IMPROVING THE OUTCOME OF TIBIAL PLATEAU FRACTURES BY ENHANCING SURGICAL SKILLS

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Abstract: *Tibial plateau fractures affect several components of the knee, thus impairing the mobility, the congruity and the stability of the joint. Due to these characteristics, thorough and complete anatomical restoration is mandatory, so specific indications and therapeutical goals have been described for each type of these fractures. Besides the theoretical recommendations from the literature, clinical experience identifies practical problems which impair the results of surgery, important for daily practice, as well as for the education of orthopaedic physicians. The need of developing the educational means in this field has been identified by several methods, thus generating the idea of guided approaches as instructional tools not only for improving the outcome after surgical treatment for these fractures, but also for enhancing practical skills in orthopaedics. Based on retrospective analysis of cases in a Level 1 Trauma Centre, these guides contribute to a better surgical training, as well as to early professional and social reinsertion of the patients*

INTRODUCTION

Tibial plateau fractures have considerable functional consequences, as they affect not only the proximal tibia, but the knee joint. Restoration of local functional anatomy is crucial for most of the daily activities requiring standing position, as well as for walking, thus representing the main therapeutic goal when approaching this type of injuries.(1,2) The difficulties in re-gaining the stability and the mobility of the joint, as well as the high risk of developing post-traumatic osteoarthritis generates considerable interest among the orthopaedic surgeons in order to identify the most efficient methods to improve the outcome of tibial plateau fractures. Thorough imagistic evaluation (CT scan with 3D reconstruction), it is unanimously recognised as mandatory and represents the fundament for treatment indications, but late complications impairing the joint function are still challenging.(3,4)

PURPOSE

The purpose of this paper is to identify the most important potential elements to be included in a guide dedicated to improving practical knowledge of orthopaedic physicians involved in treating this type of fractures in order to reduce the incidence of complications and improve the quality of life of the patients.

MATERIALS AND METHODS

A retrospective study was performed including 42 patients with tibial plateau fractures, operated in the Orthopaedic and Trauma Clinic of Clinical Emergency Hospital, Bucharest, between 01.01. 2011- 01.06.2014, mean age 42 yrs. (20-66 yrs.), in order to identify the main problems in connection to treating these injuries; the inclusion criteria were: skeletally mature patients, with closed fractures, with complete medical records up to 18 months after surgery.

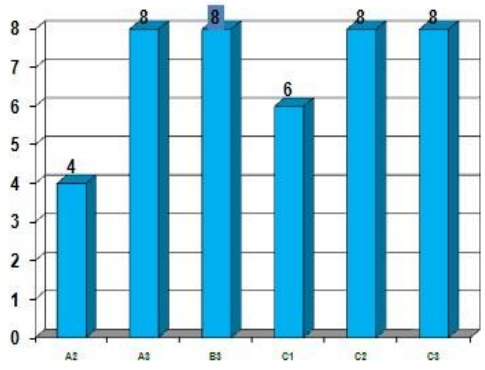
The analysis was focused on the main surgical steps, as part of the Erasmus + Project 2015-1-RO01-KA202-015230 "Collaborative learning for enhancing practical skills for patient-focused interventions in gait rehabilitation after orthopaedic surgery", since the needs analysis identified the tibial plateau fractures as of considerable interest for the training group; the reasons were represented by technical difficulties of osteosynthesis and disastrous consequences of failure.

In order to structure the practical-based surgical guide, the study group was analysed using the following criteria: demography, type of fracture, associated injuries, type of implant and functional outcome.

RESULTS

The demographic analysis revealed that the ages of the patients were: under 30 yrs. - 10 patients, 31-40 yrs. - 12 patients, 41-50 yrs. - 14 patients, 51-66 yrs- 9 patients, with no significant male/female differences within these groups; these injuries affect active patients, thus justifying their high social cost due to prolonged rehabilitation period, as well as the costs of treating the complications.

Figure no. 1. Type of the fracture (a) and intra-operative detected associated injuries (b)



a

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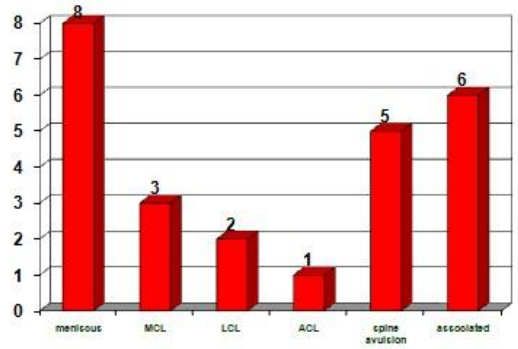


b

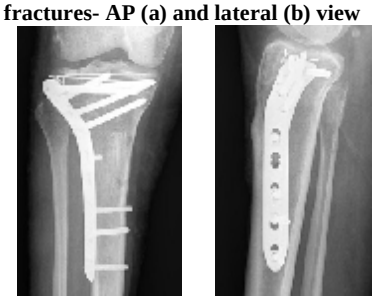
The fractures were described using both Schatzker and AO classifications (figure no. 1a), but the authors analysed not only the bone injury, but the other articular damages, as well, thus identifying meniscal and ligamentous injuries (figure no. 1b). Complete evaluation using not only Xrays (AP and lateral), but CT scan with reconstruction, was performed in all the cases for pre-operative planning.

This original approach is based on the main principles to be followed in treating tibial plateau fractures, addressing not only to bone healing, but also to joint mobility and stability. Considering the complex biomechanical characteristic of the knee joint, the authors evaluated the impact of trauma upon the structures responsible for joint congruency and stability, thus underlining that is crucial for an orthopaedic surgeon operating a tibial plateau fracture to evaluate the menisci and the ligaments and address to their injuries too, and not to limit the surgery to the bone injury.

Fracture stabilisation has to ensure the following goals, as shown in figure no. 2:

- Anatomical restoration of articular surface with absolute stability of the osteosynthesis
- Restoration and stable fixation of the metaphyso-diaphyseal angle with bicortical stable support

Figure no. 2. Restoration of functional anatomy after tibial plateau fractures- AP (a) and lateral (b) view

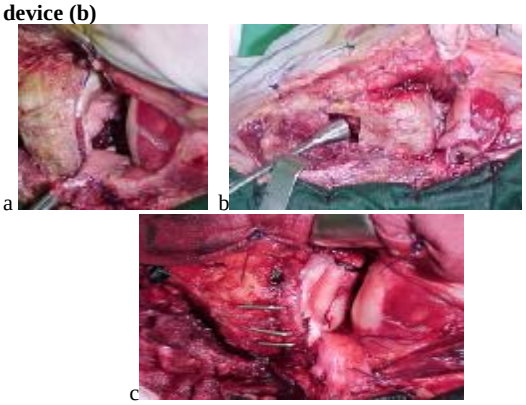


a b

In the study group, the main steps of the surgical procedure were as following:

- Arthrotomy (on one or two incisions, depending on the type of the fracture), with submeniscal approach of the fracture, regardless whether it affected the internal or external tibial plateau, as shown in figure no. 3a.
- Restoration of the articular surface, by addressing the post-traumatic injury: splitting was treated by fracture debridement (of soft tissue or bone interposition), reduction and compression, while depression required elevation (performed with the Zanoli device- figure no. 3b); anatomical reduction was the gold standard and over-correction was preferred to under-correction.

Figure no. 3. Submeniscal approach of the fracture with comminuted depression (a); elevation using the Zanoli device (b)



a b

c

- Stabilization of the articular surface: temporary fixation using K wires was used for split fractures, while for depressed fractures the most difficult problem was maintaining the elevation when the osteo-chondral fragments were small, unsuitable for screw insertion. In such circumstances, as shown in figure no. 3c, the Kirschner wires can be used a supplementary fixation if they are introduced right adjacent to the joint, in the subchondral bone, so as to sustain the restored articular cartilage. At the end of this step, a perfect anatomical reduction of the articular surface is mandatory, as it represent the condition for congruent movements of the joint, thus decreasing the risk of arthritis.
- Associated injuries have to be tackled, as demonstrated by the anterior suture in figure no. 3c, where the anterior tibial spine together with the anterior cruciate ligament (ACL) was reinserted, thus restoring the anterior-posterior translational stability of the joint.
- Restoration of the metaphyso-diaphyseal angle and stabilisation was performed using both ORIF (Open Reduction Internal Fixation), using : standard L/T plates (10 cases), and angular stability implants - 28 cases, as well as CREF, in 4 cases, due to blisters, and combined internal and external fixation in 1 case, due to compartment syndrome.

In this case, as shown in figure no. 4 (a and b), the Schatzker VI type of the fracture was a result of a high energy trauma, also determining the onset of the compartment syndrome (figure no. 4c).

Figure no. 4. Epi-metaphyseal comminuted fracture (a, b) complicated with compartment syndrome (c)

a b

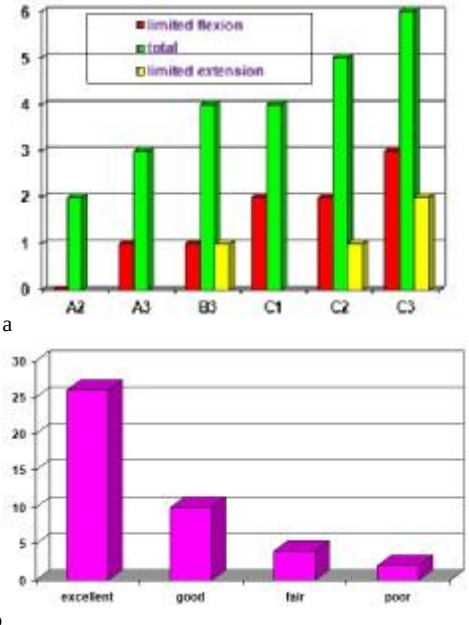
c

Urgent treatment was indicated, with decompressive fasciotomy (figure no. 5a) followed by combined internal and external fixation (figure no. 5 b,c); this type of fixation was particularly used because bicolumnar support was necessary due to the metaphyseal fracture, while the possibility to cover a potential internal implant with soft tissues was very low. Under these circumstances, the plate was put externally, and the internal support was ensured by the ExFix, with an anatomical restoration of the angle between the metaphysis and the diaphysis.

Figure no. 5. Decompressive fasciotomy (a) with combined stabilisation (b,c)

Following the above mentioned principles, the radiological results were optimal: the axis of the knee was completely restored in all cases, and bone healing appeared in all patients, with a rate depending on the initial aspect of the fracture.

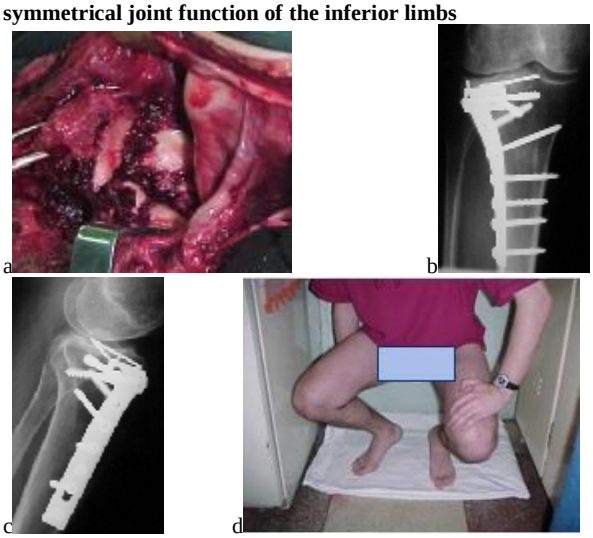
Figure no. 6. Functional impairment of the knee (a) and Knee Society Score (b) for the study group



As for the functional results, flexion of the knee was limited in 9 cases and extension was affected in 4 patients, depending, also, on the initial characteristics of the fracture, as shown in figure no. 6a. The Knee Society Score applied to the study group (figure no. 6b) showed excellent results 26 cases, good results-10 cases, fair- 4 cases and poor- 2 cases, thus demonstrating that the treatment protocol evaluated by the authors is valid and can be used in a surgical guide.

In order to illustrate the positive practical consequences of observing the described steps, the following case refers to comminuted depressed fracture (figure no. 7a), with anatomical reduction.

Figure no. 7. Comminuted depressed fracture (a) with anatomical reduction and stable osteosynthesis (b,c) with excellent functional result (d) and stable fixation (figure no. 7b,c) with excellent functional results (figure no. 7d), with symmetrical joint function of the inferior limbs



As a result of analysing the treatment and results of the study group, the following criteria were used for establishing a guided approach:

- Type of the fracture based on Ct description;
- Traumatic mechanism;
- Incidence and pathologic conditions frequently associated;
- Traumatic energy;
- Associated intra-articular injuries;
- Mandatory characteristics of stabilisation.

Based on these, figure no. 8 describes the guided step-by step approach in Schatzker I-III fractures, while figure no. 9 refers to Schatzker IV-VI types.

Figure no. 8. Guided approach in Schatzker I-III types fractures

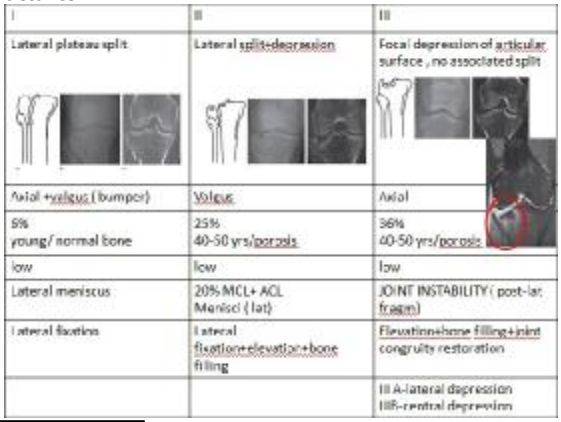


Figure no. 9. Guided approach in Schatzker IV-VI types of fractures

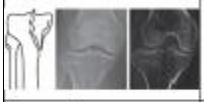
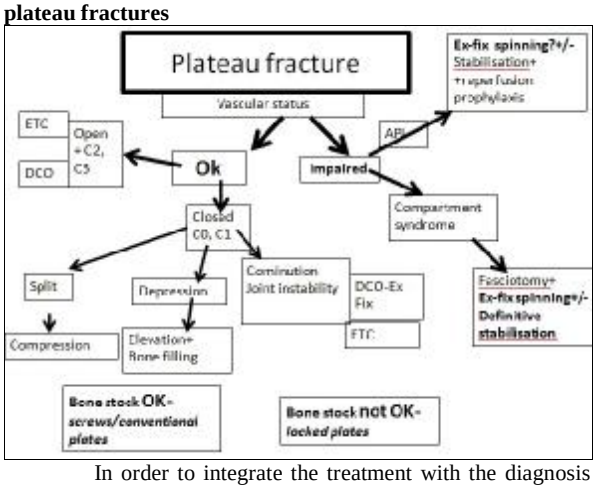
IV	V	VI
Medial tibial plateau fracture. 	Bicondylar tibial plateau fracture 	Tibial plateau (med, lat/both) fracture with diaphyseal discontinuity 
Varus+axial	Varus+valgus /pure axial	Complex (varus+valgus)
10% young / normal bone	3%	20%
high	High- complex trauma	high
LCL fibular dislocation/fracture, posterolateral corner, soft tissues, popliteal art., peroneal nerve	ACL, LCL, MCL menisci. neurovascular	Neurovascular injury , (33%) compartment syndrome, menisci, ACL, LCL, LCM
Medial fixation	Lateral +medial fixation	Lateral+Medial fixation
with or without depression;may involve tibial spines- ACL		Metaphyseal fracture that separates the articular surface from the diaphysis.

Figure no. 10. Diagnosis and therapeutic algorithm in tibial plateau fractures



In order to integrate the treatment with the diagnosis and the complications, a global algorithm was established, as described in figure no. 10; it consists of the main steps in approaching these fractures, underlining the key points where certain decisions must be made; regardless the type of the fracture, this algorithm has to be applied, acting as a check-list, preventing the surgeon from neglecting any important aspect of diagnosis and treatment, including that of complications.

CONCLUSIONS

Tibial plateau fractures are more than simple bony injuries, so they should be described as COMPLEX INJURIES, since they affect the bones, and the soft tissues within and around the joint.(5,6) They affect both congruency and stability of the knee, so they have severe functional consequences if local anatomy is not restored, as long term results depend on the type of the fracture and the post-operative results.(7)

Surgical treatment of tibial plateau fractures is crucial for restoring the function of the knee, as osteoarthritis after this type of injuries is quite frequent, with severe consequences upon the daily social and professional profile of the patients. The approach, the type of reduction and the implant are decided regarding the type of the fracture, which must be evaluated using the CT images, as X-rays solely cannot give enough information regarding the articular surface, which is the main injured structure responsible for the functional disabling sequelae.(8,9)

After classification, surgical indication is established based on the direction of the displacement (determined by the traumatic force), the degree of displacement, and the associated structures, thus establishing the necessary steps for restoring functional anatomy, joint stability and congruity.

Although theoretical landmarks have been described in tibial plateau fractures, practical issues regarding the results of surgery needs to be solved in daily practice as well as in educating the young orthopaedic physicians. Improving the results of training by using clinical experience based guided treatment, as an alternative to classical training, based mainly on theoretical study results in better long term outcome of the patients and a better quality of life after these fractures

REFERENCES

1. Yoon RS, Liporace FA, Egol KA. Definitive fixation of tibial plateau fractures. Orthop Clin North Am. 2015 Jul. 46 (3):363-75, x. [Medline].
2. Lowe JA, Tejwani N, Yoo B, Wolinsky P. Surgical techniques for complex proximal tibial fractures.J Bone Joint Surg [Am]. 2011;93-A:1548-59.
3. Markhardt B, Gross J, Monu J. Schatzker Classification of Tibial Plateau Fractures: Use of CT and MR Imaging Improves Assessment1. Radiographics. 2009;29(2):585-597.
4. Spiro AS, Regier M, Novo de Oliveira A, et al. The degree of articular depression as a predictor of soft-tissue injuries in tibial plateau fracture. Knee Surg Sports Traumatol Arthrosc. 2013;21:564-7
5. Borrelli JJr. Management of soft tissue injuries associated with tibial plateau fractures. J Knee Surg. 2014;27:5-9.
6. Südkamp NP. Soft-tissue injury: pathophysiology and its influence on fracture management. In:Reudi TP, Murphy WM, eds. AO Principles of Fracture Management Stuttgart, Germany: Thieme; 2000. p. 59-77.
7. Goff T, Kanakaris NK, Giannoudis PV. Use of bone graft substitutes in the management of tibial plateau fractures. Injury. 2013;44:S86-S94.
8. Stannard JP, Wilson TC, Volgas DA, Alonso JE. The less invasive stabilization system in the treatment of complex fractures of the tibial plateau: short-term results. J Orthop Trauma. 2004;18:552-8.
9. Canale TS. Tibial plateau fracture. In: Canale ST, ed. Campbell's operative orthopaedics. 10th ed. Philadelphia, Pa: Mosby. 2006; 3146-3161.