Treatment of osteomyelitis and the reconstruction of bone defects

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Osteomyelitis

Trauma hospital with 745 beds

Largest speciality department in Germany for treatment of infections of bone, soft tissue, joints and joint-replacements.

Department of Septic Trauma and Orthopedic Surgery
- 102 beds (average number of daily in-house-patients)
- 1900 operations / y
- 5300 outpatients / y

Our patients: typically 5 operations before admittance
Diseases we treat

- acute and chronic bone infections (osteomyelits) and resulting problems
- acute und chronic joint infections and resulting problems
- infections of total joint replacements and resulting problems
- acute and chronic bone and joint infections due to diabetic foot syndrom
- children with osteomyelitis
- soft tissue infections
- chronic wounds
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Resulting problems we treat:

- bone defects
- difference in extremity length (such as shortening of a leg)
- malposition of an extremity
- contracture of joints
- accompanying soft tissue defects

Also: prescription and/or checking of orthopedic devices (shoes, braces, prosthesis)
Particular patient patronage, special disease (due to trauma or complications after treatment).

If not treated correctly, the relapse rate will be high, the duration of the treatment much longer with higher costs and bad outcome!!

The problem of an infection of the bone is commonly underestimated.

94% of our patients underwent unsuccessful treatment elsewhere before admitted to our hospital with an average of 5 ineffective operations.
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Combined: bone infection + instability + (very common) bone defect

And quite often:

- soft tissue defects
- nerval and/or blood circulation lesions
- problems caused by long lasting inactivity and lack of movement
- reduced confidence
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The infection is caused by:
- number and virulence of the germs
- extent of the damage of the host
- co-morbidities of the patient
- iatrogenic factors

The development of an infection is multifactorial

Implants – keyword biofilm

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Staphylococcus epidermidis
Foto: Janice Carr/ CDC/ Segrid McAllister
Biofilm - implantats and bacteria
- the reproduction rate is clearly reduced
- covered by the biofilm the bacteria are less sensitive against antibiotics (factor 1000)
- covered by the biofilm the bacteria are safe against the body´s defenses
- the biofilm offers protection for chemical and mechanical impact
- higher resistance
- exchange of genetic informations

Chronic infections (implantat associated infections) are caused by bacterial biofilms !!

Osteomyelitis

“Race for the Surface” – “Wetlauf um die Oberfläche”

- Bakterien gegen körpereigene Zellen (Immunabwehr, Fibroblasten, Osteoblasten
- Ziel: Implantatoberfläche
- Gewinnen die körpereigenen Zellen: Integration des Materials
- Gewinnen die Bakterien:

Literatur:
Infection rate post-trauma/ post-operative

following planed surgery: 0,1 – 1,7%
following operative therapy of fractures: 1 – 5 %
following operative therapy of open fractures: - 50%

Factors caused by the trauma:

- contamination of the wound/tissue
- squeezed soft tissue
- loss of tissue
- disturbance of the local perfusion
- colonization with germs
The patient’s risk factors:
- age > 65 years
- obesity, malnutrition
- nicotine / alcohol dependency
- chronic diseases (cardio-vascular, allergies, circulatory disorder)
- Diabetes mellitus
- low immunity, immun-suppressive therapy
- rheumatic diseases
- accompanying infections (bladder, pneumonia..)
- damages caused by radiation
- catheter, artificial ventilation, hospitalization
The surgeon as a risk factor:

- compromised local perfusion (surgical approach, retractor, rude operation technique)
- the implant
- intra-operative complications
- wrong indication
- point of time of the surgical intervention
Primary goal of the therapy:

- long lasting stop of the infection
- closure of soft tissue defects
- reconstruction of bone defects
- stability of the extremity
- an extremity allowing full weight-bearing
- pain reduction
- professional reintegration
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Our therapy/our algorithm: at least 2-stage-surgery

1rst operative step: treatment of the infection
2nd operative step: treatment of the soft tissue defects
3rd operative step: treatment of the bone defects
4th step: social and professional reintegration

Physiotherapy all the time!
Osteomyelitis

1st operative step:

- removal of every foreign body
- radical sequestrectomy
- implantation of local antibiotic carriers
- stabilization (external fixator)
- short term antibiotic therapy

Important for the successful therapy: radical sequestrectomy!
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No fear about the resulting defects !!
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2nd operative step:
Treatment of soft tissue defects
   - as early as possible
   - as stable as possible
- Co-operation with plastic surgeons in case of large defects
- Split skin, dermato-distraction, free flap
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3rd operative step: Treatment of bone defects

- circular bone defect < 3,0cm:
  transplantation of cancellous bone

- circular bone defect > 3,0cm:
  segmental transport

- Masquelet technique
Surgeons Stretch Crippled Legs

MEN AND WOMEN, who once limped painfully through life because infantile paralysis or other disease had left them with a shrivelled leg, now walk and work and play with all the ease and grace of normal, healthy human beings. A miracle of modern surgery has achieved for them the amazing feat of actually restoring the length of the deformed leg.

Photo above shows the manner in which bones are cut. Supporting wires driven through the bones are also visible. Worm gears move the carriage which exerts a gentle pull on the bones. Left, a deformed leg that can be given normal length by stretching heal for five or six days before the stretching process is begun. Then by means of a screw action in the base of the instrument, the severed bones are gradually drawn apart. A sixteenth of an inch is the most the bones can be moved in any one day without impairing the success of the operation. This gradual separation can be made in most cases, without causing...
MEN AND WOMEN, who once limped painfully through life because infantile paralysis or other disease had left them with a shrivelled leg, now walk and work and play with all the ease and grace of normal, healthy human beings. A miracle of modern surgery has achieved for them the amazing feat of actually restoring the length of the deformed leg.

These astonishing cures are effected by a remarkable operating technique perfected by a famous New York orthopedic surgeon. Work on the method was pioneered by Professor Putti of Italy and it was later improved by a St. Louis physician but there was no dependable and accurate way of stretching the leg. The New York surgeon’s development of an ingenious instrument provided the means of controlling the stretching process. The new operation is one of the most delicate and exacting ever attempted. So far the latest technique is only used at the Hospital for Joint Diseases in New York City. In addition to the manual dexterity of the surgeon, the assistance of nature is required to make the operation a success. The surgeon cannot stretch a bone; he can only cut it. The new bone tissue which gives the leg its added length is produced by nature.

To sever the bones, an incision several inches long is made in the leg, starting about three inches above the ankle in the case of a lower leg operation. The patient is, of course, under complete anesthesia during these steps.

Next, the fibula is cut obliquely. Then four short pieces of stiff piano wire are driven horizontally through the tibia. Two of these wires pierce the bone near the knee, one pierces the ankle section, and the fourth the heel bone of the foot. A long step cut is then sawed in the tibia. The step is made longer than the length that is to be added to the leg, so that when the leg is later stretched the two sections of the bone will never entirely lose contact.

With the patient still under anesthesia, the leg is placed in the stretching instrument. This has three upright arms on each side. The wires protruding horizontally from the leg are made fast to the arms.

The incision is closed and the patient put to bed. The wound is permitted to heal for five or six days before the stretching process is begun. Then by means of a screw action, in the base of the instrument, the severed bones are gradually drawn apart. A sixteenth of an inch is the most the bones can be moved in any one day without impairing the success of the operation. This gradual separation can be made in most cases, without causing the patient any pain.

At this point, nature assumes the leading role in the drama. The mysterious power of bone structure to reproduce itself enables the severed bones to close up the space between the ends as they are drawn apart. At the maximum stretching rate, about two inches of new bone will be produced in a month.

When the bone has reached the desired length, the apparatus is removed and the leg placed in plaster cast until X-ray examination shows that the new bone tissue is able to support the patient’s weight. At this time the wires are withdrawn from the bones. This is a simple procedure and is done without anesthetic. The cast is only worn for a while longer, but the whole operation from the time the incision is made until the cast is finally removed consumes only six weeks. So far, the operation has been performed only to overcome the effects of disease or deformity, but there is nothing in the procedure that would prevent its being used on a normal person who wished to increase his height and who was willing to undergo the necessary, long drawn-out operation on his bones.
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Harvesting cancellous bone graft:

- posterior iliac crest
- anterior iliac crest
- tibial head
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Cancellous bone graft:

Typically, we add biomaterials to the cancellous bone graft in order to obtain a local antibiotic carrier and/or osteoconductive materials:

- Gentacoll®, Sulmycin®, .....
- platelet rich plasma
- mesenchymal stemcelll concentrat
- Herafill Beads G®
- PerOssal®
- Cerament G®/V®
- BonAlive®
......
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Advantage: the resulting bone is similar to the original bone with the same stability (hollow bone)
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Masquelet-technique

Complete fullfilling of the defect with acrylic cement (mixed with antibiotics, overlapping the bone-ends, intramedullar, soft-tissue-management)

Induced membrane:

- contains cells, which produce growth-faktors like bone morphogenic protein (BMP-2) and transforming growth factor β-1 (TGF β-1) (Dumont et al 2008)
- revascularises bone graft and minimizes the resorbtion of bone graft

(Giannoudis et al 2011)
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F.C., male 44 years

multiple trauma including craniocerebral injury, chest trauma, abdominal injury, open fracture of the left femur and tibia, resulting dysphagia and aphasia

Development of an osteomyelitis of the femur and of the tibia left

Development of a chronic knee empyema left
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Debridement of both bones and the knee joint, stabilization with external fixator

femoral bone defect: 15,0 cm

multi-resistant Staph. epidermis, Serratia marscensens 3 MRGN

Reconstruction of the defect using Masquelet technique
Osteomyelitis
Osteomyelitis

After 6 and 12 weeks cancellous bone graft from the posterior iliac crest, combined with PerOssal® and Vancomycin
Osteomyelitis

6 weeks later partial removal of the external fixator.

Then internal stabilization with a custom made angular stabil plate (Litos®) and cancellous bone graft (left tibial head) combined with BonAlive®
Conclusion:

- The surgical treatment is decisive
- A radical removal of all infected bone and soft tissue has to be performed
- Systemic and local antibiotic therapy supports the radical removal of bone and soft tissue and is no substitute for incorrect surgical intervention
- The resulting defect is temporarily filled with antibiotic chains (Septopal®) or bone cement
- Stabilization is necessary (external fixator)
Conclusion:

- No need to be afraid of the resulting defects! There are almost always possibilities to reconstruct the bone.
- In most cases the patients body offers the solution, biomaterials can be helpful in reconstruction of the bone, especially in difficult cases.
- The soft tissue defect and bone defect can to be treated in the majority of the cases.
- The bone reconstruction is a demanding therapy and should be performed in specialized hospitals with experience in septic and reconstructive surgery.
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Deckung HWT-Defekt durch Latissimus-Lappen, Einlage Zementspacer, dann Segmenttransport.
Thank you for your attention!