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Tibial plateau fractures: treatment strategies and failures

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Summary

Introduction. Tibial plateau fractures are a fairly rare but serious event. There are many surgical approaches described in the literature, and thus it is very important to choose the correct treatment based on the type of fracture in order to reduce the risk of failure.
Materials and methods. A literature search was performed to identify publications on therapeutic approaches to tibial plateau fractures and possible causes of failure.
Results. The main surgical approaches to tibial plateau fractures are arthroscopic assisted reduction and internal fixation (ARIF), percutaneous reduction and internal fixation (PRIF), external fixation (EF), and open reduction internal fixation (ORIF).
Conclusions. Tibial plateau fractures have many treatment options. Each approach has specific benefits and risks. It is very important to choose the correct treatment based on the type of fracture to reduce the risk of failure.

Key words: tibial plateau, Shatzker, knee fractures, failure, traumatology

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Introduction

Tibial plateau fractures are an intra-articular knee fracture that occurs in 1.66% of all fractures in adults [1]. In approaching these fractures, it is important to restore the articular surface and correct mechanical axis, and to stabilize the joint.
There are many causes of treatment failure for tibial plateau fractures, and the failure rate increases with the complexity of fracture. In 1974, Shatzker [2] proposed a classification of 6 types of fracture based on x-ray evaluation. Nowadays with the introduction of CT and tridimensional reconstruction, other classifications have been proposed which also consider other characteristics of the fracture. One of the main concepts is the tricolumn theory introduced by Liu in 2010 [3].

Materials and methods

A review of the literature was performed with a search on Medline through PubMed which used the following keywords: ("tibial plateau" [MeSH Terms] OR ("fracture" [All Fields] AND "tibia" [All Fields]) OR "proximal tibia" [All Fields] OR ("knee" [All Fields] AND "fracture" [All Fields]) AND ("Failure" [All Fields] AND ("tibia" [MeSH Terms] OR "knee" [All Fields] OR "tibial plateau" [All Fields])). Inclusion criteria were English language, retrospective or prospective studies including rand-

omized controlled trials, nonrandomized trials, cohort studies, case-control studies, systematic review, metanalysis and case series providing detailed description of cause and failure rate of surgical treatment of tibial plateau fracture. Exclusion criteria were not providing information about failure rate or complications, non-English language, letters to editors, biomechanical reports, ex vivo or cadaveric studies, and editorial commentaries.
Two independent reviewers (AGC and SL) applied the inclusion and exclusion criteria to select pertinent papers. Articles were initially selected basing on title and abstract; full text versions of relevant papers were then acquired and evaluated.
The aim of this study was to analyze and summarize, for each surgical technique, the main cause of failure.

Results

Arthroscopic assisted reduction and internal fixation (ARIF)

In lower energy tibial plateau fractures, ARIF recently has emerged as an interesting treatment. The advantages compared to standard ORIF treatment are faster post-operative recovery, better clinical function, and possibility to treat intra-articular lesions [4]. Unfortunately, ARIF requires a long learning curve and better results with this technique are related to both arthroscopic and traumatological surgical skills. Another cause of failure is the incorrect indication for this technique: complex high energy articular fractures such as Shatzker type IV-V-IV are not suitable for ARIF. The use of this technique on the wrong fracture leads to unsuccessful results and the literature agrees that the correct indication for ARIF is Shatzker I-III fractures [5].
In their systematic review, Chen et al. [6] reported 2 cases of compartment syndrome ARIF-related: a rare but catastrophic complication.

Percutaneous reduction and internal fixation (PRIF)

Synthesis with percutaneous technique is a suitable option in fractures with a single fragment and with the possibility of easy reduction. As for ARIF, the wrong indication is the main cause of failure. Bone graft associated with this surgical technique is often used to address bone defects.
The most frequent complication of PRIF is loss of reduction due to insufficient mechanical support. Screws and eventually bone graft do not always guarantee sufficient stability to avoid displacement of fragments [7].
In addition, fluoroscopy alone is often not sufficient to obtain a good reduction. The association of bone graft to PRIF is still debated. Autologous bone remains the gold standard technique, but other kinds of synthetic grafts also provide comparable results [8].

External fixation (EF)

Bridging external fixation is the gold standard as emergency treatment in cases of open fractures to provide easy and quick fracture stabilization. Otherwise, circular external fixation can be used as a definitive treatment in alternative to ORIF. Circular external fixation is a technique that requires a difficult learning curve to obtain good results. It is difficult to obtain good reduction, especially in high energy fractures. An advantage of external fixation devices is the preservation of soft tissue. It must be considered that this device requires high patient compliance, and thus treatment failure can be also caused by a poor post-operative management [9].

Open reduction internal fixation (ORIF)

ORIF is considered the gold standard treatment in tibial plateau fractures, especially for fracture involving two or three columns. There are several causes that can lead to treatment failure. Preoperative planning is mandatory to choose the correct surgical timing, the appropriate approach, and best reduction and fixation strategy. An appropriate timing allows you to preserve soft tissues and decrease risk of wound complications. Different approaches are described in the literature. In the 1980s, for bicondylar tibial fractures the most used approach was the anterior one with tibial tubercle osteotomy [10]. Only in 1993 was the medial and lateral extended approach introduced by Tscherne and Lobenhoffer [11]. Nowadays several approaches have been described to obtain the best possible reduction for each type of fracture [12]. The correct approach consents to achieve better reduction and decrease the risk of secondary displacement. Juan Boluda-Mengod et al. [13] in 2021 purposed a new algorithm for decision-making approaches in ORIF.
It is important to choose the correct device to obtain the proper stability. In single column fractures, a single plate may be sufficient, while in double or three column fractures two or three plates may be needed, especially to obtain good stability of the posterior column. The use of an incorrect device or uncorrected positioning can lead to synthesis failure.
One of the most important causes of ORIF failure is post-operative infection. The overall infection rate in tibial plateau fractures is 9.9%, but it is important to consider that there is a difference in infection rate between low-grade and high-grade fractures. In the meta-analysis by Shao et al. in 2017 [14], it was highlighted that smoking, compartment syndrome, open fractures and operative time are all risk factors for infection. It must be considered that operative time is a surgeon-related risk factor.

Discussion

Tibial plateau fractures are severe injuries that occur rarely and which are usually associated with soft tissue complications. In high grade fractures (Shatzker V and VI), the rate of complications can reach 68% [15]. It is still debated which treatment is associated with the best clinical outcomes. There are several

aspects to consider before surgery. First of all, it is important classify the fracture pattern and in multifragmentary fractures a CT scan is mandatory to appropriately plan treatment. Soft tissue conditions must be evaluated to decide surgical timing to minimize the risk of wound complications and compartment syndrome.

In literature there is insufficient evidence to ascertain the best method of fixation or the best method of addressing bone defects [16]. In Shatzker I, II, III, IV fractures, PRIF and ARIF can provide similar clinical outcomes with some advantages: less invasiveness, soft tissue preservation and faster post-operative recovery. In high grade tibial plateau fractures (Shatzker V and VI), ORIF represents the gold standard technique. In high grade fractures with severe soft tissue impairment, external fixation represents an interesting option. Li et al. in 2020 [17] in their meta-analysis compared circular external fixation to ORIF. This study pointed out that circular fixation may offer some advantages such as shortened length of hospital stay and an early return to pre-injury activity. At the same time, ORIF permits more accurate reduction and external fixation is associated with an increased risk of malunion. Our analysis does not allow for definitive clinical recommendations.

ARIF in Schatzker types I-III fractures was first described by Caspari and Jennings [18]. Classical drawbacks of this technique are higher cost, longer operative time and necessity of a skilled surgical equip on traumatology and arthroscopy. Le baron et al. [19] in a multicentric retrospective study compared clinical and radiological outcomes of two group of Shatzker type I-III fractures treated with ARIF or ORIF with a minimum follow-up of 2 years. The complication rate was comparable between groups: 9% for ARIF and 8% for ORIF. In addition, there was no significant difference in clinical outcomes and in reduction quality between groups.

PRIF represents a viable alternative for treatment of low-grade tibial plateau fractures. Especially for monocondylar fracture with depressed fragment,s good results have been reported with this technique. Chen et al. [7] stressed the advantages of PRIF in treating monocondylar fractures. It is still debated if arthroscopy is superior to fluoroscopy to obtain good outcomes. Lobenhoffer et al. reported no significant differences between these two reduction techniques [20]. In contrast, other studies reported a higher rate of osteoarthrosis due to worse reduction using fluoroscopy.

Conclusions

Accurate classification of the fracture and surgical planning are the first step to obtain successful outcomes in treatment of tibial plateau fractures. Surgical timing and operative time are important to decrease risk of soft tissue complications and infections. The pattern of fracture has to be considered when choosing the most appropriate approach and synthesis device to obtain the best reduction and stabilization.

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Ethical consideration
This is a literature review article and does not require an ethics committee.

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