

# Fractures of the lower leg

## Fractures of the proximal tibia

Fractures of the proximal tibia belong to the most serious intra-articular to fractures with a large number of early and late complications and a dubious prognosis.

- Etiopathogenetically:
  - most often by the action of axial forces in the axis of the limb
  - valgus, varus stress especially in older people
  - combination

Due to the physiological valgusness of the axis of the limb, due to the morphological predispositions in the shape and more subtle spongy structure, fractures are more often on the lateral side than on the medial side. Often, fractures are combined with injuries to the ligamentous apparatus knees and neurovascular structures.

### AO 41 classification

- group A: extra-articular
  - A1 - abruption of the intercondylar eminence
  - A2 - simple fracture metaphysis
  - A3 - comminuted fracture of the metaphysis
- group B: partially intra-articular
  - B1 - split fractures of the condyle (splitting)
  - B2 - impressions of the lateral plate
  - B3 - impression and split
- group C: completely articular fractures
  - C1 - articular and metaphyseal simple
  - C2 - articularly simple, metaphyseally multifragmented, or comminuted
  - C3 - articularly multifragmented, or comminution

### Classification - according to Tscherne (modified Moore's original classification of dislocation fractures)

#### AND. Marginal fractures in ligament injuries and luxation knee joint (rim avulsion)

1. Segonda's fracture - avulsion of the lateral attachment of the joint capsule
2. Detachment of tuberculum Gerdi (attachment tractus iliotibialis)
3. breaking off or impression of the edges of the articular surfaces of the tibial condyles - possible on both sides

#### II. Plata fractures (no ligament damage)

1. non-dislocated stable fractures
2. breaking off the lateral condyle
3. impression fractures of the lateral condyle
4. breaking off the lateral condyle with an impression
5. bicondylar fractures
  - the medial one is less damaged, the lateral one may have a significant impression
  - the intercondylar eminence remains fixed to one of the fragments, thus no significant instability occurs

#### III. Dislocation fractures - luxation mechanism of occurrence is characteristic, no. accompanied by ligamentous and vascular injuries

1. breaking off the medial condyle (split fracture)
  - the fragment as a whole remains intact and dislocates distally



Segond fracture, AO classification: 41 B1

- characteristic x-ray finding: in the lateral projection, the fracture line runs at an angle of about 45° from the center of the plate dorsocaudally, i.e. the fragment forms the dorsal half of the medial condyle
- neurovascular injury rarely

## 2. fracture of the entire condyle

- in contrast to a monocondylar fracture of the tibial plate, the fracture line extends into the contralateral part of the plate by the fact that part or the entire intercondylar eminence is broken off, it forms either a separate fragment or is separated from the broken off condyle, then a lesion of the cruciate ligaments can be assumed
- there is a lesion of the collateral ligament on the contralateral side
- on the lateral side due to the distraction, there is an injury n. peroneus communis and popliteal vessels

## 3. four-part fracture

- the intercondylar eminence is broken off from both the condyles and the diaphysis (unlike a bicondylar fracture of the tibial plate), causing considerable instability

## Diagnosics

- medical history, mechanism of trauma
- clinical examination
  - momentum, blood circulation, sensation of the periphery
  - in case of uncertain finding of pulsation event. duplex sono, or acute DSA
  - soft tissue condition
  - if we are planning an operation, an examination of the fibrous apparatus under general anesthesia is suitable
- x-ray:
  - standard projection
  - possibly a plateau image with the central beam tilted 10° caudally – respecting the physiological reclination of the tibial head
  - possibly two oblique projections perpendicular to each other
- conventional tomography
- CT
- MRI
- arthroscopy:
  - suitable for diagnosing lesions of intra-articular structures

## Therapy

A gross reduction is required within PP to prevent soft tissue damage. The absolute priority is the treatment of vascular lesions and decompression of the peroneus nerve.

therapeutic goal:

- restoration of joint congruence
- normalization of axial arrangement
- restoring the stability of the fibrous apparatus
- enabling early mobilization

### conservative procedure for stable non-dislocated fractures

- skeletal traction behind the calcaneus, rehabilitation with a motor splint after two weeks of immobilization in extension

surgical intervention:

- unstable or displaced fractures
- in the osteosyntheses technique, there is a tendency to retreat from extensive open reduction and plate osteosynthesis to mini-osteosynthesis and ask-assisted methods of osteosynthesis
- monocondylar fractures:
  - repositioning
  - osteosynthesis with channeled cancellous screws, possibly a supporting plate
  - for impression fractures - elevation (by trepanation of the cortex we establish access and try to elevate the compressobathed zone) and spongioplasty
  - fixation of smaller fragments of screws from small instruments
  - possible arthroscopic revision of intra-articular structures
- bicondylar fractures:
  - percutaneous mini-osteosynthesis + hybrid ZF (combination of clamp ZF and Ilizarev)
  - bridging ZF (femur – tibia) with later transition to hybrid ZF
  - splint techniques should be indicated very sparingly (anatomical splints Link system)

## approaches

we generally choose longitudinal incisions:

- for bicondylar central incisions
- in case of involvement of only one part of the plate, a medial or lateral parapatellar ace-shaped incision
- Mercedes-type Y incisions – previously used, today they are obsolete and discarded

## rehabilitation

- always striving for early rehabilitation
- early motorbike and walking with light weight
- full load after about 3 months (depending on the type of fracture)

## complication

- often these fractures are combined with a soft knee injury
- high risk of compartment syndrome
- injury and. poplitea

## Fractures of the proximal tibia in children

They are very risky for acute complications and late consequences.

1. avulsion of the intercondylar eminence (see soft knee injury)
2. fractures of the proximal tibia
3. epiphysiolysis of the proximal tibia
4. avulsion of the tuberosity of the tibiae

## Fractures of the proximal tibia in children

Rank classifies into:

### fractures with risk of arterial bleeding

etiopathogenetically: traffic accidents, falls from bicycles

- the tibialis anterior artery penetrates the interosseous membrane at the level of the proximal metaphysis and is firmly fixed there, i.e. vulnerable
- therapy: rough reduction, temporary fixation and treatment of arterial bleeding

### fractures with a risk of progressive valgus deformity

etiopathogenetically, it is not clearly clarified and there are several hypotheses (hyperemia of the medial part, loss of physiological traction of the torn periosteum, interposition of the periosteum and the pes anserinus...)

- both spontaneous regression of angulation and progression and torpid recurrences can occur even after repeated osteotomies
- therapy: exact reduction of even slightly dislocated fractures is necessary under general anesthesia under the control of an x-ray intensifier, if the fracture line on the medial side remains even 2 mm open on the x-ray, operative revision, removal of the interponate and reconstructive suture of the periosteum is indicated
- with developed valgus deformity, repeated corrective osteotomies are often necessary

Long-term dispensary is always necessary.

## Injury to the proximal epiphysis of the tibia and fibula

### anatomical correlate

- the secondary ossification nucleus of the proximal epiphysis of the tibia appears around the 2nd month, the fusion of the common epiphysis and metaphysis takes place between the 16th and 19th months. a year
- the secondary ossification nucleus of the proximal epiphysis fibula manifests around the 3rd year and fuses between the 16th and 19th a year
- the internal collateral ligament attaches up to the metaphysis, distal to the growth cartilage, the physis is thus protected against valgus violence, and therefore injuries to the distal epiphysis of the femur are significantly more frequent
- risk of popliteal artery damage due to close anatomical relationship

etiopathogenesis:

- indirect hyperextension or abduction violence is more common during sports and traffic accidents, but also direct violence
- part of the syndrome of the abused child, or perinatal injuries of newborns during complicated births

incidence:

- injury to the proximal growth plate of the tibia is very rare, injury to the proximal growth cartilage of the fibula

is quite rare

## clinic

- hemarthrosis, ...

## classification

- in general
- Salter-Harris

## therapy

- hemarthrosis puncture
- non-dislocated separations of all types are treated conservatively with a plaster bandage in 20° flexion, for 4-5 weeks
- dislocated separations I. and II. type we precisely reposition, valgus and varus angulations are corrected by pulling on the axis of the limb in semiflexion of the knee (even "innocent" types I and II lysis are associated with the risk of growth disorders, therefore a perfect and gentle reduction is absolutely necessary)
- hyperexternal injuries are first repaired by traction in slight flexion and then transferred to 90° flexion, by direct pressure on the metaphysis from behind they are repaired and immobilized in this position
- in case of instability, it is possible to percutaneously fix the epiphysis with two crossed K-wires
- displaced fractures III. and IV. type with significant distraction is better to be repaired openly and secured by osteosynthesis with tension screws so as not to damage the growth cartilage

## complication

- see above
- + late: various types of growth disorders, bone bridge (not so often), tibial angulation by hypervascular stimulation, limb shortening

# Avulsion of tuberositas tibiae

## anatomy

- the nucleus in the tuberositas tibiae appears around the age of 9 (earlier in girls) and merges with the main epiphyseal nucleus around the age of 15
- avulsion occurs most often in boys between the ages of 14 and 16. year, when most of the growth cartilage of the tibia has already disappeared and only a narrow cartilaginous bridge remains between the nuclei of the epiphysis of the tibia and the tuberosity (therefore it is classified as a transitional period fracture, similar to the distal tibia Kleiger fracture)

etiopathogenetically:

- most often sports injuries – athletics, jumps, rebounds, sprints
- indirectly - by pulling on the ligamentum patellae - either by excessive contraction quadriceps, or by violent passive flexion of the knee
- there is often an avulsion in terrain affected by Osgood-Schlatter disease



Avulse tuberositas tibiae in a patient with Osgood-Schlatter disease

## classification sec. Watson-Jones

1. avulsion of the bone in the range of attachment of the ligamentum patellae
2. larger fragment in the proximal direction
3. the fracture line runs from the tip of the tuberosity to the proximal articular surface of the tibia

## clinic

- swelling, deformity and soreness at the site of attachment
- hemarthrosis may be present
- analgesic holding in semiflexion with impossible active momentum for pain

## diagnosis

- anamnesis, clinic,...
- x-ray – clear finding, appropriate bilateral comparison

## therapy

- not dislocated: conservatively - plaster immobilization
- for dislocation: reduction and osteosynthesis with traction screws, postoperative four-week immobilization

Note: **m. Osgood-Schlatter**

- osteochondrosis deformans juvenilis tuberositas tibia, (apophysitis, aseptic necrosis of the apophysis, extra-articular osteochondral fracture)
- chronic overloading leads to tearing of the cartilaginous part and ossification of this fragment, loose bodies

- can also form under the lig. patellae
- most often in adolescent boys
- x-ray - fragmentation of the tuberosity of the tibiae, irregular ossification and prominence of the tuberosity
- unlike traumatic avulsion:
  - inconspicuous beginning
  - intermittent mild discomfort
  - quick recovery, good prognosis
- operative therapy (extraction of free bodies) comes into consideration only after the closure of the growth plates

## Fractures of the diaphysis of the tibia

A fracture of the diaphyses of the lower leg can be caused by an indirect (e.g. fall on skis) or direct mechanism (e.g. after a car hits the lower leg). In the case of an indirect mechanism, the surrounding soft tissues are usually minimally damaged, these injuries are also sometimes referred to as ``low-energy injuries, *on the contrary, in the case of a direct mechanism, there are frequent open fractures with great damage to the soft tissues, i.e., these are ``high-energy injuries.*

The classification of these fractures consists in evaluating the **dislocation' and the degree of comunion.**

### Diagnostics

In the diagnostic process, it is very important to correctly evaluate the mechanism of the injury. In low-energy trauma, deformity of the lower leg, swelling of the surrounding soft tissues, and hematoma can be seen. With high-energy violence, on the other hand, soft tissues are bruised very significantly, for this reason we have to think about the possible occurrence of compartment syndrome, the risk of the skin covering dying and contamination of the open wound.

### Therapy

Most of these fractures are indicated for surgical treatment. Closed fractures are often solved with an intramedullary nail, open fractures are sometimes, due to the risk of infection, treated primarily with external fixation and internal osteosynthesis is indicated only after healing of the soft tissues. Accurate reduction is absolutely essential, as lower leg fractures are highly prone to complications (joints, deformities).

## Links

### Resources

- PILNÝ, Jaroslav. *Fractures of diaphyses of lower leg bones (fracture cruris)* [online]. [cit. 2016-11-11]. <[http://www.ortopedie-traumatologie.cz/Zlomeniny-diafyz-kosti-berce-\(fraktura-cruris\)%20](http://www.ortopedie-traumatologie.cz/Zlomeniny-diafyz-kosti-berce-(fraktura-cruris)%20)>.

### Related Articles

- Types of fractures and their dislocations
- Children's fractures and epiphysiolysis