Open fractures and complications

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Fractures

- Closed fractures
- Potentially open fractures - decollement, abrasion
- Open fractures - classifications by the AO/ASIF and Gustilo are used
For a long time:
Open fracture = amputation
Mortality 75%

Poor functional result in survivals
Open fracture

Soft tissue injury involves the bone

- Treatment
- Woundcare
- Bone fixation
Treatment of open fx

Main aspects:

• Urgency - emergency!!!

• Radical debridement

• Bone stabilization

• Soft tissue coverage
Goals

- Vitality of the soft tissues (and the bone)
- Prevention of infection
- Bone healing
- Functional restitution
Deciding factors:

- Type of injury - low vs high energy trauma
- Time
- Location and extension of the injury
  - Soft tissue
  - Bone
- Contamination
- General conditions of the patient - diseases, age, etc.
- Therapy - first aid and definitive th.
Classification of open fractures according to Gustilo-Anderson

- **Grade I** - the skin is stubbed by the broken bone, wound is smaller than 1 cm
- **Grade II** - direct skin trauma, 1-5 cm, without severe anatomical structure damage
- **Grade III** - injury of vessels, nerves, muscle, wound is bigger than 5 cm

A/ the wound can be closed without tension of the soft tissues
B/ severe skin and periosteal defect, skin grafting is necessary
C/ vessel injury needs reconstruction - revascularisation
Treatment of grade I open fractures

- Within the first 6 hours after excision and wound closure it can be treated as a closed fracture
- Conservative stabilization
- Internal fixation

After 6 hours risk of infection increases!!!
Treatment of grade II open fracture

- Excision of the wound
- Open treatment of the wound - primary delayed suture or secondary suture
- Operative fracture treatment
- - in the upper extremity same as closed fractures
- - in the lower limb unreamed intramedullary nailing, external fixator
Treatment of grade III open fractures

- Excision and debridement
- The skin defect is covered temporarily by vacuum sealing or Epigard or Porciderm
- Later skin grafting or flap transfer
- Bone fixation by external fixator
  
  In III/A-B unreamed intramedullary nail also can be used
Vacuum sealing technique
Sural flap

The bone has to be covered by well oxygenized flap - skin grafting with half thickness graft is not suitable
Mesh grafting
Subtotal amputation - grade III/C open fracture
Replantation
Conversion

• When the soft tissue healed, the bone in correct position has not recovered yet but callus formation is seen on X-ray control, fixator removal and plastering recommended
• Removal of the external fixator within 1-6 weeks and change to internal fixation with or without bonegrafting
• If pin tract infection developed after removal of the external fixator transitorically plastering and postponement of the internal fixation are recommended
Advantages of external fixator

- Minimal damage to the tissues
- Free woundcare
- Possibilities of reduction, compression or distraction
- The stability of retention can be controled, when it is necessary changed
Disadvantages of the external fixator

- Pin infection and loosening
- Often less stable than the internal fixation
- Uncomfortable
- It can press or hurt other part of the body
- Danger of vessel or nerve injury
- The movements of thicker muscles are hindered
- By „covering“ limits the analysis of X-ray control
- The classical constructions need anatomical preoperative reduction and exact positioning
Summary of external fixation

- External fixator is a relative stable device with broad indication
- It is the golden standard in grade III/B-C open fractures and septic cases
- It makes the fixation of comminuted and segmented fractures easier
- Suitable for additional fixation of adaptive OS in intraarticular fractures
- Classic device of bone lengthening
- Essential method in polytrauma cases
- It allows to perform the adequate internal fixation in appropriate time
Septic complications

- After sterile orthopedic surgery and closed fx 1-5%
- After open fx septic complications occur in 2.11-25.31%
- Treated acute osteomyelitis turns into chronic form in 15-31%
Biofilm with bacteria on the implant surface

- With metal implant $10^5$ bacteria cause infection
- Without metal implant $10^7$ bacteria

Exception: Titanium
Acut exacerbation was reported after 80 years of asymptomatic period
Dodt - 1962
Prevention

• Asepsis
• Atraumatic operative technique
• Careful use of Tourniquet
• The tissues are kept wet
• No stitches under tension
• Stable OS
• Antibiotic prophylaxis – max. 24 hours
Symptoms

- Fever, subfebrility 1-2 days after infection
- Hyperaemy, swelling, calor, pain
- In old, anergic patients instead of these symptoms general weakness, embarrassment, exsiccosis
- Laboratory: increased WBC, We, CRP
- Sonography: fluid can be detected
- X-ray: boneresorption after 2 weeks, periosteal reaction, sequester formation is seen usually after 6-8 weeks
X-ray with sequesters
Principles of treatment

- Debridement
- Immobilisation – stable OS
- Prevention of cavity formation, evacuation of haematoma
- Cover of the bone with well vascularized soft tissues for the good oxygenization and blood supply – axial flap transfer if it is necessary
- Drainage, vacuum sealing
- Effective systemic and topical antibiotic therapy
- Substitution of segment defect
The therapy basically surgical

Antibiotics by protocol
1. Empiric administration of broad spectrum
2. Changing following antibiogram

Septic defect non union
Conditions of effective antibiotic therapy

- The suspected pathogen has to be sensitive
- Administration in the right time
- As long as it necessary
- It has to be in high concentration in the infected area (dose, absorption, penetration, secretion)
Targeted, narrow spectrum antibiotic is required as soon as possible. (Direct smear helps the selection in the empirical antibiotic therapy)
Disadvantages of the systemic antibiotic therapy

• Penetration of the antibiotic to the ischemic infected zone?
• Side effects
Local antibiotic treatment

- Instillation or lavage-suction drainage
- Septopal chain
- Garamycin sponge
- Bone cement with antibiotics - basically gentamicin
Septopal chain
Treatment of infection if the OS stable

- The stabilization is kept
- Careful debridement
- Systemic and topical antibiotic treatment
- Open plate technique
- Lavage-suction drainage
Unstable OS

- **FIXATEUR EXTERNE** - with stable V-or parallel frame - **GOLD STANDARD**
- Plate OS - „over dimensioned” with 4-5 screws as minimum by segment
- Statically locked intramedullary nail - after careful reaming with lavage-sucktion drainage
Soft tissue cover

- Local myocutan or fasciocutan flaps
- Gastrocnaemius, soleus flap, sural flap, arteria dorsalis pedis flap
- Free flaps
  - Latissimus dorsi flap, etc
Latissimus flap

Separation of the latissimus dorsi flap.

The isolated arteries of the leg.

The flap after grafting.

The graft survived, the soft tissues were healing up.
Bone replacement

- Bone grafting

- Fibula pro tibia

- Crista ilei or fibular free flap

- Segment transport
Shortening of the limb

• On the upper extremity
• Older patients
Other complications of fracture treatment

• Fracture disease - caused by the immobilization
• Sudeck syndrome - sympathetic reflex dystrophy, algodystrophy
• Delayed union
• Non union
• Posttraumatic arthritis
„Fracture disease”

- Atrophy caused by inactivity
- Contractures
- Muscle atrophy
- The limb can be cold, wet
- X-ray: diffuse osteoporosis
Sudeck dystrophy

• Mostly in depressive people
• Mainly women between 40-60 years of age
• Inflammation leads to dystrophy, atrophy
Sudeck dystrophy

• Stage I (acute hyperaemia)
  Edematous swelling, tight, warm skin, hyperhydrosis, pain, contracture distally to the injury

• Treatment
  Keep extremity in rest, painkillers, subaquatic exercises, swimming, cooling, physiotherapy, anxiolytics, vasodilators, NSAID, psychotherapy
Sudeck dystrophy

- Stage II (dystrophy)

After months the inflammation and pain are decreasing, atrophy in the tissues, contractures, focal atrophy on the X-ray

• Treatment
  Mobilization, subaquatic and dry exercises
Sudeck dystrophy

- Stage III (atrophy)
  - Atrophy, contractures, definitive malfunction

- Treatment
  - Passive exercises, poor results
Delayed union

- Average time of consolidation + 50%
- Reason: poor vascularization or insufficient fixation
Non union - pseudoarticulation

- Closed broken ends without healing
- Definitive statement
- Reason: insufficient blood supply or fixation, infection
Forms of non union

- **Aseptic**
  - hypertrophic
    - „elephant leg”
  Treatment: fixation with stable OS
  Vital

- Hypo-, or atrophic
  - „horse leg”
Stabilization and bone grafting
  Avital

- **Septic**
  Defect nonunion
Adjuvant treatment

- Electromagnetic stimulation
- Ultrasound
  (low intensity, throbbing)
- ESW (Extracorporeal shock wave)
Thank you for the attention.