Treatment of osteomyelitis and the reconstruction of bone defects

Gerlach U-J
Department of Septic Trauma and Orthopedic Surgery
BG-Unfallkrankenhaus Hamburg
Ärztlicher Direktor: Prof. Dr. C. Jürgens

BG Klinikum Hamburg

Osteomyelitis

Trauma hospital with 745 beds

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

Departement 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

Osteomyelits

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

Osteomyelitis

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, prothesis)

Osteomyelitis

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.

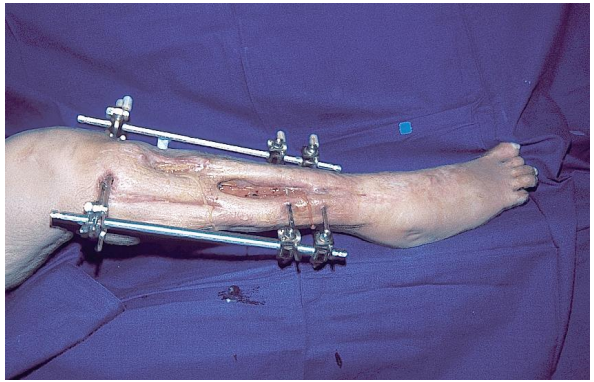
94% of our patients underwent unsuccessful treatment elsewhere before admitted to our hospital with an average of 5 ineffective operations

Osteomyelitis

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



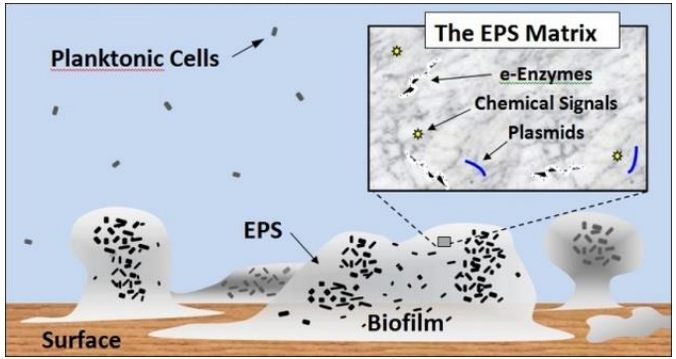
Osteomyelitis

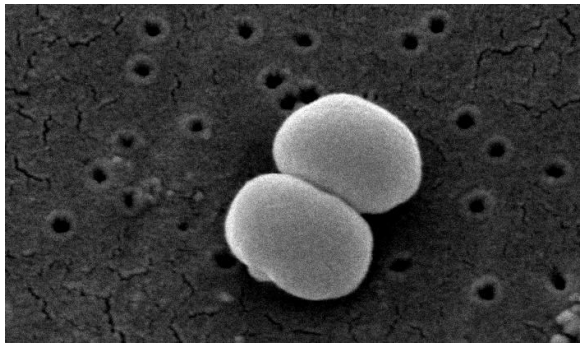
The infection is caused by:

- number and virulence of the germs
- extent of the damage of the host
- co-morbidities of the patient
- iatrogenic factors

The developement of an infection is multifactorial

Implants – keyword biofilm





Staphylococcus epidermidis
Foto: Janice Carr/ CDC/ Segrid McAllister

Osteomyelitis

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

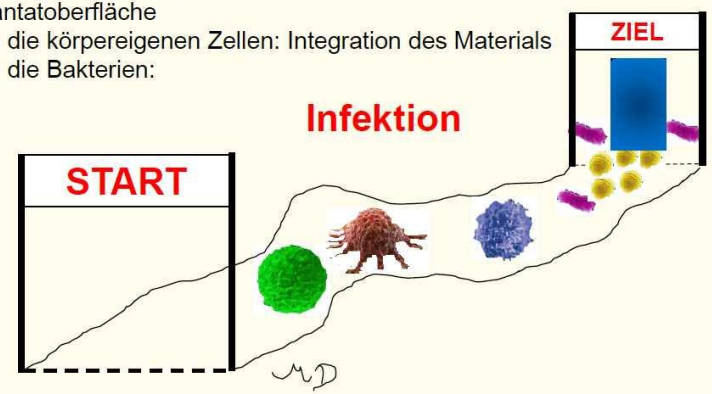
Chronic infections (implantat associated infections) are caues by bacterial biofilms !!

(Gristina u. Costerton 1985, Marie u. Costerton 1985, Anwar et al 1992, Costerton et al 1999, Gottenbus et al 2002, Parsek u. Pingh 2003, Hall-Stoodley et al 2004, Zimmerli et al 2004, Lynch u. Robertson 2008; Costerton 2010)

Osteomyelitis

"Race for the Surface" – "Wettlauf um die Oberfläche"
(Gristina A G, 1987, Science 237: 1588 - 1595)

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



Literatur:
1. Stemberger A, H Grimm, F Bader, HD Rahn, R Ascherl. „Local Treatment of Bone and Soft Tissue Infections with the Collagen-gentamicin Sponge." Eur J Surg Suppl 578 (1997): 17-26.
2. Harris LG, RG Richards. „Staphylococci and implant surfaces: a review." Injury 37 (2006): 95-104.
3. Vaudaux P, DP Lew. „Tolerance of staphylococci to bactericidal antibiotics." Injury 37 (2006): 15-19.
4. Gristina AG, PT Naylor, QN Myrvik. „Musculoskeletal Infection, Microbial Adhesion, and Antibiotic Resistance." Infect Dis Clin North Am 4 (3) (1990): 391-408.5. Darouiche RO. „Treatment of infections associated with surgical implants." N Engl J Med 350 (14) (2004):1422-1429.
6. Diefenbeck M, T Muckley, GO Hofmann. „Prophylaxis and treatment of implant-related infections by local application of antibiotics." Injury 37 (2006): 95-104.
7. Lucke M, G Schmidmaier, S Sadoni, B Wildemann, R Schiller, NP Haas, M Raschke. „Gentamicin coating of metallic implants reduces implant-related osteomyelitis in rats." Bone 32 (2006): 521-531.
8. Schmidmaier G, M Lucke, B Wildemann, NP Haas, M Raschke. „Prophylaxsis and treatment of implantrelated infections by antibiotic-coated implants: a review." Injury, Int. Care Injured 37 (2006): 5105-5112.3/3
9. Luckea M, TB Wildemanna, S Sadonia, C Surkea, R Schillerb, A Stemberger, M Raschke, NP Haas, G Schmidmaier. „Systemic versus local application of gentamicin in prophylaxis of implant-related osteomyelitis in a rat model." Bone 36 (2005): 770- 778.
10. Fuchs T, R Stange, G Schmidmaier, MJ Raschke. „The use of gentamicin-coated nails in the tibia:preliminary results of a prospective study." Arch Orthop Trauma Surg (2011) doi: 10.1007/s00402-011-1321-6.
11. Raschke M, T Vordemvenne, T Fuchs. „Limb salvage or amputation? The use of a gentamicin coated nail in a severe, grade IIIc tibia fracture." Eur J Trauma Emerg Surg (2009)

Osteomyelitis

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

Osteomyelitis

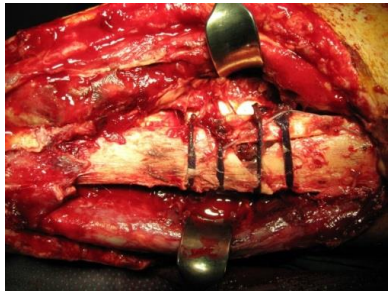
The patient´s risk factors:

- 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

Osteomyelitis

The surgeon as a risk factor:

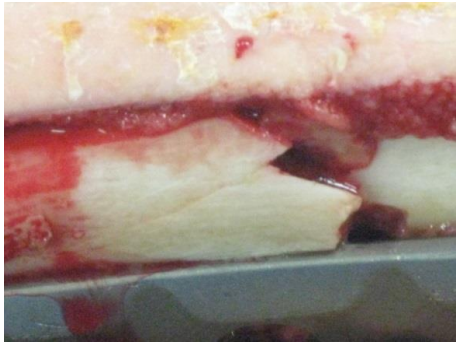
- compromised local perfusion (surgical approach, retractor, rude operation technique)
- the implant
- intra-operative complications
- wrong indication
- point of time of the surgical intervention



Osteomyelitis

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



Osteomyelitis

Our therapy/our algorithm: al 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!




BG Klinikum Hamburg

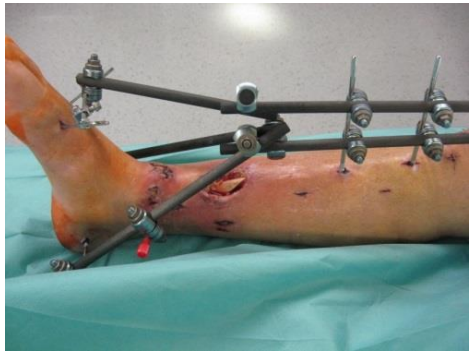
Osteomyelitis

1st operative step:

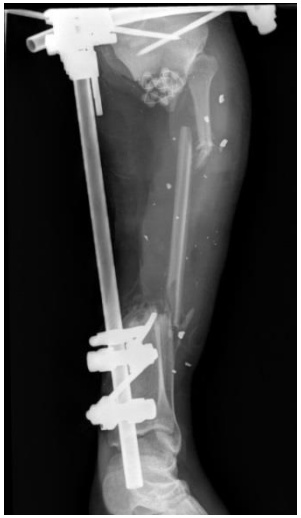
- removal of every foreign body
- radical sequestrectomy
- implantation of local antibiotic carriers
- stabilization (external fixator)
- short term antibiotic therapy

Important for the successful therapy: radical sequestrectomy !

Osteomyelitis



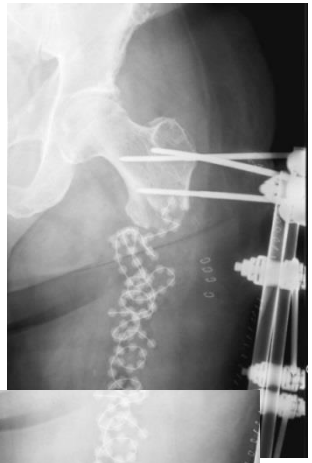
Osteomyelitis



☠

No fear about the resulting defects !!

☠



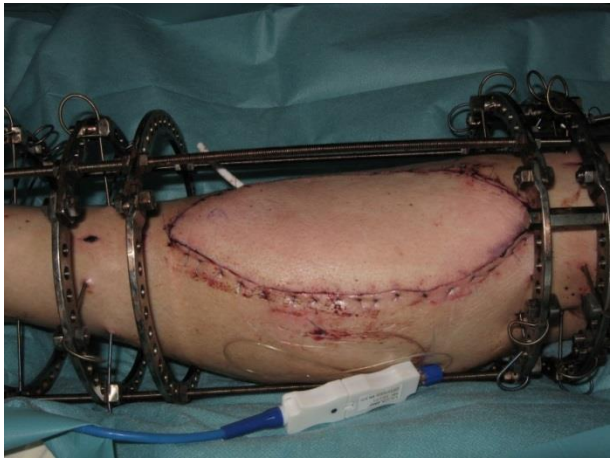
Osteomyelitis

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



Osteomyelitis

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

Osteomyelitis

SUBSCRIBE

g+1 0

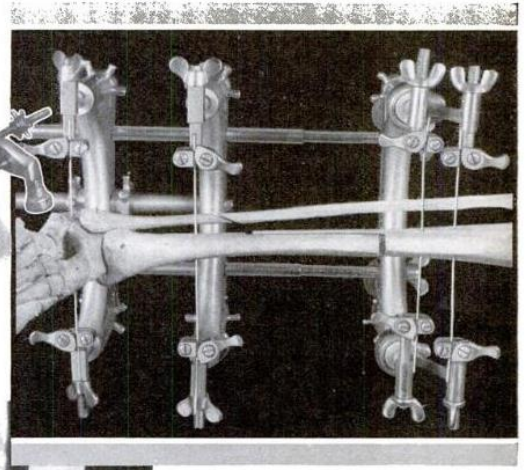
0 Reviews
Write review

Popular Science Sep 1934

Surgeons Stretch Crippled Legs

Amazing new operation severs bones and then lengthens them gradually until a short limb attains normal proportions so limp vanishes

During the bone-stretching process, the patient's leg lies in this machine. The foot is against the plate at extreme right and back of knee in the receptacle at the left



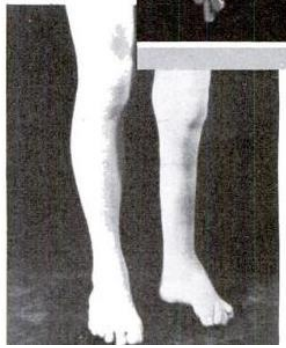


Photo above shows the manner in which bones are cut. Supporting wires driven through the bones are also visible. Worm gears move the carriage which exerts a gentle pull on the bones. Left, a deformed leg that can be given normal length by stretching

MEN AND WOMEN, who once limped painfully through life because infantile paralysis or other disease had left them with a shrunken 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.

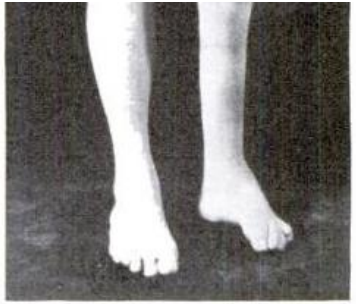
heal for five or six days before the stretching process is begun. Then by means of a screw action in the base of the instrument, the severed bones are gradually drawn apart. A sixteenth of an inch is the most the bones can be moved in any one day without impairing the success of the operation. This gradual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

Popular Science Sep 1934

MEN AND WOMEN, who once limped painfully through life because infantile paralysis or other disease had left them with a shrunken 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 as known the latest technique is used only 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.

Dividing the bones in the leg demands the utmost care and skill. The bones usually severed are the fibula and the tibia of the lower leg. Sometimes the femur of the thigh is severed but this is done only when maximum lengthening is desired.



leg that can be given normal length by stretching

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.

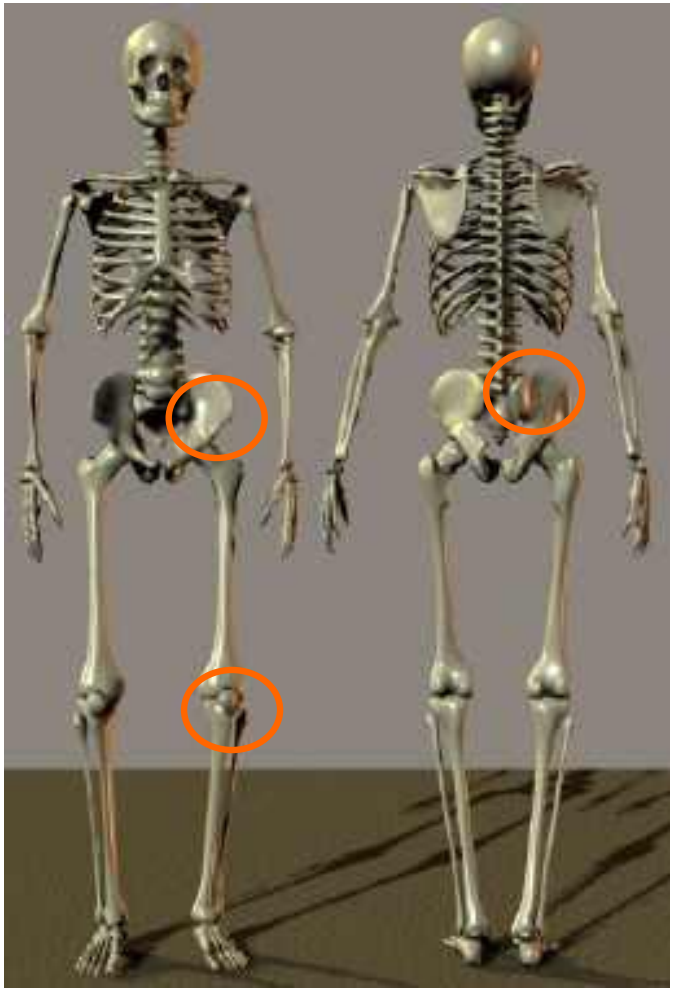
At this point, nature assumes the leading role in the drama. The mysterious power of bone structure to reproduce itself enables the severed bones to close up the space between the ends as they are drawn apart. At the maximum stretching rate, about two inches of new bone will be produced in a month.

When the bone has reached the desired length, the apparatus is removed and the leg placed in a plaster cast until X-ray examinations show 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 an anesthetic. The cast is 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.

Osteomyelitis

Harvesting cancellous bone graft:

- posterior iliac crest
- anterior iliac crest
- tibial head



Osteomyelitis

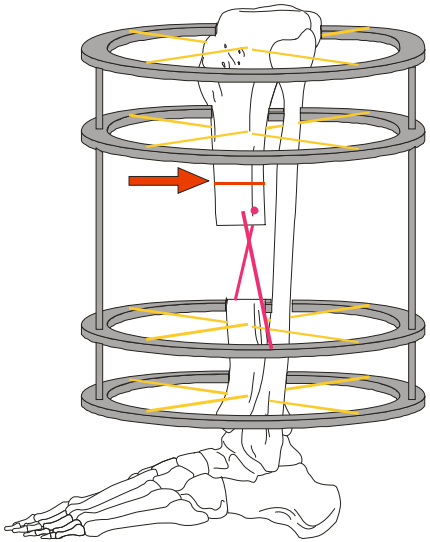
Cancellous bone graft:

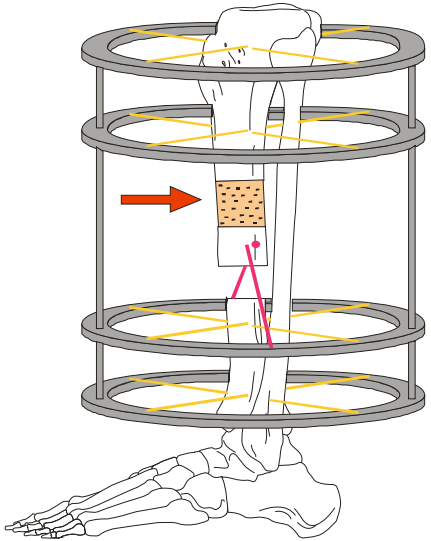
Typically, we add biomaterials to the cancallous bone graft in order to obtain a local antibiotic carrier and/or osteoconductive materials:

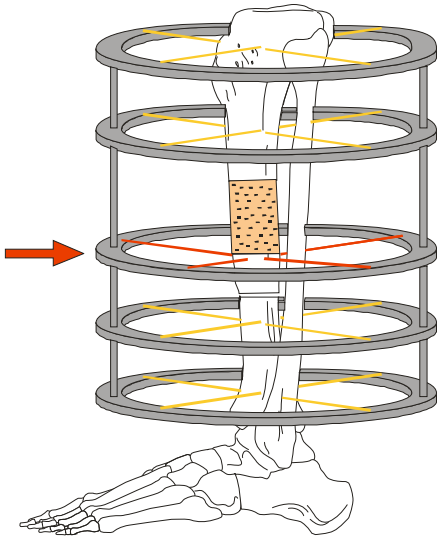
- Gentacoll®, Sulmycin®, …..
- platelet rich plasma
- mesenchymal stemcelll concentrat
- Herafill Beads G®
- PerOssal®
- Cerament G®/V®
- BonAlive®

……

Osteomyelitis



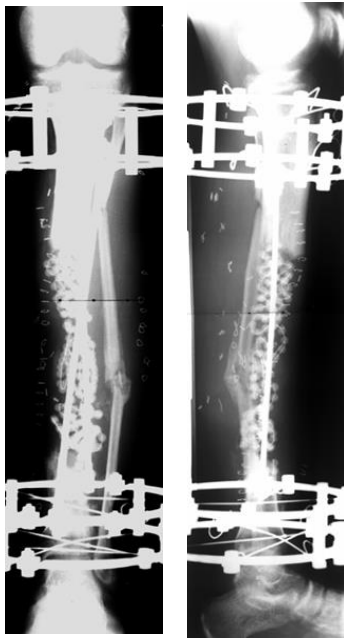




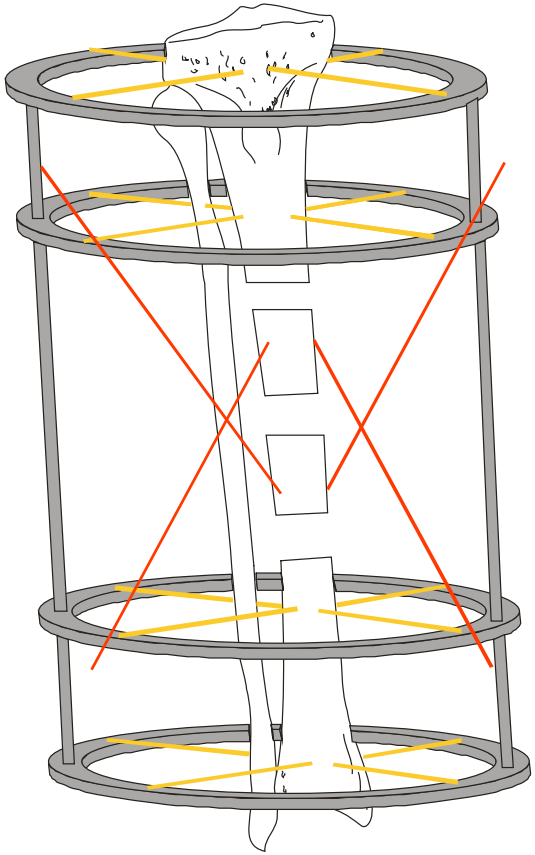
Osteomyelitis

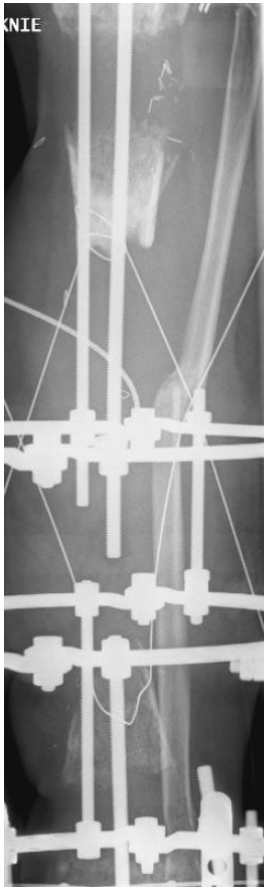
Advantage: the resulting bone is similar to the original bone with the same stability (hollow bone)

Osteomyelitis

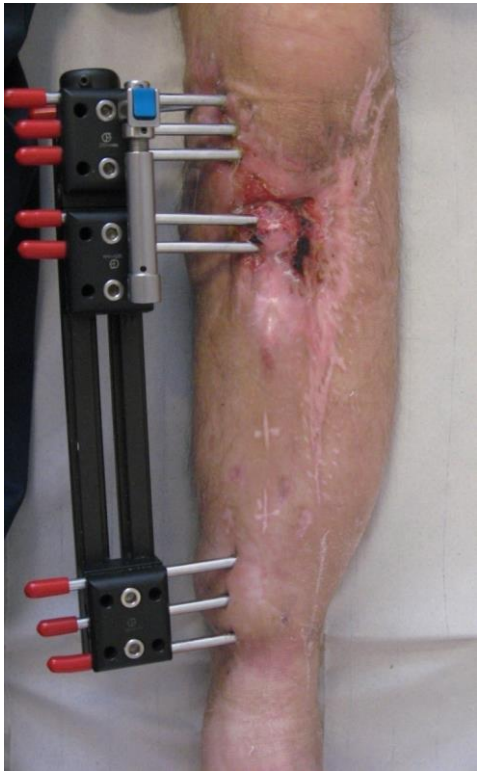


Osteomyelitis

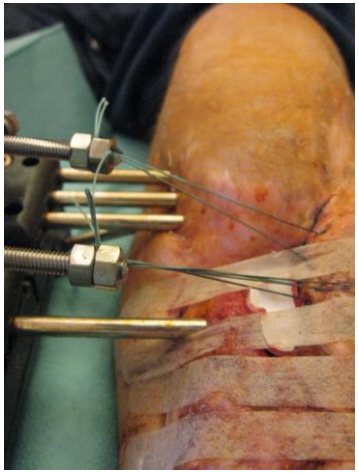


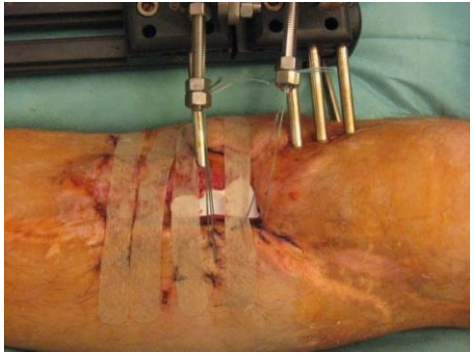


Osteomyelitis



Osteomyelitis

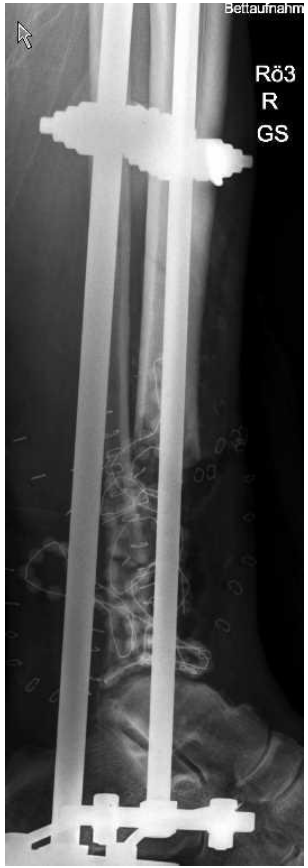


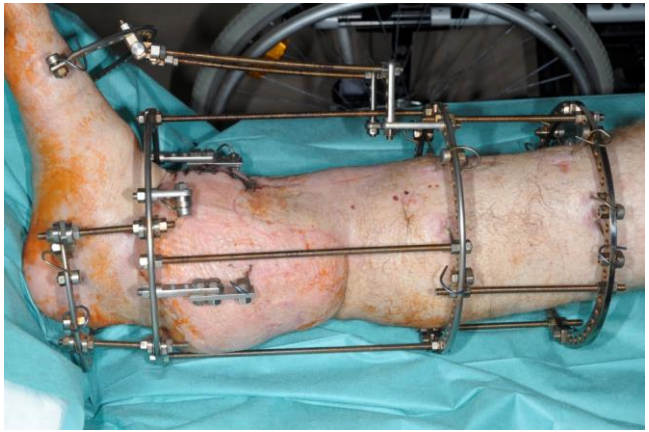


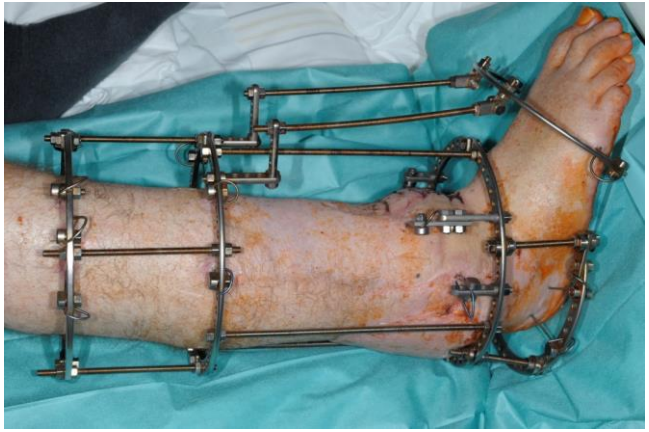
Osteomyelitis

Osteomyelitis

Osteomyelitis



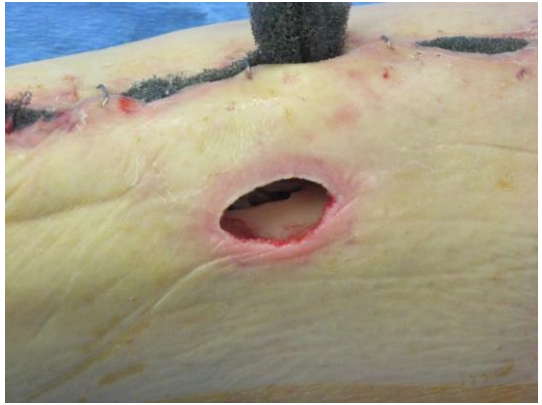




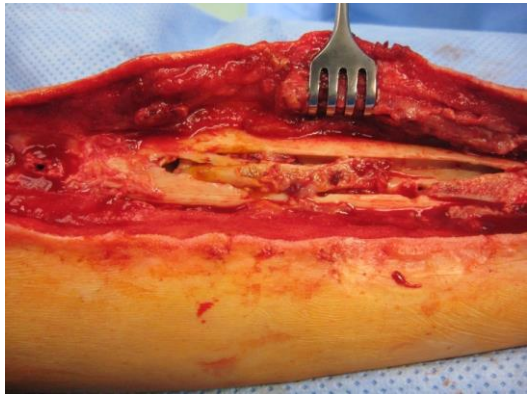
Osteomyelitis

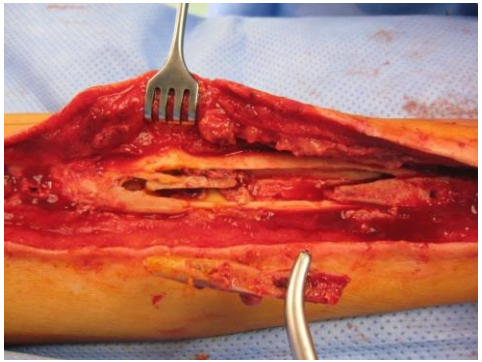


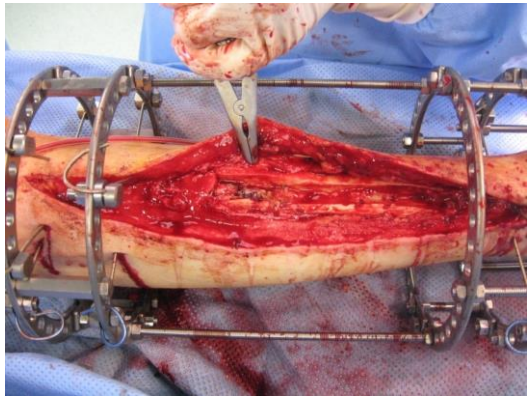

Osteomyelitis

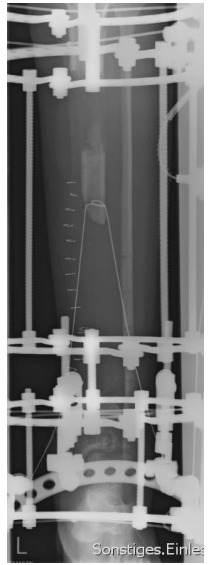


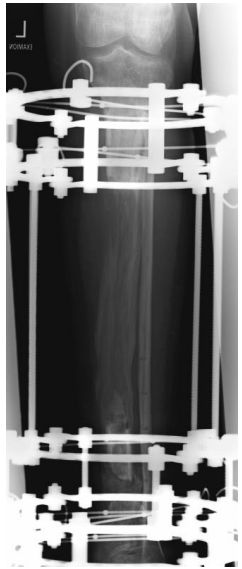
Osteomyelitis











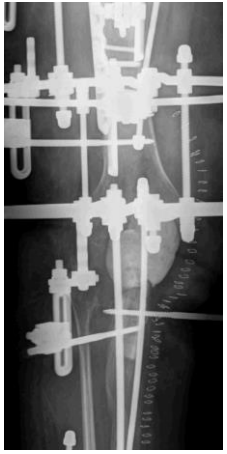
Osteomyelitis

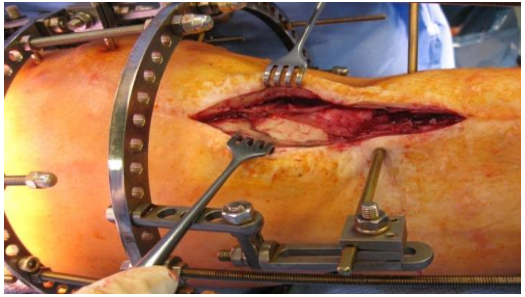
Masquelet-technique

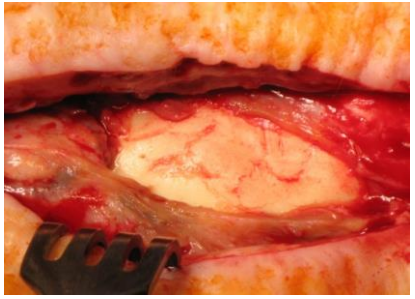
Complete fullfilling of the defect with acrylic cement (mixed with antibiotics, overlapping the bone-ends, intramedullar, soft-tissue-management)

Induced membrane:

- contains cells, which produce growth-faktors like bone morphogenic protein (BMP-2) and transforming growth factor ß-1 (TGF ß-1) (Dumont et al 2008)
- revascularises bone graft and minimizes the resorbtion of bone graft (Giannoudis et al 2011)







Osteomyelitis

F.C., male 44 years

multiple trauma including craniocerebal 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 tiba left

Development of a chronic knee empyema left






BG Klinikum Hamburg

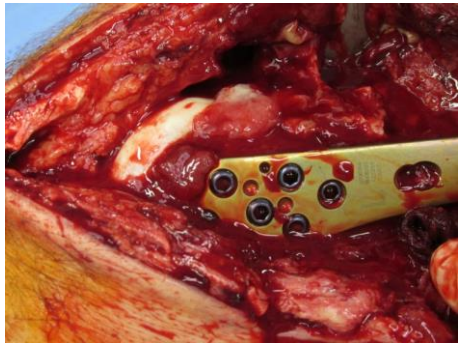
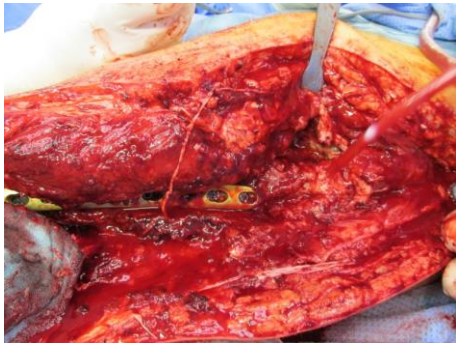
Osteomyelitis

Debridement of both bones and the knee joint, stabilization with external fixator

femoral bone defect: 15,0 cm

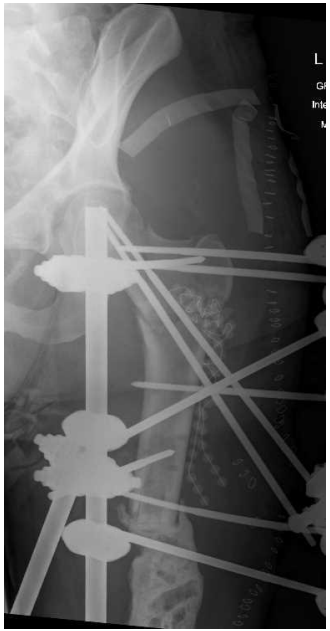
multi-resistent Staph. epidermis, Serratia marscensens 3 MRGN

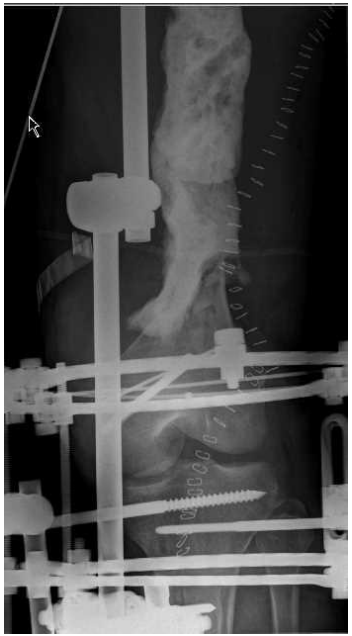
Reconstruction of the defect using Masquelet technique

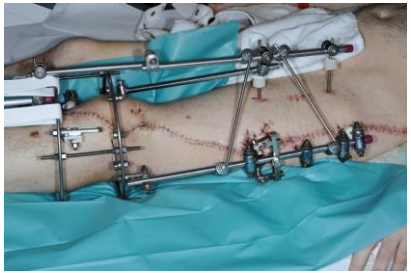





BG Klinikum Hamburg

Osteomyelitis







Osteomyelitis

After 6 and 12 weeks cancellous bone graft from the 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®

Osteomyelitis

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 temporarely filled with antibiotic chains (Septopal®) or bone cement
- Stabilization is necessary (external fixator)

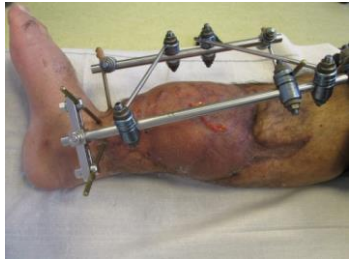
Osteomyelitis

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

Osteomyelitis

Deckung HWT-Defekt durch Latissimus-Lappen, Einlage Zementspacer, dann Segmenttransport.




Thank you for your attention !
AIDA
AIDAmar
www.aida.de