[6,18,23,32] These fractures are relatively uncommon, with a bimodal distribution in both men and women. In young adults they are the result of high-energy trauma, while in the elderly usually follow accidental low energy falls.

Conservative treatment is reserved for very simple undisplaced fractures that represent a small minority of the overall tibial plateau fracture population or for very low demand patients with severe comorbidities. The general consensus for the young patients with such an injury is to undergo operative treatment, aiming for anatomical reduction, rigid fixation, and early movement. These operative indications and goals are currently expanding further in patients even over 55 years with good results, despite the presence of osteoporosis/osteopenia, coexisting medical problems, or of degenerative joint disease.[7,8,18]

Currently, open reduction and internal fixation with plates and screws is considered the gold standard method of treatment. Modern locking plating systems, providing increased angular stability, low implant profile, improved design matching the periarticular bone surface, as well as compatible with the minimal invasive techniques (Minimally Invasive Percutaneous Osteosynthesis – MIPO[10,16,22,31]) are nowadays the mainstay of clinical practice. Arthroscopic assisted reduction and internal fixation is recommended by some authors for selected cases (pure depression fractures). The considerable risk of development of compartment syndrome due to the drainage of irrigation fluids into the tibial compartments, as well as the prolongation of the surgical time and the logistics of the operation room restrict the expansion of this module.[3,28,29] The use of circular ring fixators offer a reliable alternative method of treatment for high-energy fractures with gross intra-articular comminution (AO/OTA type C3) associated with severe soft-tissue damage.[15,21]

A meticulous assessment of the severity of the sustained local injury is essential in the care of patients with a fracture of the tibial

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plateau. The treatment strategy and the outcome is strongly related to the condition of the soft-tissue envelope. Often, temporary stabilisation is required via a spanning the knee external fixator, to allow for soft-tissue resuscitation, pain relief, gain of more information related to the fracture configuration (usually with a CT-scan) and definitive treatment at the optimal time.[7] Other important factors in terms of prediction of immediate as well as long-term results are age, concurrent health problems, smoking history, occupation, functional ability and personal expectations.[9,18,34,35,38]

The purpose of this study was to evaluate the perioperative results and functional outcome following operative treatment of tibial plateau fractures using locking plates and the MIPO technique of a single institution.

Materials and methods

A retrospective review of all proximal tibial fractures treated at our institution in the period from January 2004 to June 2007, was undertaken. Patients' data were obtained by evaluating hospital charts, office records, and pre-operative and post-operative radiographs. Pathologic, pediatric, and extrarticular proximal tibial fractures (AO/OTA type 41.A) were all excluded.

Demographics, mechanisms and conditions at the period of the accident, hospitalisation details, operation description, post-operative rehabilitation, complications, clinical and functional outcome over a period of 12 months post-surgery were collected for all cases.

The fractures were classified according to the AO/OTA[6,41] and Gustilo-Anderson[14] systems, and the Rasmussen score[33] was used to quantify the functional outcome at the last visit. Follow-up assessments were performed at set time points, including 4, 8, and 12 weeks, 5–7 months, and 12–13 months post-surgery. The range of movement of the knee was measured with a goniometer. Varus and valgus instability was measured in extension and at 20° of knee flexion and compared with that of the normal side. Radiographs were used to assess the degree of joint depression and frontal angulation. The reduction was graded as excellent if the residual depression was 2 mm or less, satisfactory if it was between 2 and 5 mm, and poor if it was greater than 5 mm. Malalignment in the frontal or sagittal plane was defined as an angulation greater than 5°.

Descriptive statistical methods were used in order to comprehensively present our results.

Results

Over a period of 3.5 years, 58 proximal tibial fractures (intra-, extra-articular) were identified. The mean age at surgery was 43 years (range 19–79), while 19 were women and 39 men. The most common mechanism of injury was related to road traffic accidents (RTA) accounting for the 75% of the cases, Table 1.

Nine, (18.4%) AO/OTA type A, 31, (53.5%) AO/OTA type B, and 18, (31.1%) AO/OTA type C fractures were identified (Table 2). Only the cases representing fractures with articular extension were analysed further (49 cases type B–C). Three of these fractures were open; two were grade I, and one was grade II. One patient sustained a closed injury with associated disruption of the popliteal artery.

Table 1
Patients demographics.

Male/Female	39/19
Age	Mean 43 years (range 19–79)
Follow-up	Mean 18 months (range 12–18)
Mechanism of injury	
Automobile collision	19 (33%)
Motorcycle collision	16 (28%)
Fall	12 (21%)
Pedestrian	8 (14%)
Sport-related injury	3 (5%)

Table 2
The distribution of the cases according to the AO/OTA fracture classification.

AO/OTA classification	Number, %	Surgical treatment
41 B1	5, 10.2%	2 CRIF with screws 3 ORIF with single plate
41 B2	7, 14.3%	3 ARIF with screws 4 ORIF with single plate
41 B3	19, 38.8%	ORIF with single plate
41 C1	6, 12.2%	ORIF with single plate
41 C2	7, 14.3%	ORIF with single plate
41 C3	5, 10.2%	2 ORIF with single plate 3 ORIF with double plate

ORIF: open reduction and internal fixation; ARIF: arthroscopic reduction and internal fixation; CRIF: close reduction and internal fixation.

Standard radiographic control of the entire tibia (anteroposterior and lateral) and of knee (anteroposterior, lateral, and oblique views) was performed in all patients at admission. CT-scan with three-dimensional (3D) reconstruction was obtained for further investigation in order to identify the size, location, and extension of the articular fragments.[40] All patients were treated operatively. Perioperative intravenous antibiotics and prophylaxis against deep-venous thrombosis were routinely administered. In one patient a temporary external fixation was utilised, while 12 were temporarily immobilised with a splint during the observation period. This period in-between the accident and surgery ranged between 4 and 14 days.[4,5,26,27]

The majority (90%) of cases (44) were treated with open reduction and internal fixation with anatomical angular stable polyaxial locking plates (Perilocking and NCB, Zimmer). Nine of these cases underwent also grafting (either autologous or synthetic) to support the depression of the subchondral bone and the articular surface.[18,20,24] For open reduction and internal fixation a lateral "hockey-stick" approach was used in all patients, In 29 cases, a MIPO technique via a proximal incision of 5 cm was feasible (Fig. 1). In three cases (type C3) a medial approach was utilised for reduction and additional fixation of the medial condyle.[1,2,16]

Five fractures (10%) underwent mini-osteosynthesis with cannulated screws. Three of which were arthroscopically assisted procedures (type B2 fractures). A conventional antero-lateral portal was utilised for the arthroscope, and an antero-medial for the instruments. Indirect reduction of the depressed articular surface was attained via an inferior transosseous tunnel, verified with arthroscopy, and stabilised with 6.5 mm cannulated cancellous screws.

Passive motion of the operated knee has started for all patients at the immediate post-surgery period. Toe-touch weight bearing with the use of two crutches was allowed for the first 8 weeks. Progressive weight bearing was permitted following this period depending on the progress of healing on the X-ray control. Full weight bearing was allowed after 9–12 weeks for the majority of these cases.

The mean post-surgery follow-up for these cases was 18 months (range 9–36). Two patients were lost to follow-up. The others 47 patients were contacted to return for physical and radiographs examination, and were graded by the Rasmussen clinical score.[33] Forty-four patients (94%) progressed to bony union in an average time of 4.2 months (range 3–7) (Figs. 2a–c, B–C, 3a and b). The other three patients developed a non-union: in one case the non-union was complicated by breakage of the used implants (double plating). Nevertheless, this non-union healed after re-plating with a polyaxial locking plate and autologous bone