Management of Infected Hardware

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Overview

- Wound and Hardware Infection can be a Critical Development in Determining Patient Outcome
- Infection Involving Hardware Can Jeopardize Bone Healing
- Can be Limb Threatening
- Early Diagnosis is Paramount
Epidemiology

- Incidence
  - Up to 16% infection rate following traumatic fractures

- Risk Factors
  - Host Immunocompetency
  - Extremes of age
  - Diabetes
  - Obesity
  - Alcohol or Tobacco abuse
  - Steroid use
  - Malnutrition
  - Medications
  - Previous Radiation
  - Vascular Insufficiency
Pathophysiology

- Mechanisms
  - Seeding
    - Disruption of soft tissue envelope, blood vessels, and periosteum allow bacteria to avoid host defenses
    - Direct seeding of implant or anatomical structure
    - Hematogenous seeding
  - Biofilm Formation
    - dependent on exopolysaccharide glycocalyx
Bacterial Colonization of Implants

- Biofilm: due to the adsorption of proteins, sugars, and other macromolecules onto the implant surface
  - Possible changes in the material itself are attributable to the host or the bacteria
  - Effects of the implant on the local environment
  - Systemic effects of the implant in the host

Bacterial Colonization of Implants


- Once the biofilm is formed, takes roughly 6 weeks in order to eradicate the infection with antibiotics

- *Staph Aureus* is the most common organism to form a complex multi layer biofilm
<table>
<thead>
<tr>
<th>Type of Infection</th>
<th>Etiology</th>
<th>Time of Onset</th>
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</thead>
<tbody>
<tr>
<td>Early Postoperative Infection</td>
<td>Staph aureus, B-hemolytic Strep, Gram-negatives</td>
<td>Symptoms within days to weeks of surgery</td>
</tr>
<tr>
<td>Chronic Infection</td>
<td>Coag-negative Staph Gram-negatives</td>
<td>Symptoms several months to 2 years after prosthesis placement</td>
</tr>
<tr>
<td>Hematogenous seeding</td>
<td>Inciting event from prior infection in other area of the body</td>
<td>Within days of inciting event</td>
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</table>
But What Does it All Mean???

▶ Stabilize Fracture
▶ Choose optimal hardware for your procedure
▶ Optimize your patient = quit smoking!!
▶ Sterile Technique
▶ Pre-op Antibiotics (Post-op x24hrs if Appropriate)
Treatment of Infected Hardware

- Systematic Approach
- Use All Your Resources
  - Infectious Disease Consult
  - Don’t Hesitate to get 2\textsuperscript{nd} Opinion
- Get Appropriate Imaging
  - Serial X-rays, CT, MRI, Bone Scan
- Be Clear with Patient about Plan and Possible Outcomes
Treatment

1. Diagnosis of Wound Infection
2. Treatment – Initial Surgery for Fracture Site Infection
3. ImplantRetention or Removal
4. Management of the Infected Wound
5. Wound Closure and Definitive Stabilization
6. Bone and Soft Tissue Reconstruction
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Studies

• Labs
  • WBC
    • may be normal in chronic or indolent infections
  • Erythrocyte Sedimentation Rate
    • may remain elevated for months following initial injury or surgery in absence of infection
  • C-Reactive Protein
    • most predictive for postoperative infection in the first week after fracture fixation
    • should decrease from a plateau after postoperative day 2 (after fixation of fractures)
      • will increase further or fail to decrease if a hematoma or infection is present

• Cultures
  • in-office cultures swabs or aspirations of wounds or sinus tracts are unreliable
  • intraoperative deep cultures are most reliable method of isolated causative organisms
  • multiple specimens from varying locations should be obtained
Imaging

- **X-rays**
  - Peri-implant lucency can be seen
  - Involucrom - reactive bone surrounding active infection
  - Sequestrom - retained nidus of infected necrotic bone

- **CT**
  - Pre-op Planning
  - Evaluate Fracture Healing

- **MRI**
  - Rule Out Soft Tissue Abscess
  - WBC Labeled Scans
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Initial Surgical Management of Infected Hardware

- Debridement of Non-viable Tissue
- Thorough Irrigation of Tissue with NSS to decrease bacterial load
- Remove or Maintain Hardware = A Question of Timing
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Operative Treatment

- **Acute Infection**
  - Occurs in first *2 weeks*
  - If hardware maintains absolute stability, it may be possible to retain until fracture is healed

- **Delayed Infection**
  - Occurs *greater than 2 weeks after* initial surgery
  - Usually requires removal of hardware at initial washout, stabilization of fracture with external fixator, antibiotics implant
Clinical Evidence


- The following parameters were identified as important for the potential salvage of exposed hardware with soft-tissue coverage:
  - **Stable Hardware**
  - **Time of Exposure less than 2 weeks**
  - **Control of Infection**
  - **Location of Hardware**
Clinical Evidence

- **Retention of the intramedullary nail is performed if the fixation is stable** and the infection is under control.

  
  - 20 patients with infection after intramedullary nailing of the tibia
  - Treatment protocols were based on the time of onset of infection (acute, subacute, and chronic) and the status of bone healing.
  - **Acute infection group managed successfully** with nail retention, debridement, soft tissue coverage, and IV antibiotics.
Clinical Evidence


  - Eighty-six patients (eighty-seven fractures; 71%) had fracture union with operative debridement, retention of hardware, and culture-specific antibiotic treatment and suppression.
  
  - Predictors of treatment failure were open fracture (p = 0.03) and the presence of an intramedullary nail (p = 0.01).

  - Failure trended toward an association with smoking and infection with *Pseudomonas* species
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4. Management of the Infected Wound

1. Deep Cultures should be obtained in the OR
2. Antibiotic Therapy should be held prior to obtaining cultures unless patient septic
3. ID Consult
4. 6 weeks IV antibiotics

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Frequency(%)</th>
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<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>30</td>
</tr>
<tr>
<td>Methicillin-resistant Staphylococcus aureus (MRSA)</td>
<td>Was present in 2 of 40 cases (5%) infected by Staphylococcus aureus</td>
</tr>
<tr>
<td>Coagulase-negative staphylococci</td>
<td>22</td>
</tr>
<tr>
<td>Gram-negative bacilli</td>
<td>10</td>
</tr>
<tr>
<td>Anaerobes</td>
<td>5</td>
</tr>
<tr>
<td>Enterococci</td>
<td>3</td>
</tr>
<tr>
<td>Streptococci</td>
<td>1</td>
</tr>
<tr>
<td>Polymicrobial</td>
<td>~27</td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
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Knowing the typical bacteria associated with fracture wound infections helps guide choice of initial antibiotics.
4. Management of the Infected Wound

- Consider Negative Pressure Therapy
- Decrease Dead Space
- Hardware Coverage
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5. Wound Closure and Definitive Stabilization

- Delayed Primary Closure
- Skin Grafting
- Secondary Intention
- Bone Healing with prolonged period of immobilization or staged ORIF
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6. Bone and Soft Tissue Reconstruction

- Stage procedure to remove hardware and obtain deep cultures prior to performing reconstruction
- Obtain stat gram stain immediately in OR prior to administering prophylactic antibiotics
- Plan back up fixation as patient will likely have inadequate bone stock

**Pre-op Plan** = Advanced Imaging, Bone Graft, Bone Stim, Multiple Forms of Fixation
Treatment of Infected Hardware

- Race between fracture/osteotomy healing and infection suppression/wound healing
  1. Suppression of Acute Infectious Process
  2. Soft Tissue Coverage
  3. Fracture/Osteotomy Healing
    1. 6 weeks of IV antibiotics followed by oral suppressive therapy
    2. If removal of hardware is a possibility, oral suppression can be discontinued
    3. If secondary/staged procedure, take cultures at time of hardware removal
Operative Treatment Pearls

- Indications
  - ANY active infection

- Technique
  - Maintain Hardware if stability at risk with removal in acute phase of infection
  - Low-pressure irrigation with normal saline (I use Cysto tubing)
  - Thorough identification and debridement of infection
  - Deep bone specimens for culture and biopsy
THANK YOU