FRACTURE HEALING

GENERAL PRINCIPLES OF FRACTURE TREATMENT

CONSERVATIVE TREATMENT

INTERNAL FIXATION

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Function of the bone

• Primary mechanical – the skeleton holds the body weight, passive organ of movements

• Secondary biological – depot of microelements (Ca, P, etc), blood pool, blood cell producer
Bones

Long (tubular) bones

Flat bones
The structure of the bones

Cancellous bone

Cortical bone
Blood supply of the bones

- 4/5 intramedullar
- 1/5 periosteal
Bone healing

- The aim is basically to reconstruct the mechanical function.
Callus formation – secondary bone healing
Direct angiogenic - primary bone healing
The 3 Böhlerian rules

• Reduction
• Retention
• Rehabilitation
A portion of fractures can be treated satisfactorily and with easily manageable conservative methods:

- plaster casts, braces
- traction
- functional therapy.
Functional treatment

- No fixation is required
- For example:
  - Non displaced patellar fracture
  - Compression fractures of the dorsolumbal spine without neurological symptoms
    Beck index > 0.80
  - Fibular fractures in the proximal 2/3
  - Tile A pelvic fractures
  - etc
Plaster fixation

- "Lege artis"
- In diaphyseal fractures with fixation of the proximal and distal joints
- First time the plaster and soft bandage is cut to avoid strangulation
- Functional position
- Avoid pressure of nerves and vessels
- Control of circulation, DVT prophylaxis
Plastering

- Mathysen – Dutch army surgeon (1852–54)
- \( \text{CaSO}_4 \)
Plastering
„Plastic bandages“
Braces
Plaster and brace fixation

- Not only for conservative treatment
- It must be used for support after adaptive osteosynthesis
Continuous traction

Skeletal

Soft tissue
Pelvic and acetabular fx

- In the level of the bed
- In abduction
- 1/7 of the body weight
Proximal femoral (hip) Fx

- Braun splint
- Tuberositas tibiae extension
- 1/10 of body weight
- In the axis of the thigh bone
Calcaneal extension in crural fracture

Maximum: 3 kg!!!
Certain fractures can practically only be treated surgically
History

• Stimson references techniques of intramedullary fixation in which ivory pegs were jammed in the medullary canal in his 1883 textbook on fracture care.

• Hey-Groves probably inserted the first metallic intramedullary device in a gunshot fracture of the femur during World War I.

• Smith-Petersen applied a percutaneous medullary fixation technique to solve immobility problems associated with hip fractures in older patients.

• Küntscher's first report in 1939

• Pauwels' patellar tension bend wiring was published by Heineck in 1909
Early failures in the operative fracture treatment

- Anaesthesia
- Asepsis
- Lack of compression or controlled micromovements
Workgroup for development of internal fixation

- AO/ASIF (Arbeitsgemeinschaft für Osteosynthesefragen, Association for the Study of Internal Fixation): Müller-Allgöwer-Willenegger-Schneider /Switzerland/
- Gerhard Küntscher Kreis
- Other workgroups

Today's modern principles of osteosynthesis were worked up by the AO
Basic principles of the ASIF

- Fracture reduction and fixation to restore anatomical relationships
- Stability by fixation or splintage, as the personality of the fracture and the injury requires
- Preservation of the blood supply to soft tissues and bone by careful handling and gentle reduction techniques
- Early and safe mobilization of the part and the patient

• Anatomical reduction
• Stable fixation
• Saving blood supply
• Early functional treatment

Do not operate X-ray pictures!
The arguments supporting the use of surgical fracture treatment:

Demand for faster fracture healing
Demand for complete morphological and functional restitution
Avoidance of the development of fracture illness (algodystrophy)
Avoidance of the development of fracture illness and algodystrophy

- Following a long period of immobilization, there is a decrease in bone calcium
- The joint capsule and ligaments contract and the joint will be stiff
- Atrophy of muscles
the conservative treatment of a tibial fracture. Three weeks of traction in the hospital. Three weeks in a non-weight-bearing high cast. A further six weeks in a walking cast. Three to six months of physical therapy following cast removal for the complete recovery of function.

With operative treatment, for example intramedullary nailing, this treatment period can be reduced to six to eight weeks.
the two different types of fracture healing
A prerequisite for primary or angiogenic healing of fractures is absolutely stable immobilization.
Methods to achieve absolute stability:

- lag screws
- cancellous screws
- plates: DCP or Dynamic Compression Plate
- Compression with the tension device
- Tension band principle
Lag screw
Herbert screw
DC plate
(dynamic compression plate)
LC-DC plate (low contact DC plate)
Neutralization plate and compressor
Secondary healing, or healing of a fracture with callus also requires a certain stability, however, it must not be as rigid and for this reason is called relative stability.

Relative stability: The fracture is only minimally stabilized so that the necessary micro-movement remains. At this time fast secondary fracture healing occurs.
The fracture is not reduced to its anatomical position, and only the appropriate alignment adjustment is made

that the bone should be properly adjusted with regard to axis, rotation and length
Relative stability can be achieved:

Bridge plating
External fixation
Intramedullary fixation
In bridge plating, the fracture zone is bridged by the plate.
External fixation: The essence of this is that the fracture fragments are fixed and stabilized with an external longitudinal frame made of bars or tubes connected to wires or pins or Schanz screws.
Intramedullary nailing
The different methods:

Nailing with reaming

Nailing without reaming

Reaming: increases intramedullary pressure to 450–1510 hgmm!

By solid nail 1x!
By reamed 12 mm nail 9x!
Locking is considered static if the locking screws are inserted through the round hole both proximally and distally to the fracture. In this way the locking screws secure the longitudinal stability as well.

In dynamic locking, a locking screw is inserted into one of the oval holes. In this method compaction at the fracture site may occur, thus the immobilization is dynamic.

Advantages of locking
Preservation of the length of the bone
Stability in rotation
Lower diameter of the nail is enough
Wider indicatio
Indication of operative fracture treatment

• Relative
• Absolute

If a fracture can be treated by an operative procedure, it does not mean, that it has to be.
Indications of operative treatment

- Open fractures
- Impossible closed reduction
- Insufficient retention by conservative method
- Displaced joint fractures
- Salter-Harris III-IV type epiphyseal injuries
- Distraction fractures
- Non union, delayed union
- Replantation
- Multiple fractures
- Redisplacement
- Pathological fractures
- Shortening of immobilisation period
- Facilitate nursing
- Fractures complicated with nerve or vessel injuries
- Shortening of hospitalization
- Reaching earlier recovery
Contraindication of internal fixation

- III. grade open fracture - relative
- Acut bone or soft tissue infection
- High grade osteoporosis - relative
- Insufficient blood supply or unstable scar tissue
- Weak general condition of the patient
Disadvantages of internal fixation

- Risk of infection
- Evacuation of the fracture haematoma
- Arteficial damage of the blood supply
- Scar formation
- Risk of complications by the anaesthesia
- Transfusion complications
- Allergy, foreign body reaction
Time of the operation

- Acut - within 6 hours - e.g. femoral neck fracture
- Delayed operation - e.g. calcaneal fracture
- Late, recontstructive operation - e.g. radial osteotomy
Classification\(^1\) of internal fixations

- **MIPO**
  Minimal invasive percutaneous osteosynthesis

- **ORIF**
  Open reduction with internal fixation
Classification² of internal fixations

- Intramedullary fixation
  Intramedullary nailing, gamma-nailing etc.

- Extramedullary fixation
  Plate osteosynthesis, screwing, cerclage, etc.
Classification³ of internal fixations

- Rigid (stable) osteosynthesis: Plates, compression screws
- Dynamic (relative stable) internal fixation: Intramedullary nail
Stability of internal fixation

- Adaptational osteosynthesis - it needs support by external fixation
- Movement stable osteosynthesis
- Weight bearing stable osteosynthesis
Adaptational OS

- Kirschner wiring
Percutaneous K-wire fixation
Intramedullary splinting
Movement stable synthesis with tension bend wire
Tension bend wire effect
Movement stable OS with screw fixation
Mini screw fixation of the osteochondral fracture of the patella
Weight bearing stable osteosynthesis
been a new trend as plates have been developed with threaded screw heads which lock within the body of the plate. Can be used on osteoporotic, poor quality bone.

Principle of internal fixator
Thank you for the attention!