Clinica Ortopedica e Traumatologica
Università degli Studi di Pavia

Fondazione IRCCS Policlinico San Matteo

Chairman: Prof. F. Benazzo

Treatment of infection

F. Benazzo, S.M.P Rossi

Treatment of infection

Goals:

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

Treatment of infection

Different steps:

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

Treatment of infection

1. Prevention

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

Treatment of infection

1. Prevention of infections

- Associated soft-tissue injury causes impairment of local immune function
- Fracture stability is of paramount importance in achieving fracture union and in preventing infection
- ORIF: appropriate prophylactic antibiotic coverage for Staphylococci and Gram-negative organisms should be provided

Treatment of infection

1. Prevention of infections

- 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.

Treatment of infection

1. Prevention of infections

Closed fractures

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

Treatment of infection

1. Prevention of infections

Open fractures:

- An open wound may be considered infected
- Immediate aggressive debridement, 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

Treatment of infection

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.

Treatment of infection

2. Diagnosis

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

Coagulase-negative staphylococci (30–43% of cases)
Staphylococcus aureus (12–23%)
Mixed flora (10–11%),
Streptococci (9–10%)
Gram-negative bacilli (3–6%)
Enterococci (3–7%), and anaerobes (2–4%).
No microorganisms are detected in about 11% of apparent infections
Polymicrobial infection in 12–19% of cases

Treatment of infection

2. Diagnosis

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 · 103/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

Treatment of infection

2. Diagnosis

Controversial:

- Histopathological examination of frozen tissue:
  more than 5 five 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

Treatment of infection

2. Diagnosis

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 95%)

Treatment of infection

3. Antibiotic Treatment:

Bacteria Identified

Microorganisms	Antibiotics	Grading
Methicillin-susceptible *S. aureus*	Oxacillin ± rifampin	A-II
	Amoxicillin/clavulanic acid ± rifampin	A-II
	Ciprofloxacin or Levofloxacin or	A-I
	Moxifloxacin + rifampin	A-II
	Co-trimoxazole or	A-III
	Minocycline ± rifampin	A-III
	Clindamycin	A-III
Methicillin-resistant *S. aureus*	Teicoplanin or Vancomycin ± rifampin	A-II
	Co-trimoxazole or Minocycline ± rifampin	A-II
	Linezolid ± rifampin	A-II
	Daptomycin	A-II
Streptococcus spp.	Amoxicillin	B-III
	Levofloxacin or moxifloxacin	B-III
	Ceftriaxone	B-III
	Clindamycin	B-III
Enterobacteriaceae	Ciprofloxacin or levofloxacin	B-III
	Ceftriaxone	B-III
P. aeruginosa	Cefepime or ceftazidime	B-III
	Ciprofloxacin or levofloxacin	B-III
	Piperacillin/tazobactam	B-III
	Meropenem or imipenem	B-III

- Only IV administration possible
- Need of hospitalisation for at least 4-6 weeks

Italian Guidelines for the Diagnosis and Infectious Disease Management of Osteomyelitis and Prosthetic Joint Infections in Adults S. Esposito, S. Leone, M. Bassetti, S. Borré, F. Leoncini, E. Meani, M. Venditti, F. Mazzotta and Bone Joint Infections Committee for the Italian Society of Infectious Tropical Diseases (SIMIT)

Treatment of infection

3. Antibiotic Treatment:

Empirical therapy

	Parenteral therapy	Dosages	Oral therapy [a]	Dosages
Without risk factors for MRSA [b]	Amoxiclav or	2.2 g t.i.d	Flucoxacillin or	1 g q.i.d
	Ceftriaxone	2 g o.d.	Amoxiclav (1 g t.i.d) or	1 g t.i.d
	± Rifampin	600 mg o.d.	Moxifloxacin (400 mg o.d.) or	400 mg o.d.
			Ciprofloxacin or	500–750 mg b.i.d
			Levofloxacin or	500 mg o.d. or b.i.d
			Co-trimoxazole or	960 mg b.i.d
			Doxycycline or minocycline	100 mg b.i.d
			± rifampin	600 mg o.d.
With risk factors for MRSA [b]	Vancomycin or	1 g b.i.d	Linezolid or	600 mg b.i.d
	Teicoplanin [c] or	10–12 mg/kg o.d., first day b.i.d	Co-trimoxazole or	960 mg b.i.d
	Linezolid or	600 mg b.i.d	Doxycycline or minocycline	100 mg b.i.d
	Daptomycin	6 mg/kg o.d.	± rifampin	600 mg o.d.
	± rifampin	600 mg o.d.		

MRSA risk factors:
- Recent hospitalization (within 12 months); surgery
- parenteral nutrition
- previous antibiotic therapy;

Minocycline or fluoroquinolones or cotrimoxazole in case of in vitro susceptibility
Glycopeptides as initial empirical therapy until methicillin-susceptible S. aureus (MSSA) confirmed
Orala therapy to be used for possible sequential therapy

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Treatment of infection

3. Antibiotic Treatment:

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 physioliogical serum
- No antibiotics in the lavage serum:

→ Istotoxicity of the components of the drug (excipients)
→ Absolutely impossible to control concentration of the drug in the serum
→ Risk of selection of Resistant bacteria

Treatment of infection

5. Surgical Solutions

Surgical debridement:

- Open debridement of necrotic and fibrous tissues
- Meticulous irrigation of the area
- Can be repeated

May be a successful option in patients with early postoperative infection (< 4 weeks),

If means of fixation (plates or screws) exposed :
- Debridement of margins of the wound
- Bleeding of the margins
- Don't put too much tension on sutures when try to close the wound

Treatment of infection

5. Surgical Solutions

Local antimicrobial delivery : incorporating antimicrobial agents into
- Cement
- Hydrossiapatite
- 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.

Treatment of infection

5. Surgical Solutions

Local antimicrobial delivery

4 antibiotics can be used:

- Amikacin
- Gentamicin
- Tobramicin
- Vancomicin

Treatment of infection

6. Removal of fixation device

Need a compromise between

- Stability
- Fracture healing
- Removal of hardware for easier healing of the infection

Treatment of infection

6. Removal of fixation device

ORIF/CRIF:
If good fracture healing (X-rays and CT-scan):

- Remove hardare after 2 months

- Partial weight bearing after 3 months
- Full weight bearing at 4 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 hardaware and no weight bearing until fracture completely healed

Conclusions

- Prevention should be meticolous
- 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 with IV administration
- Any surgical procedure is time gaining to let the fracture heal
- Removal of the harware is in most of cases the only solution the eradicate infection