Treatment of infection

Goals:
- Healing of infection
- Healing of fracture
- Try to keep the rehab program going on

Different steps:
1. Prevention
2. Diagnosis
3. Antibiotic treatment
4. Lavage (arthroscopic)
5. Possible surgical solutions
6. Removal of fixation devices

Risk Factors for infection
- Prior surgery at the site of the fracture
- Rheumatoid arthritis
- Immunocompromised status
- Diabetes mellitus
- Obesity
- Poor nutritional status
- Psoriasis
- Long-term urinary catheterization
- Extreme age hypothermia
- Experience of the surgeon

Aggressive management of open wounds and severely damaged soft tissues
- Early diagnosis and aggressive treatment of implant-related infection with antibiotics, debridement, and maintenance of stable internal fixation are essential to successful treatment.
Treatment of infection

1. Prevention of infections

Proper surgical management of fractures:

Rapid soft-tissue integration with the implant and a healthy vascular supply are of key importance in limiting the ability of bacteria to win the race for the surface.

Closed fractures

- Limit bone devascularization
- Cover any implants with healthy soft tissue
- Assess muscle viability: color, bleeding, and contractility.
- No periosteal stripping.
- ORIF of articular injuries delayed until the soft-tissue envelope is healthy.

Open fractures:

- An open wound may be considered infected
- Immediate aggressive débridement, fracture stabilization, and early reconstruction of the soft tissues
- Edges of the traumatic wound should be excised
- Any devitalized skin and muscle should be excised
- Use sequential irrigation with saline, then soap, and finally benzalkonium chloride.
- Use of high pressure pulsatile lavage is controversial

2. Diagnosis

Classification of infections

Early:
- During the first 3 months post-surgery.
- Some authors limit these surgical site infections to the first 4-6 weeks.

Delayed:
- Between 3 months and 1-2 years post-surgery

Late:
- > 2 years post-surgery.

Each type has specific etiopathogenic properties that influence the therapeutic options.

Microorganisms cause device-related infection by different routes.

- Direct inoculation during the perioperative period:
  - Early and delayed infections
- Hematogenous seeding during bacteremia or through direct contiguous spreading:
  - Late infections

Common microorganisms:

- Coagulase-negative staphylococci (30-43% of cases)
- Staphylococcus aureus (12-23%)
- Pseudomonas (5-15%)
- Enterococci (5-12%)
- Gram-negative bacilli (5-16%)
- Gram-positive cocci (2-6%)

No microorganisms are detected in about 11% of apparent infections.

Polymicrobial infection in 12-19% of cases

Establishing a microbiological diagnosis is imperative because the type of infecting organism often affects the therapeutic approach:

- ESR and CRP although suggestive, are non-specific
- CRP is more sensitive
- Blood leukocyte count and differential count not sufficiently discriminative
- Role of procalcitonin has not yet been defined
- Synovial fluid leukocyte count and differential: simple, rapid, and accurate

Synovial fluid leukocyte count > 1.7 x 10^3/l and differential > 65% neutrophils
- Sensitivity of 94% and 97%
- Specificity of 88% and 98%, respectively
Treatment of infection

2. Diagnosis

Bacterial Identification:
- Antimicrobials 2–3 weeks before aspiration; false-synovial fluid cultures
- Culture of aspirated synovial fluid positive in 45–100% of cases
- Prolonged incubation time for cultures (slow-growing organisms, Propionibacterium acnes): at least 5 days on standard agar plates and up to 15 days in enriched broth
- Culture of a superficial wound or sinus tract can be misleading
- Tissue cultures:
  - from debridement
  - Implanted material in enrichment broth media

Controversial:
- Histopathological examination of frozen tissue:
  - more than 5 neutrophils per at least 5 high-power fields at a magnification of 400
  - high sensitivity and specificity of more than 80% and 90%, respectively
- Molecular techniques: extremely sensitive may enable rapid and accurate identification of do not provide information concerning antimicrobial susceptibility

Imaging studies:
- Plain X-rays and CT scan — more to evaluate fracture healing and timing for removal of fixation devices
- MRI — not a first choice exam
- Bone scintigraphy — Technetium-99 m-labeled methylene diphosphonate highly sensitive but lacks specificity and always positive in first year
- The accuracy of combined leukocyte–marrow imaging, 90%, is the highest among available radionuclide studies
- Fluorodeoxyglucose positron emission tomography (FDG-PET) — very sensitive, but different specificity in the literature (from 50% to 90%)

3. Antibiotic Treatment:

Bacteria Identified

Tips
- Rifampin should always be included in the treatment of staphylococcal infection (if sensitive), should be never given as monotherapy due to the potential that the patient will develop resistance
- Fluoroquinolones are excellent combination agents because of their bioavailability, antimicrobial activity spectrum, and tolerability
- Co-amoxiclav, oxacillin, and co-trimoxazole plus rifampin can be a good alternative for the treatment of methicillin-sensitive S. aureus (MSSA) (MRSA) infections following surgery
- Continuous perfusion of vancomycin with plasma levels of approximately 25 mg/l
- Teicoplanin administered once daily for very prolonged periods also appears to be efficacious
Treatment of infection

4. Arthroscopic Lavage
- Can be done if important joint swelling
- Better if done in the first days post-op for an early infection
- Can be repeated at 10-15 days
- Only with physiological serum
- No antibiotics in the lavage serum:
  - Isototoxicity of the components of the drug (excipients)
  - Absolutely impossible to control concentration of the drug in the serum
  - Risk of selection of resistant bacteria

5. Surgical Solutions

Local antimicrobial delivery: incorporating antimicrobial agents into
- Cement
- Hydroxyapatite
- Bone graft

Can be used in:
- First surgery for prevention
- Second surgery for treatment of infection

Advantage
- High local level and a minimal systemic level are achieved
- Reducing the risk of potential toxicity.

Local antibiotic therapy has not been proven or accepted worldwide.

6. Removal of fixation device

Need a compromise between
- Stability
- Fracture healing
- Removal of hardware for easier healing of the infection

ORIF/CRIF:
If good fracture healing (X-rays and CT-scan):
- Remove hardware after 2 months
- Partial weight bearing after 3 months
- Full weight bearing at 6 months post-op
- Normal post-op rehab program concerning ROM and strength recovery

If no fracture healing and still positive infection criteria:
- Remove hardware and put an external fixation
- Remove hardware and don’t give weight bearing until fracture completely healed
Treatment of infection

6. Removal of fixation device

External fixation:
- Usually can be kept until fracture healing

Nailing
- No experience

But: remove the nail as soon as possible and
- Use an External fixation
- No more hardware and no weight bearing until fracture completely healed

Conclusions

- Prevention should be meticulous
- The real treatment is the diagnosis with the identification of the organism and his susceptibility to antimicrobials
- Most of the time antibiotic treatment must be IV administration
- Any surgical procedure is time gaining to let the fracture heal
- Removal of the hardware is in most of cases the only solution to eradicate infection