The Use of Antibiotic Carriers in Chronic Infection

R. Schnettler

Dep. of Trauma Surgery, University Hospital Gießen-Marburg
(Head: Univ.-Prof. Dr. Dr. R. Schnettler)
acute and chronic osteomyelitis

are mostly caused by open fractures combined with an insufficient primary treatment
Acute osteomyelitis occurs in two clinical situations:

- following trauma
- following surgery
Osteomyelitis literally means inflammation of bone and marrow elements.
the diagnosis of chronic osteomyelitis is based on the presence of chronic drainage from fistulas or ulcers
Fistula
Infected plate osteosynthesis
Infected plate osteosynthesis
Open Fracture

Osteitis
Historic Treatment

1962
Historic Treatment

1962
Treatment of post-traumatic osteitis

- Radical sequestrotomy
- Stable re-osteosynthesis
- Local antibiotics temporarily
- Secondary defect reconstruction with autogenous/allogenous cancellous bone
- Soft tissue reconstruction
Infected non-unions

Combination of two local problems

- Instability
- Chronic infection
Pathogenic agents causing chronic osteomyelitis

- Staphylococcus aureus: 54.5%
- Staphylococcus coag. neg.: 3.6%
- Enterobacteriaceae: 22.3%
- Pseudomonas aeruginosa: 7.6%
- Others: 4.0%
- Streptococcus sp.: 8.0%

Schnettler 1996
Treatment of post-traumatic osteitis

Radical sequestrotomy
Treatment of post-traumatic osteitis

Stable reosteosynthesis
Treatment of post-traumatic osteitis

Local antibiotics temporarily
WHY local antibiosis?
Infection experiment in dogs

Klemm et. al. 1973
Infection experiment in dogs

Klemm et. al. 1973
Infection experiment in dogs

3 phase szintigraphy

Klemm et. al. 1973
Infection experiment in dogs
3 phase szintigraphy
Klemm et. al. 1973
Why Gentamicin?

- Broad therapeutic spectrum
- High bactericidal efficacy
- Concentration dependent therapeutic efficacy
- High chemical stability
- Limited toxic effects in the tissue
Conventional application of the active agent

- active agent
  - systemic application
  - target tissue
  - liquid comp. of the body
  - organs
  - secretion

Schnettler et. al. 1998
Local application of the active agent

- Carrier with active agent
- Implantation
- Target tissue
- Liquid comp. of the body
- Tissue organs
- Secretion

Schnettler et. al. 1998
Staph. aureus

Schnettler et al. 1998
local antibiosis with Septopal®

Schnettler et al. 1998

6 h
local antibiosis with Septopal®

12 h

Schnettler et. al. 1998
No Systemic Effects
Comparison of different concentrations of Gentamicin after systemic and local application

<table>
<thead>
<tr>
<th></th>
<th>Gentamicin 1 x 80 mg i.m.</th>
<th>Septopal</th>
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<tbody>
<tr>
<td><strong>μg / ml</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>serum</td>
<td>3 - 5</td>
<td>0,5</td>
</tr>
<tr>
<td>urine</td>
<td>80 - 200</td>
<td>7</td>
</tr>
<tr>
<td>wound secretion</td>
<td>0,4</td>
<td>80</td>
</tr>
<tr>
<td><strong>μg / g</strong></td>
<td></td>
<td></td>
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<tr>
<td>connective tissue</td>
<td>0,6 (&lt; 0,25 - 1,9)</td>
<td>23 ( 9 - 34 )</td>
</tr>
<tr>
<td>cancellous bone</td>
<td>&lt; 0,25 (0 - 0,6)</td>
<td>4 (0,5 - 36 )</td>
</tr>
<tr>
<td>cortical bone</td>
<td></td>
<td>2 (0 - 3,6)</td>
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</tbody>
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Nies et. al. 1991
Concentration of Gentamicin within wound secretion after implantation of Septopal

Nies et. al. 1991
Different methods of treatment of bone defects are available to trauma surgeons.
Autogenous transplantation

autogenous bone chips

tricortical autogenous bone bloc
Allogeneic bone grafts (deep frozen bone)
Infected Non-Unions of Bone Fragments
Long Pipe Bones (n=170)

- 108 open fractures
- 62 closed fractures

Schnettler, Klemm 1996
Infected Non-Unions of Bone Fragments
Long Pipe Bones (n=170)

- Tibia 64.1%
- Radius 2.4%
- Humerus 4.7%
- Femur 28.8%

Schnittler, Klemm 1996
Infected Non-Unions of Bone Fragments
Long Pipe Bones (n=170)

- Primary care
- Osteos. with a plate 135 79.4%
- Fixateur externe 9 5.3%
- Intramed. nail 26 15.3%

Schnettler, Klemm 1996
Infected Non-Unions of Bone Fragments
Long Pipe Bones (n=170)

Results

- 75.3% healed non-union inactive osteomyelitis
- 9.4% persistent non-union inactive osteomyelitis
- 8.2% persistent non-union persistent osteomyelitis
- 7.1% healed non-union persistent osteomyelitis

Schnettler, Klemm 1996
the old way of treatment
the old way of treatment
1978 - 1982

the old way of treatment
Today

Bone shifting

www.uniklinikum-giessen.de/ucg
1998 - 1999

22 cm
new formed bone
Use of Ilizarov technique

bifocal transport
bone-shifting

the new way of treatment
Treatment of post-traumatic osteitis

Soft tissue reconstruction
local antibiotic prophylaxis in open fractures
Septopal Mini-Chain
Primary shortening
Secondary distraction

Use of Septopal in open fractures
33,3 cm

46,3 cm
Debridement of Soft Tissue and Bone
Primary shortening
Local Antibiosis

www.uniklinikum-giessen.de/ucg

Local Antibiosis

WWW.AADO.org
3° open Defect Fracture
Local Antibiosis with Septopal®
Local Antibiosis with Septopal®
Monorail-Procedure
Monorail-Procedure
Use of Septocoll in open fractures
Sural artery flap to cover soft-tissue defects
Sural nerve with its accompanying arteries
En bloc dissection
Challenge!

Multi-resistant strains
Local antibiotics adopted to antibiogram

Vancomycin chains
Conclusion
Only radical tumor-like resection of the infected bone and soft-tissue...
...is leading to success
Outlook

- Nano-HA (Ostim®) + collagen type 1
  improvement of calcification
- Nano-HA (Ostim®) + collagen type 1
  + phosphoserin S
  OPC attractive scaffold
- Nano-HA (Ostim®) + osteoinductive factors
  combination of osteoconduction and osteoinduction
Spondylodiscitis Th12/L1

Courtesy Dr. Rauschmann
thoracotomy, diaphragmal splitting, debridement
Perossal®-Pellets

Courtesy Dr. Rauschmann
dorso-ventral spondylodesis, corporectomy

postop 6 months

Courtesy Dr. Rauschmann