

MANAGEMENT OF TIBIAL PLATEAU FRACTURES: DIAGNOSTICS, CLASSIFICATION AND TREATMENT

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AUTHORS

Julian Ross - Altona Children's Hospital, Hamburg, Germany

Karl-Heinz Frosh - University Medical Center Hamburg-Eppendorf, Hamburg, Germany

SUMMARY

Background: Tibial plateau fractures constitute approximately 1–2% of all skeletal injuries. These complex intra-articular injuries frequently involve significant soft tissue damage, necessitating precise anatomic reduction and stable internal fixation to facilitate early mobilization and mitigate the risk of posttraumatic osteoarthritis. Despite advancements in osteosynthesis, high complication rates persist, particularly in high-energy trauma and geriatric populations with osteoporotic bone.

Objective: This article delineates a standardized diagnostic and therapeutic algorithm for tibial plateau fractures, emphasizing the utility of the 10-segment classification system in determining surgical approaches and optimizing internal fixation strategies.

Key Points: Comprehensive diagnostics include mandatory computed tomography and magnetic resonance imaging to assess frequently associated meniscal and ligamentous injuries. The 10-segment classification facilitates precise localization of articular damage, guiding the selection of surgical exposures. Surgical options range from minimally invasive arthroscopy to complex open reduction and internal fixation. Specific approaches described include the anterolateral, posterolateral, and enhanced medial or lateral exposures involving epicondylar osteotomy for central segment visualization. In elderly patients with advanced osteoporosis or pre-existing gonarthrosis, primary total knee arthroplasty is considered an alternative to osteosynthesis. Postoperative complications remain significant, with surgical site infections occurring in up to 45% of cases and posttraumatic arthritis reported in 60% of complex fractures.

Conclusion: Optimal clinical outcomes depend on rigorous preoperative imaging, the application of segment-based classification for approach selection, and the achievement of stepless articular reconstruction. Standardized protocols and specialized surgical techniques are essential to minimize long-term functional impairment and secondary degenerative changes.

KEYWORDS

Tibial Fractures; Fracture Fixation, Internal; Arthroscopy; Arthroplasty, Replacement, Knee; Knee Injuries

INTRODUCTION

Approximately 1-2 % of all bony injuries are represented by tibial plateau fractures. Its complexity and associated soft tissue injuries can be a challenge for surgical skills. An anatomic reduction and stable fixation are of crucial importance in order to achieve rapid mobilization, improved rehabilitation and to minimize posttraumatic osteoarthritis. Severe concomitant injuries require a standardized diagnostic algorithm. The academic literature does not give a unique classification system. The 10-segment classification offers information of the localized damaged area having huge implications for the choice of surgical approach and application of osteosynthesis material. Depending on the severity of injury, the therapy ranges from minimally invasive surgery, plate osteosynthesis up to primary endoprosthesis, especially in elderly patients. Although new techniques showed good to excellent results, tibial plateau fractures are still accompanied by high rates of complications.

This article brings together our findings and provides the specific approaches of our center including details of imaging, classification, therapeutic algorithm with focus on specific surgical techniques.

DEMOGRAPHIC DATA

Approximately 1-2% of all bony injuries are represented by tibial plateau fractures [1,2,3,4]. Its complexity and associated soft tissue injuries are always a challenge for the surgical skills [5]. An anatomic reduction and stable fixation is of crucial importance in order to achieve rapid mobilization, improved rehabilitation, and to minimize posttraumatic arthritis[6,7,8,9,10,11,12]. Usually high-energy trauma like falls and traffic accidents leads to fracture in younger patients, whereas only 5-10 % of all tibial plateau fractures are caused by sport[13]. The frequency of low-energy trauma increases in the elderly due to the increasing prevalence of osteoporosis with age, especially in females [14].

DIAGNOSIS

At first, a detailed anamnesis and physical examination are essential to fully comprehend the different injury mechanisms and its consequences. The focus is on the localization and intensity of pain, range of motion as well as instability. Knee injuries walking along with hemarthrosis should result in X-rays of the joint in two or three planes, depending on the matter in question. In cases of suspected tibial plateau fracture a CT scan is fundamentally required. Alternatively, MRI may be very useful for the evaluation of small bony impressions and soft tissue involvement. Every knee dislocation is associated with a high risk of vascular as well as nerve injuries (20%: A. und V. poplitea, N. peroneus communis) and should therefore be carefully examined by a pulse control and a CT angiography[15]. While 80–85% are plateau fractures, luxation fractures represent only 15–20%[16]. With complex or bicondylar tibial plateau fractures, it may be advantageous to use an external fixator for primary treatment, followed by a secondary CT scan[17]. The MRI is considered the gold standard for determining frequently associated meniscal and ligamentous injuries with an accuracy of 85-100%, in particular regarding luxation fractures[18]. The number of concomitant injuries depends significantly on the degree of fragment dislocation. Besides reported high rates of meniscal injuries (Eggl et al: 42.9%; Barei et al: 38.6%; Bennett et al:

20%), recently a large clinical study proved that 21,9 % of patients with tibial plateau fractures suffer from concomitant ligamentous injuries. The MCL or LCL were isolated affected in 49,3% and 31,9% of all cases, while ruptures of the anterior cruciate ligament accounted for 5,8%[19]. Fractures that have healed in the wrong position require always a CT and MRI before revision surgery and if possible, also long leg X-rays. Additionally, lateral slope radiographs can be regarded as useful.

FRACTURE AND DISLOCATION CLASSIFICATION

The academic literature does not give a unique classification system for tibial plateau fractures. Hence, a comparison of injury patterns and therapeutic recommendations seems to be difficult.

One of the most commonly used classification for tibial plateau fractures is the two-dimensional AO classification including in particular plateau fractures. Probably most known in the German-speaking countries, it is based on the radiological fracture morphology and the primary division of Müller and Allgöwer[20] (figure 1).

Group A: extra articular fractures (avulsion, metaphyseal simple, metaphyseal multi fragmentary)

Group B: partial articular fracture (pure split, pure-depression, split-depression)

Group C: complete articular fractures (articular simple/metaphyseal simple, articular simple/metaphyseal multi fragmentary, articular multi fragmentary)

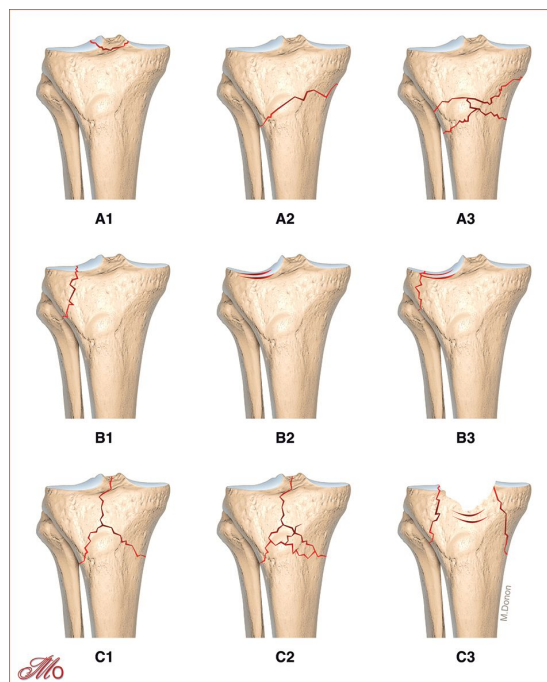


Figure 1 - Two-dimensional AO classification by Müller and Allgöwer. Group A: extra articular fractures (avulsion, metaphyseal simple, metaphyseal multifragmentary) Group B: partial articular fracture (pure split, pure-depression, split-depression) Group C: complete articular fractures (articular simple/metaphyseal simple, articular simple/metaphyseal multifragmentary, articular multifragmentary)

Luxation fractures are shown in the classification system according to Moore[16] (figure 2). Considering clinical and radiological fracture morphology, this grouping of five types provides a better preoperative assessment of ligamentous, neurovascular and meniscus-associated injuries and damage to the knee.

I medial split fracture

II entire condyle fracture

III rim avulsion fracture

IV rim impression (unstable associated with avulsion of cruciate)

V four-part fracture (unstable associated with neurovascular injuries in 50%)

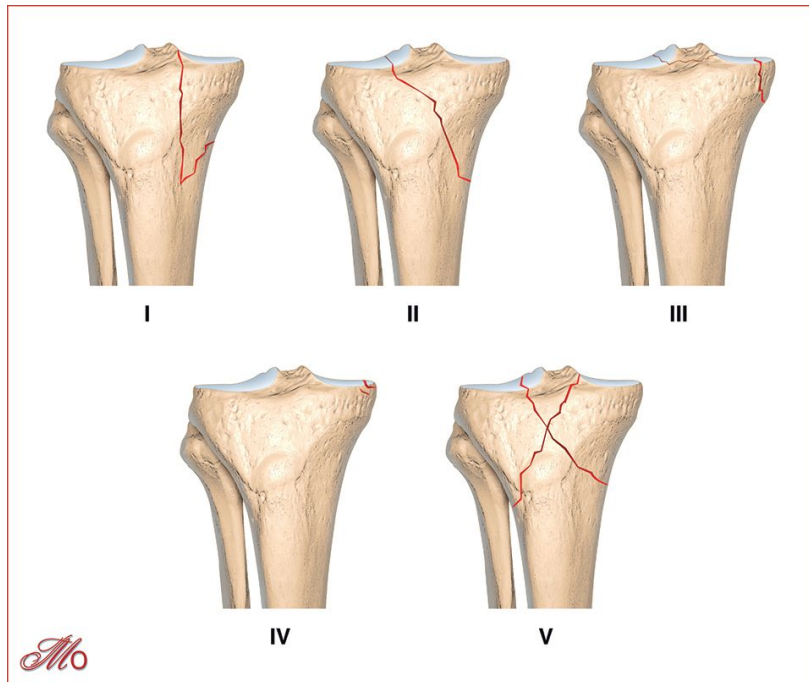


Figure 2 - Classification of luxation fractures by Moore
I medial split fracture
II entire condyle fracture
III rim avulsion fracture
IV rim impression (unstable associated with avulsion of cruciate)
V four-part fracture (unstable associated with neurovascular injuries in 50%)

Both classification systems describe the nature of fracture, but not their precise localization. For this reason, especially in case of deformed healed fractures they cannot be sufficiently applied. To describe the localization accurately, Frosch et al. have established a new additional classification system for tibial plateau fractures[19,21] (figure 3 to 7). For this purpose, the tibial plateau is subdivided into four quadrants and ten segments. The region of the anterior and posterior cruciate ligament each represents one segment. Each of the four quadrants is further divided into a medial and lateral segment, resulting in eight segments in relation to the joint surface (without the cruciate ligaments). Localization of damaged segments have huge implications for the choice of surgical approach and application of osteosynthesis material.

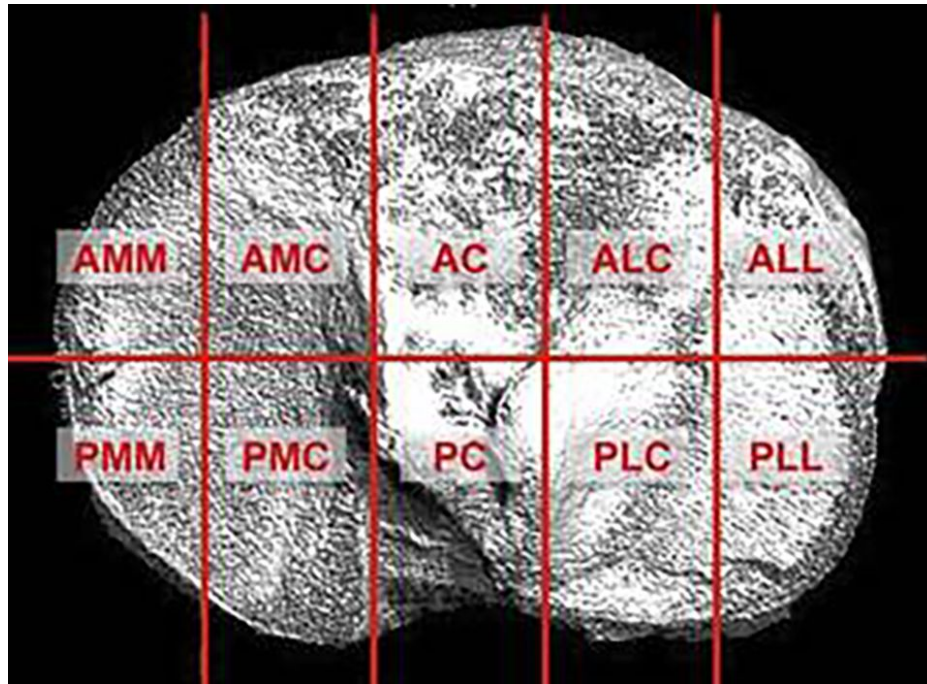


Figure 3 - 10-segment classification by Frosch. The region of the anterior and posterior cruciate ligament each represents one segment. Each of the four quadrants is further divided into a medial and lateral segment, resulting in eight segments in relation to the joint surface without the cruciate ligament. ALL Antero-latero-lateral; ALC Antero-latero-central; AC Antero-central; AMC Antero-medio-central; AMM Antero-medio-medial; PLL Postero-latero-lateral; PLC Postero-latero-central; PC Postero-central; PMC Postero-medio-central; PMM Postero-medio-medial.

Fracture and dislocation classification		
Two-dimensional AO classification by Müller and Allgöwer	Classification of luxation fractures by Moore	10-segment Classification by Frosch
A extra articular fractures (avulsion, metaphyseal simple, metaphyseal multifragmentary)	I medial split fracture	ALL Antero-latero-lateral
B partial articular fracture (pure split, pure-depression, split-depression)	II entire condyle fracture	ALC Antero-latero-central
C complete articular fractures (articular simple/metaphyseal simple, articular simple/metaphyseal multifragmentary, articular multifragmentary)	III rim avulsion fracture	AC Antero-central
	IV rim impression (unstable associated with avulsion of cruciates)	AMC Antero-medio-central
		AMM Antero-medio-medial
		PLL Postero-latero-lateral
		PLC Postero-latero-central
V four-part fracture (unstable associated with neurovascular injuries in 50%)	PC Postero-central	
	PMC Postero-medio-central	
	PMM Postero-medio-medial	

Figure 4 - Shows a comparison of the different classification systems



Figure 5 a Preoperative computertomography of a 49-years old patient with tibial plateau fracture AO B2. b Fracturoscopy – arthroscopic visualization of the damaged articular surface c Postoperative computertomography showing a satisfactory reduction and stable fixation after arthroscopic supported osteosynthesis.

Figure 6 - Different historical described standard surgical approaches to the tibial plateau

- **anteromedial** (Tscherne and Lobenhoffer 1993)
- **posterior / posteromedial** (Gala et al 2003; Frosch et al. 2010, Luo et al. 2010)
- **anterolateral** (Lobenhoffer et al. 1993)
- **enhanced posterolateral** (Frosch et al. 2010)
- **enhanced lateral** (Bowers et al. 2008)
- **enhanced medial** (Engh et al. 1999)

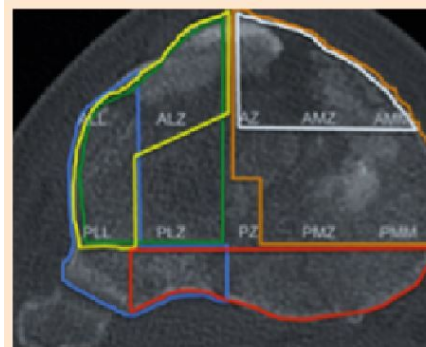


Figure 7 - Type of surgical approach and visualization of affected segments

Anterolateral	ALL, ALC, PLL
Posterolateral	ALL, PLL, PLC
Enhanced lateral	ALL, ALC, PLL, PLC
Anteromedial	AC, AMC, AMM
Posteromedial	PMM, PMC, PC, (PLC - only dorsal parts of the segments)
Enhanced medial	AC, AMC, AMM, PMM
<small>ALL Antero-latero-lateral; ALC Antero-latero-central; AC Antero-central; AMC Antero-medio-central; AMM Antero-medio-medial; PLL Postero-latero-lateral; PLC Postero-latero-central; PC Postero-central; PMC Postero-medio-central; PMM Postero-medio-medial.</small>	

TREATMENT CONCEPT

The therapy of tibial plateau fractures has three goals:

1. Exact anatomical restoration of the articular surface
2. Correction of axial malalignment

3. Early functional postoperative rehabilitation

Intraarticular fractures with articular displacement of more than 5 mm result in poor clinical results[22,23]. Scharf et al. showed that elderly patients with often concomitant existing gonarthrosis have a threefold higher arthrosis index after tibial plateau fracture[24].

First of all, it should be emphasized that the distinctive swelling and contusion of the soft tissue demand an immobilization supported by measures such as elevation, cooling, lymphatic drainage or even an application of an external fixator because of open or instable fractures. The final osteosynthesis is usually made within 5-8 days after the trauma. Associated vascular or neural injuries, compartment syndrome, open fractures will inevitably lead to emergency operation. The conservative treatment is indicated in the event of stable, non-displaced fractures (e.g. Segond fracture) with an articular displacement < 2mm. High and multiple comorbidities are arguments against surgery. The early use of guided motion (CPM) and isometric muscle training can be helpful to gain back range of motion and muscle strength. Partial weight bearing of a maximum of (15-20 kg) might be necessary for 6-12 weeks, under radiological monitoring[25].

Open reduction and internal fixation are still regarded as standard technique for tibial plateau fractures. Therapeutic success depends on the right choice of approach, which should be safely applied by the surgeon. After visualization of the fracture, impressed articular surface is lifted by plunger or raspator. Then K- wires, screws and angle stable plate systems are used for securing and bracing the articular block. Particularly with regard to osteoporotic bone this procedure reduces the risk of material failure by providing a better mechanical stability against torsion and bend compared to conventional plate systems[26].

MINIMALLY INVASIVE SURGERY

Slightly or non-dislocated tibial plateau fractures up to AO type B-fractures can be treated minimally invasive. Hence, the absence of a capsular injury matters to avoid an iatrogenic compartment syndrome caused by increased intraarticular water pressure[19,27,28]. Under arthroscopic control surgeons reach anatomic reduction by means of bone plunger after cortical fenestration. A conventional anterolateral plate osteosynthesis is often used for fixation. Given a uniform load distribution and reduced risk of material dislocation, the “Jail” technique represents an advantageous alternative. Especially if the cannulated 3,5-mm-screws, which lies vertical to each other, are placed strictly below the fixating screws[29]. Satisfactory articular reconstruction is crucial for long-term success in the treatment of complex, comminuted tibia plateau fractures. The intraoperative, secondary insertion of an arthroscope (2.4-mm or 2.8-mm optics) through the open surgical approach can provide it through directly visible reduction and fixation correction using impactor guided fragment elevation in addition to standard reduction techniques. This new procedure, first described as fracturoscopy by Krause et al., permit a significantly better visualization of postero-latero-central segment[19,30]. It proved to be useful for evaluating additional intraarticular injuries associated with complex tibial plateau fractures such as meniscal injuries or cruciate ligament injuries which can be treated during the same operation. Despite a lower surgery-related soft tissue trauma, attention have to be paid to a limited procedure time (<2h) and an accurate padding of the thigh in order to avoid potential affections of the peripheral nerves. We have to distance ourselves from cruciate ligament plastic parallel to primary osteosynthesis by reason of a risk for arthrofibrosis and delayed ingrowth[31]. In these cases, primary suture and augmentation of ruptured cruciate ligaments should remain the preferred surgical procedure.

RECOMMENDED SURGICAL TECHNIQUES

Anterolateral approach

In 88% the lateral joint surface is fractured[32]. To treat damage sufficiently, the anterolateral approach can be performed by straight skin incision proximal from the Epicondylus femoris lateralis to Gerdy's tubercle in a distal direction, in particular with regard to future potential implantation of a knee endoprosthesis (figure 8).

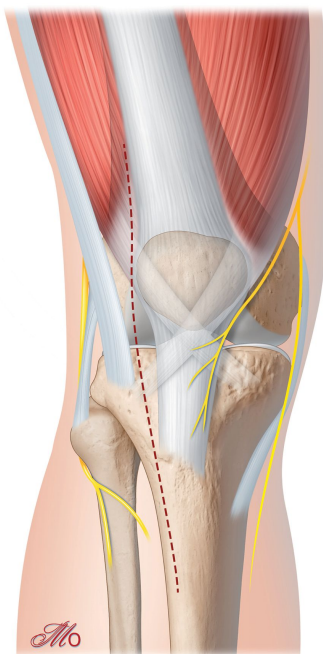


Figure 8 - Skin incision of anterolateral approach. Depending on the fracture course sometimes the skin incision has to be made more ventral or dorsal (antero-latero-central or antero-latero-lateral)

Depending on the fracture course (antero-latero-central, antero-latero-lateral), sometimes the skin incision has to be made more ventral or dorsal. Following longitudinal incision of Tractus iliotibialis along the Gerdy tubercule a subperiosteal dissection of the Tractus from Gerdy's tubercule and tuberositas tibiae is required in order to visualize the articular surface after a subsequent horizontal arthrotomy below lateral meniscus (figure 9).

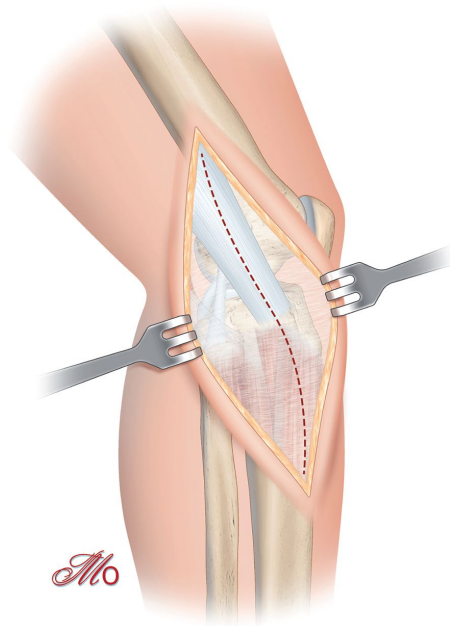


Figure 9 - Anterolateral approach. Longitudinal incision of Tractus iliotibialis along the Gerdy tubercle, followed by a subperiosteal dissection of the Tractus from the fibula head and tuberositas in order to visualize the articular surface after a subsequent horizontal arthrotomy below the lateral meniscus.

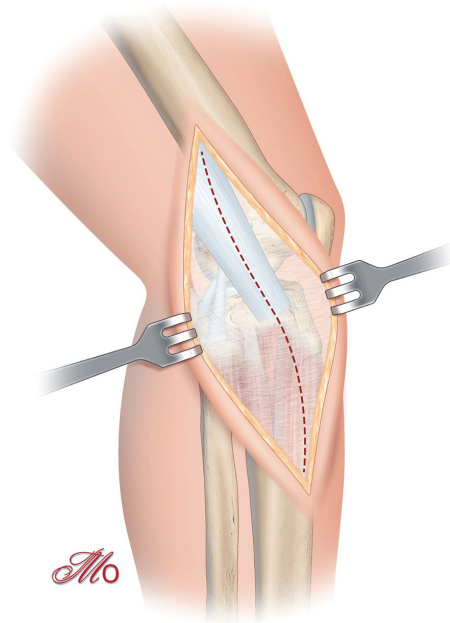


Figure 9 - Anterolateral approach. Longitudinal incision of Tractus iliotibialis along the Gerdy tubercle, followed by a subperiosteal dissection of the Tractus from the fibula head and tuberositas in order to visualize the articular surface after a subsequent horizontal arthrotomy below the lateral meniscus.

During the preparation of plate bearing and incision of fascia of M. tibialis anterior the focus lies in the protection of the soft tissues. But the decisive disadvantage of this approach is that affected posterolateral areas are not accessible[19, 33].

Posterolateral approach

Multiple authors recommend different approaches to posterolateral tibia plateau (direct posterior, posterolateral, posteromedial, modified anterolateral). However, 7 % of posterolateral fractures cannot adequately treated by

using these standard techniques. Therefore, the recent described posterolateral approach by Frosch et al. is better suited to allow sufficient visualization of postero- as well as anterolateral quadrants[34]: The patient lies in a lateral position. Through a 15-cm-long posterolateral skin incision starting 3 cm above the joint line and following the fibula in a distal direction, two access windows can be created ventral and dorsal to the fibula head. The ventral procedure is similar to the preparation of the anterolateral approach. At the dorsal border of M. biceps femoris the N. peroneus is gently mobilized. Then a blunt dissection of the popliteal fossa between the lateral head of the M. gastrocnemius and the M. soleus is performed (figure 10).

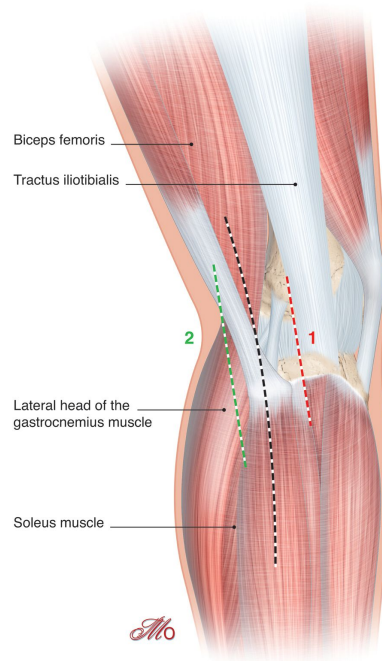


Figure 10 - Skin incision of posterolateral approach (dashed black line). Lateral standard arthrotomy (1). Blunt dissection of the popliteal fossa between the lateral head of the M. gastrocnemius and the M. soleus (2).

The latter can be proximal partially incised for visualization of the fracture and plate bearing. To give insights into 20-30 % of the posterolateral tibial plateau the medial retraction of M. soleus and the lateral head of M. gastrocnemius is necessary. This enables the anatomic reduction and stable fixation using plates or screws while protecting soft tissue and important ligamentous structures (figure 11).

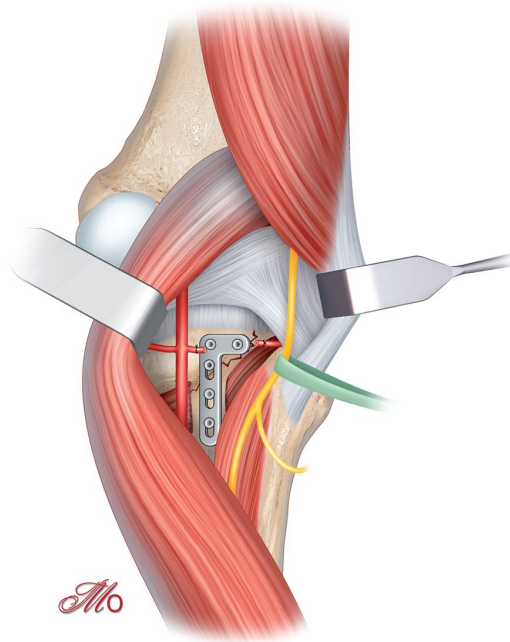


Figure 11 - Schematic drawing and intraoperative situs of a right knee from the posterolateral view after reduction of the fracture and plate osteosynthesis

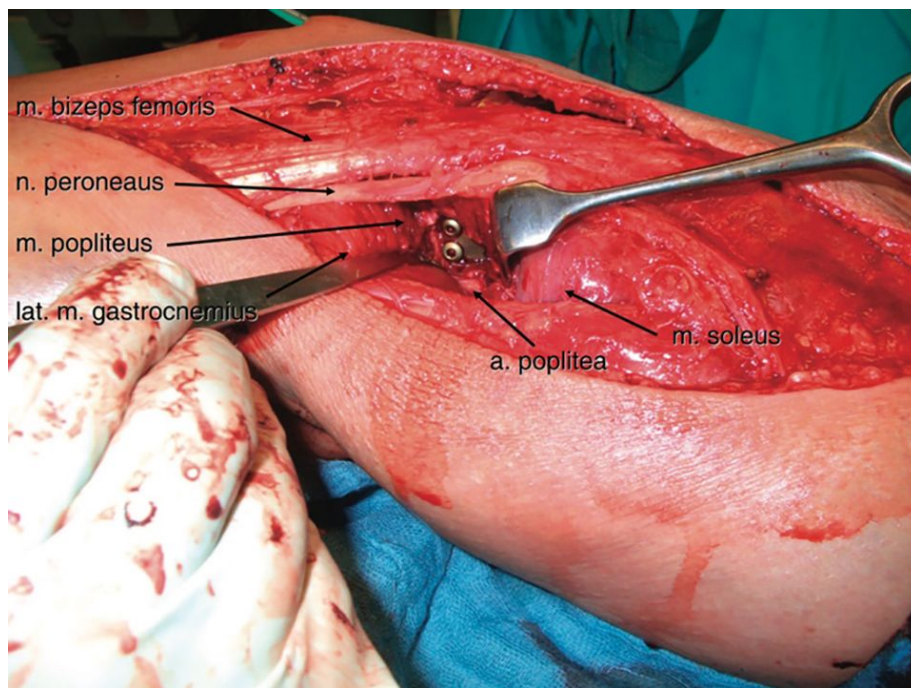


Figure 11 - Schematic drawing and intraoperative situs of a right knee from the posterolateral view after reduction of the fracture and plate osteosynthesis

Enhanced lateral approaches

A simple fluoroscopic reduction control is recognized as the most important risk factor for persistent articular displacement [19,35].

None of the before mentioned surgical options can provide a satisfactory treatment of affected central segments in the event of complex lateral articular destruction. There are basically two ways to meet this demand. The osteotomy of fibula head or epicondylus femoris lateralis allows an almost complete overview of the articular surface. [36] For the transfibular approach literature reports not only reduced peroneus lesions, but also

secondary loss of reduction and material migration[28,37]. The authors continue to see the osteotomy of the epicondylus femoris lateralis as superior, with no need for discovering the peroneal nerve. Usually, already a osteotomy of femoral ligament attachment can be enough to open the tibial joint space. If insufficient, the femoral popliteus tendon can be involved in the osteotomy to visualize more complex fracture courses (Fig. 12 and 13). Two cannulated lag screws (3,5-mm- or 4,0 mm) are inserted for the refixation of lateral epicondylus.

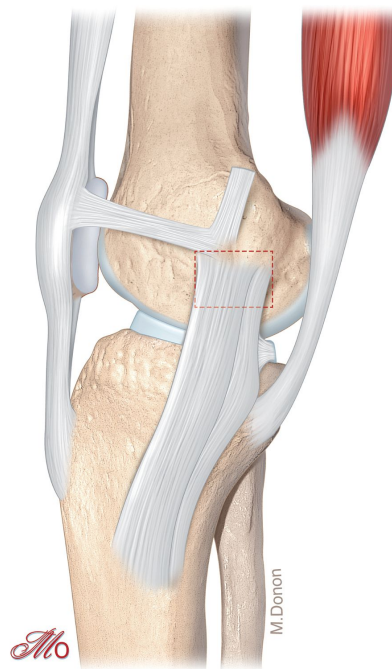


Figure 12 - The above drawings show the position of the femoral osteotomy for the enhanced (a) medial and (b) lateral approach (red lateral collateral ligament only, white including popliteus tendon)

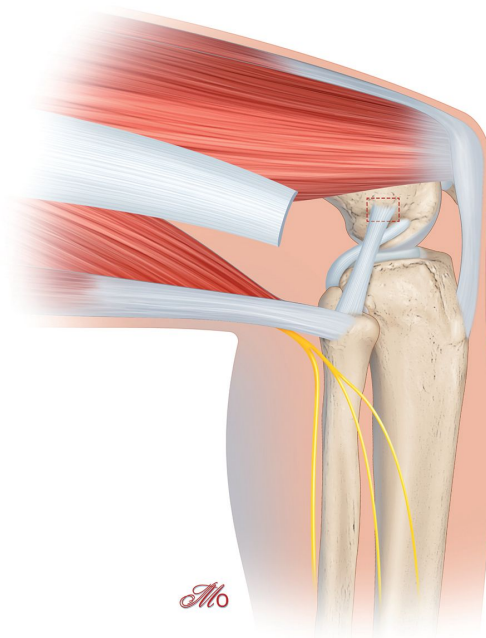


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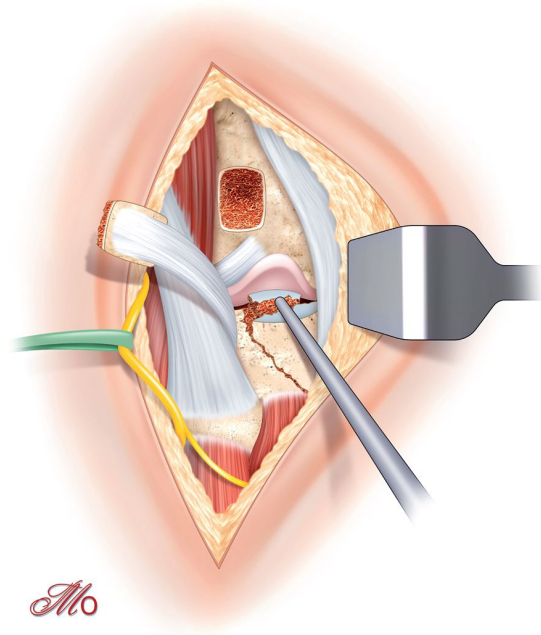


Figure 13 - Enhanced lateral approach. Exemplary operative treatment of lateral tibial plateau fracture of a left knee in prone position

Anteromedial and enhanced medial approach

Medial tibial plateau fractures frequently occur in combination with bicondylar injuries[32]. Isolated depression or split fractures should be treated surgically by an anteromedial skin and longitudinal incision of joint capsule, followed by an arthrotomy after a horizontal cut through meniscotibial fibers 2 mm proximal of their tibial attachments[38]. Limited exposition is owed to the anterior superficial part of ligamentum collaterale mediale and posterior oblique ligament. The surgeon can visualize 70 % of complete medial plateau if a 2x2x1 cm bone block is medially osteotomized in analogy to the lateral epicondyle (Fig. 14). As a result, only the posterior third remains badly visible. Possible complications include wound healing disorder caused by inadequate left soft tissue bridge.

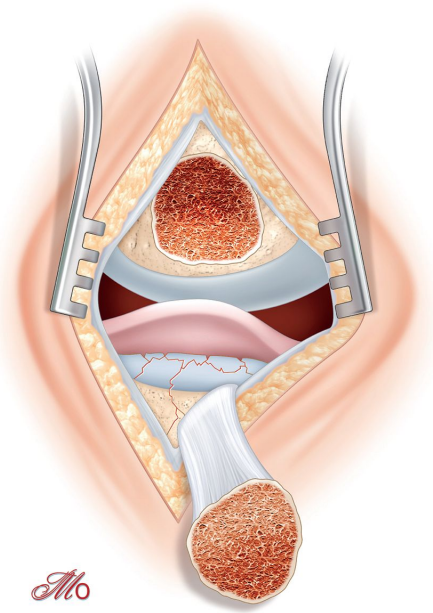


Figure 14 - Enhanced medial approach. A medial epicondylar osteotomy of an approximately 2x2x1 cm bone block can visualize 70 % of complete medial plateau (AC, AMC, AMM, PMM). a, b Anatomical reduction of a medial fracture with complete visualization of the articular surface below the medial meniscus which is retracted by a blue string. ve ventral, do dorsal, pr proximal, di distal.

Posteromedial approach

A posteromedial approach was developed by Lobenhoffer et al.[19]. With this approach posteromedial shearing fractures and its posteromedial extension of the fracture line should be surgically repaired. Above this, it is recommendable to reconstruct the medial articular surface and column first in case of bicondylar tibial plateau fractures with a simple coronal split fracture. Thus, a reference for correct axis, length and width of tibial plateau can be defined in the further course.

The patient lies supine with the injured knee bent. After skin incision at the dorsomedial tibial crest, the fracture course should be optimally visible by retraction of the dissected hamstring tendons. Finally, stepless reconstruction of the joint surface can be achieved by reduction of the extraarticular cortical damage. A fixation with a special posteromedial plate provides the best possible support.

With dorsal multi fragmented fractures, an access in prone position is indicated, otherwise visual control would be limited. To avoid scar contractions, the skin incision over the medial head of M. gastrocnemius should not cross the popliteal fold. Next, the fascia is exposed, and a blunt dissection of the popliteal fossa is initially performed between the lateral head of the M. gastrocnemius and the M. semimembranosus. This is followed by lateral retraction of the medial head of M. gastrocnemius which gives view of the dorsomedial joint capsule (Fig. 15).

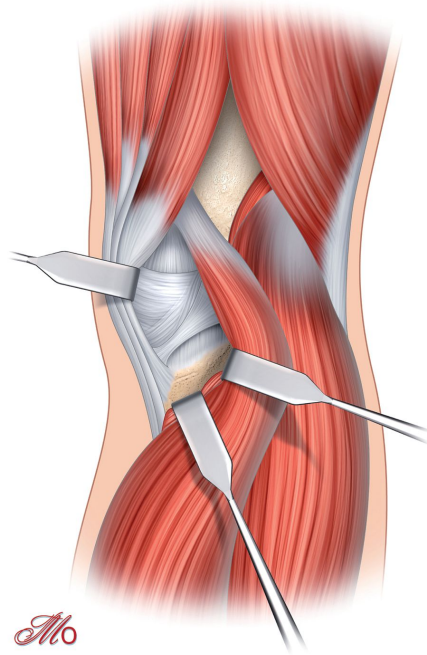


Figure 15 - Posterior approach. The patient lies supine with the injured knee bent. After skin incision at the dorsomedial tibial crest, the fracture course should be optimally visible by retraction of the dissected hamstring tendons.

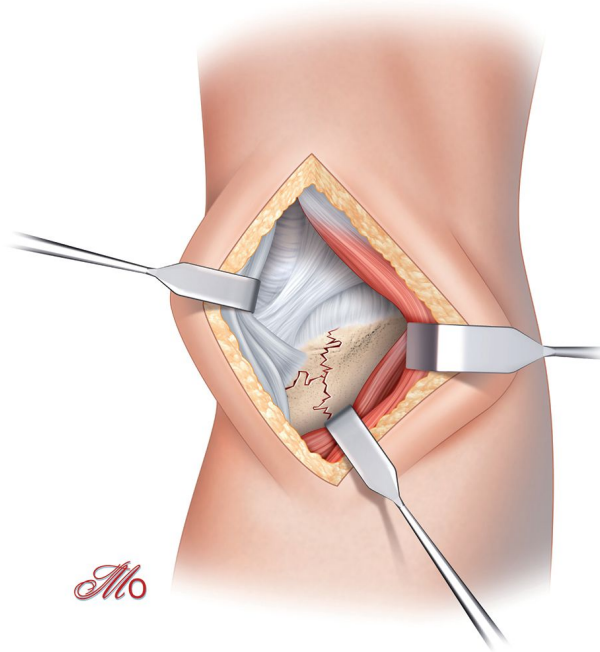


Figure 16 - Posterior medial approach. Skin incision over the medial head of M. gastrocnemius. Exposition of fascia cruris and blunt dissection of the popliteal fossa between the lateral head of the M. gastrocnemius and the M. semimembranosus. Lateral retraction of the medial head of M. gastrocnemius and arthrotomy of the dorsomedial joint capsule gives view of the posterior tibia head.

Complementary an extension of the skin incision along popliteal fold or even a partial incision of the femoral sinewy part of M. gastrocnemius may be necessary, especially if access to postero-latero-central tibial plateau is needed. During a very cautious posteromedial capsular incision, the posterior cruciate ligament and M. semimembranosus may nevertheless be jeopardized. The partial detachment of proximal popliteus muscle uncovers the posteromedial plate bearing. Bone avulsions of the posterior cruciate ligament need only one small opening to be fixed [29].

Indication for bone replacement/augmentation

Secondary loss of reduction, sintering or axial deformity frequently cannot sufficiently be filled in with autologous bone from the iliac crest. This procedure came on as disadvantageous because of the additional approach at the pelvis.

Alternative bone replacement material (mainly bone allograft) work through an osteoinductive effect and serve vessels and new developed bone as lead structure. Even if Roche et al. have showed that the application of bone cement can deliver good results, we restrictedly recommend it as tibioplasty in the elderly[39]. Secondary endoprosthesis implantation or revision has to be taken seriously. If applicated, the cement must therefore maintain a greater distance (>1 cm between cement and articular surface)[25].

Endoprosthesis

Fracturoscopy serves as decision tool regarding reconstructive or endoprosthesis treatment concepts. Normally, the affected extremity and its functionality can be retrained by osteosynthesis. Considering imperative need

of partial weight bearing, reduced bone quality and compliance as well as high comorbidity in elderly patients, primary endoprosthesis should be taken into account[17]. Fracture morphology, bicondylar fractures, meniscus lesions, age of patient and the number of comorbidities represent risk factors for secondary joint replacement[40]. In fact, only 3-7 % of patients who suffered from a tibial plateau fracture ten years ago need an arthroplasty[41]. Bicondylar involvement leads to a secondary endoprosthesis in up to 11 % [40].

Primary endoprosthesis are superior to osteosynthesis in case of following indications[17]:

- previously existing gonarthrosis
- extended ossal defective area
- fragment necrosis
- advanced osteoporosis
- complex fracture morphology
- secondary malalignment or dislocation in older patients, in particular after the age of 65(intraarticular osteotomy vs. endoprosthesis)
- posttraumatic instability (pseudo-instability) of knee joint

Depending on the severity of damage, the therapy ranges from simple surface replacement, long tibial prosthetic shaft, augments up to fully coupled prosthesis. Before implantation, individual and stringent indication is important, especially for the biological younger patients. Although some studies were able to demonstrate good to excellent results, posttraumatic joint replacement are accompanied by perioperative complications and revision rates of up to 21%[17,42].

Complications

Even for experienced surgeons the surgical treatment is likely to remain challenging so that complication rates of up to 40 % are described in current literature[17].

Due to the initial accidental trauma and subsequent operation the soft tissue is usually traumatized twice. Fractures of the proximal tibia often results in surgical sites infections (SSI), all in all between 2.6–45% to literature reports[43]. In this regard, other fractures treated with open reduction and internal fixation (ORIF)

shows a noticeably lower rate of 2-3%[44,45]. Besides independent predictors like operative time and open fractures, the reasons why patients with proximal tibial fractures are prone to SSI remains unclear.

Staphylococcus aureus with or without resistance (MRSA), followed by Pseudomonas, Staphylococcus epidermidis, Enterobacteriaceae or Enterococcus species have been identified as the most common microbial spectrum[43].

In the first review dealing with this topic, Henkelmann et al. showed that 55,8 % of patients who once suffered from deep infections had a poor outcome with substantial limitations of the affected joint and leg. Besides joint stiffness due to operation (arthrodesis 7.8%), ankylosis (9.3%) or not specified stiffness (1.6%), the most common limitation was pseudarthrosis or non-union (15.3%). In 5,4 % of all reported cases it ended in an amputation[43].

Even without infection the functional outcome may be poor[46]. In the long-term limited range of motion and axial deformity occur in 16-27 % [47]. According to a recent study, complex fractures are associated with an increased risk of posttraumatic arthrosis of up to 60%[47]. Furthermore, persistent ligamentous knee instability has as a prevalence of 11 % to 18 % [48].

After tibial plateau fractures approximately 75% of recreational sportsmen can take up their sporting activities again, whereas professional athletes returning rarely to their previous level[49,50]. Osteoporosis, insufficient reduction and fixation are fundamental factors for a secondary failure of osteosynthesis[17].

However, in case of postoperative diagnosed relevant articular displacement, defects or axial deformity an early revision appears justified from our view.

CONCLUSION

To achieve good and excellent clinical results after tibial head fractures a detailed evaluation of the fracture is necessary. A CT scan should be performed in all fractures, additional MRI if relevant soft tissue injuries are expected (i.e. in dislocation fractures). Highly unstable fractures should be primarily stabilized by an external fixator to prevent further soft tissue damage and compartment syndrome. Different classification systems are helpful to evaluate the fracture and to choose the optimal surgical approach to visualize the involved articular surface and to properly fix the fracture. Anatomic reduction is the key to success. Extended approaches including epicondylar osteotomy might be necessary to achieve this goal. Adequate postoperative rehabilitation is necessary to gain back range of motion and muscle strength. By careful consideration of the above-mentioned factors good and excellent clinical results can be achieved even in complex tibial plateau fractures.

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