Complications and infection

Ananda M Nanu

The Soft Tissue Envelope

No Returns or Second Chances

Handle With Care

Caution! Open carefully, Hazardous biomaterial inside

Fracture repair requires

- Good blood supply
- Good bone contact
- Good mechanical stability

Fracture repair in infection requires

- Good blood supply
- Good bone contact
- Good mechanical stability
- Eradication of infection

Inadequate soft tissue envelope

- History of open injury
- Host status
- Inadequate fixation of fracture

- Infected non-union
- Without deformity
- With deformity
- With gap

Standards of care

- In closed fractures, pre-op antibiotics decrease infection rates in surgery*
- ABx at least 10 minutes prior to surgery**
- No safe early window in which to operate on damaged tissue.
- Use travelling traction until wrinkle test +. This decreases infection***

**Boxma H Lancet 1996*

***Oishi CS CORR 1993*

****Haidukewych GJ JOT 2002*

Tibial shaft fractures

- Poor soft tissue coverage
- Poor vascularity
- High rate of open injuries
- Fibula lateral strut
- Fracture may be initially treated non-operatively

Tibial shaft –Intramedullary nailing

- Biomechanically best
- Earlier WB- Load sharing device
- Less surgical exposure
- Exchange nailing easy
- Mechanical and biological stimulus

Tibial shaft – IM nailing

- Non rigid
- Vascular insult inside and out
- Endosteal, periosteal damage (Open)
- Less alignment control
- Technically demanding Prox/Distal

When does delayed become nonunion?

- No universally agreed cut off point
- Arbitrary time 6-9 months
- No progress in radiology for 3 months
- If massive bone defect- immediate NU

Risk factors for surgical site infection

Host related:

- Older age
- Co-morbidity
- Drugs
- Remote infections (dental, etc)
- Preoperative hospitalization

Procedure related:

- Emergency operation
- Duration of surgery
- Surgical technique
- Timing of surgery

Influences on bacterial growth

- All bacteria require a medium with which to grow.
- The commonest medium following ORIF is a haematoma, seroma or fluid collection around an implant.
- Such a medium can be reduced by meticulous haemostasis and the use of suction drains.
- The surface structure of an implant is also critical when determining the critical size of an innoculum which will result in an infection.

Influences on infection—dead soft tissues

- Skin necrosis can be prevented by not closing wounds that are too tight.
- Damage to muscle and periosteum can be reduced by meticulous surgical technique—in open cases, careful debridement of all necrotic tissue is vital.
- Thermal damage can be caused either by cauterization or occasionally by drilling.
- Reduce thermal damage by ensuring drill tips are sharp and lubricated.

Influences on infection—dead hard tissue

- Devascularized bone and foreign bodies are good culture media for bacterial growth.
- Risk of infection can be minimized by excising all devascularized bone and removing all foreign bodies.
- Adequate debridement in an open fracture is the most important surgical maneuver in the prevention of infection.

Wound revision in acute infection

- Wash-out with lots of fluid
- Debridement (repeated) of all dead tissue, fibrin or pus
- Checking stability of fixation and implants:
  - To be improved if inadequate
- Gentamycin beads? antibiotic sponges?
- Wound closure depending on local situation
- Antibiotics for 6 weeks (according to culture test)

Infection and implants for fracture fixation

- Any implant/device providing mechanical stability should stay in place
- Loose implants must be removed or replaced to optimize the fixation
- A rigidly fixed fracture will unite in spite of infection
  Almost 50% of implants need to be removed in established deep infections, even if the implants were stable at the time of first diagnosis of infection

Strategy of diagnosis and treatment

- WHY did they become infected?
  - Soft tissue envelope?
  - Open injury
  - Host factors
- *Investigations focused on above.*

- *Priorities....eradicate infection then reconstruction*

Classification

- Waldvogel, 1971
  - Classification based on pathogenesis
- May, 1989
  - 5 parts, post-traumatic tibial osteomyelitis
- Cierny & Mader, 1985
  - 4 factors affecting outcome
  - Host, site, extent of necrosis, degree of impairment

Pathogenesis

Waldvogel, 1971

1. Hematogenous
2. Contiguous focus of infection
3. Direct inoculation

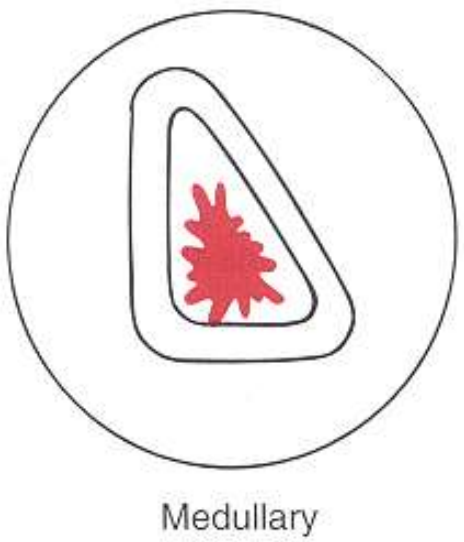
Anatomic Classification

(*Cierny-Mader*)

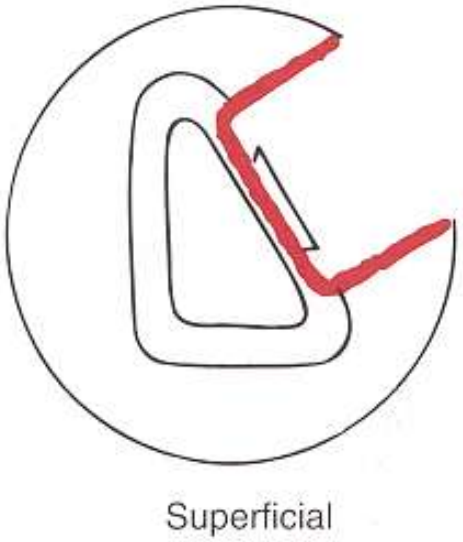
1985

ANATOMIC TYPE

Type I: Medullary osteomyelitis
Type II: Superficial osteomyelitis
Type III: Localized osteomyelitis
Type IV: Diffuse osteomyelitis



Medullary



Superficial

Localized

Diffuse

Cierny-Mader classification

I. Medullary

Endosteal nidus, contained intramedullary, minor soft tissue signs external

II. Superficial

Surface of bone, often with soft tissue defect

III. Localized

Localized sequestra, sinus tract,
stable

IV. Diffuse

Permeative process, combination of I/II/III,
Unstable

Cierny-Mader classification

A-Host: Good immune system & delivery

B-Host: Compromised host

- **B^L**: *locally* compromised
- **B^S**: *systemically* compromised
- **B^C**: combined

C-Host: Requires suppressive or no Tx

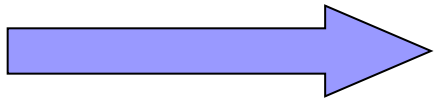
- Minimal disability
- Tx worse than disease, not a surgical candidate

Cierny-Mader classification

Anatomic Type

+

Clinical Stage



Class

Example: IV Bc tibial osteomyelitis = diffuse tibial lesion in a systemically compromised host with poor local conditions

Cierny-Mader classification

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Local factors

- Chronic oedema
- Venous stasis
- Large vessel disease
- Arteritis
- Extensive scarring
- Radiation fibrosis

Host factors

- Mal-nutrition
- Immune deficiency
- Diabetes
- Hypoxia
- Malignancy
- Organ failure
- Substance abuse...smoking drugs alcohol
- Drug inhibition

Infections associated with fracture-fixation devices

Staphylococcus aureus	30%
Coag neg staphs	22%
Gram neg rods	10%
Anaerobes	5%
Enterococci	3%
Streptococci	1%
Polymicrobial	27%
Unknown	2%

Trampuz & Zimmerli, Switzerland

Infection in trauma

- All elective patients screened and decolonised

Problem is emergency admissions!

- Trauma screened on admission, high risk decolonised prophylactically

Current antibiotic prophylaxis trauma

- Standard: 2g Amoxycillin
  5mg/kg Gentamycin

- Penicillin Allergy: Teicoplanin 400 mg
  Gentamycin 5mg/kg

With induction of anaesthesia

Reduce incidence of Clostridium Difficile!

Emerging pathogens

- MRSA
- ESBL's – extended spectrum beta-lactamase producing bacteria …E-Coli
- ESBL's also producing CTX-m enzymes
- Panto - Valentin –Leucocide Staph.Aureus
- NDM

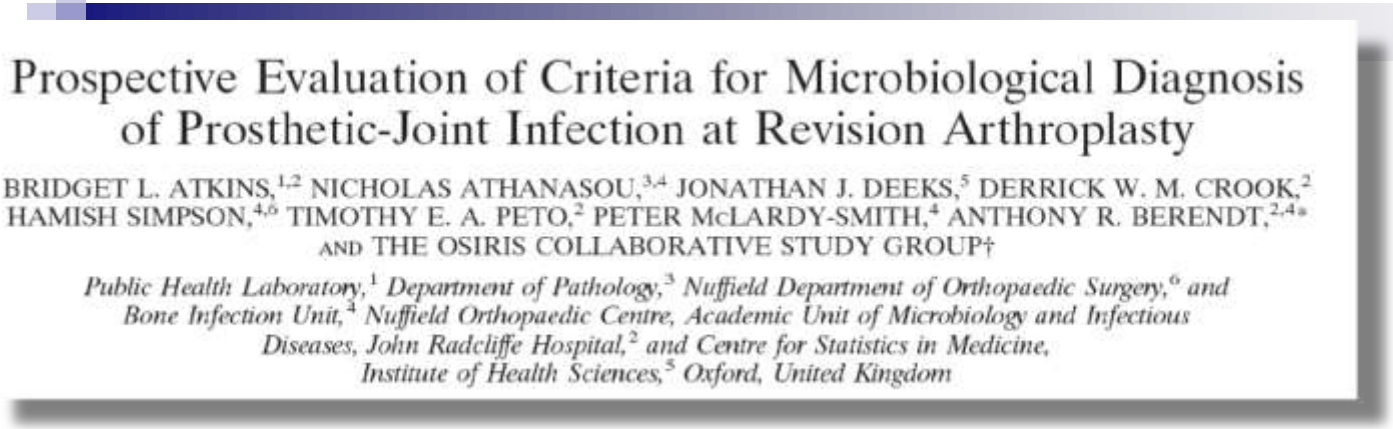
Prevention of infection

- Patient factors
- Injury factors
- Surgery factors and skills

Patient and surgical factors can be modified!

Diagnosing Infection: Microbiology
"To swab or not to swab"

- Correct antibiotic therapy is dependent on obtaining an appropriate clinical samples for culture and sensitivity testing.
- Deep tissue specimens (needle aspirates, currettage of ulcer base, bone biopsy) collected aseptically, are considered to provid[illegible] reliable culture samples.
- Superficial swab cultures
  - Cost effective
  - Less invasive
  - Adequately diagnostic



Prospective Evaluation of Criteria for Microbiological Diagnosis of Prosthetic-Joint Infection at Revision Arthroplasty

BRIDGET L. ATKINS,[1,2] NICHOLAS ATHANASOU,[3,4] JONATHAN J. DEEKS,[5] DERRICK W. M. CROOK,[2] HAMISH SIMPSON,[4,6] TIMOTHY E. A. PETO,[2] PETER McLARDY-SMITH,[4] ANTHONY R. BERENDT,[2,4]* AND THE OSIRIS COLLABORATIVE STUDY GROUP†

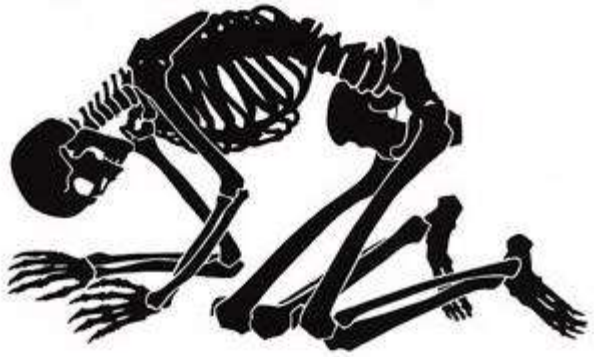
Public Health Laboratory,[1] Department of Pathology,[3] Nuffield Department of Orthopaedic Surgery,[6] and Bone Infection Unit,[4] Nuffield Orthopaedic Centre, Academic Unit of Microbiology and Infectious Diseases, John Radcliffe Hospital,[2] and Centre for Statistics in Medicine, Institute of Health Sciences,[5] Oxford, United Kingdom

- Send between 3-5 samples
- Use fresh, sterile instruments for each sample
- Take samples before antibiotic prophylaxis is given
- Send samples for histological diagnosis

  >5 neutrophils per high power field indicates infection with sensitivity of 43-84% and specificity of 93-97%.

J Clin Micro 1998; 36(10):2932-9

Treatment of Orthopaedic Infection



Antibiotics alone may not be enough!

"The right operation,

The right antibiotics,

Together at the same time"

“The best septic surgeon can only transform a septic wound into a contaminated wound”

- Face it ..there are always bacteria left
- Warm soapy water and levage
- Earliest diagnosis and 1st debridement most NB
- High local concentrations ‘ no resistence todate!’
- ‘spring-roll’ bonegraft with Vancomycin fleece around it
- Race for the surface...the future ‘Iodised metals’

Infected non-union

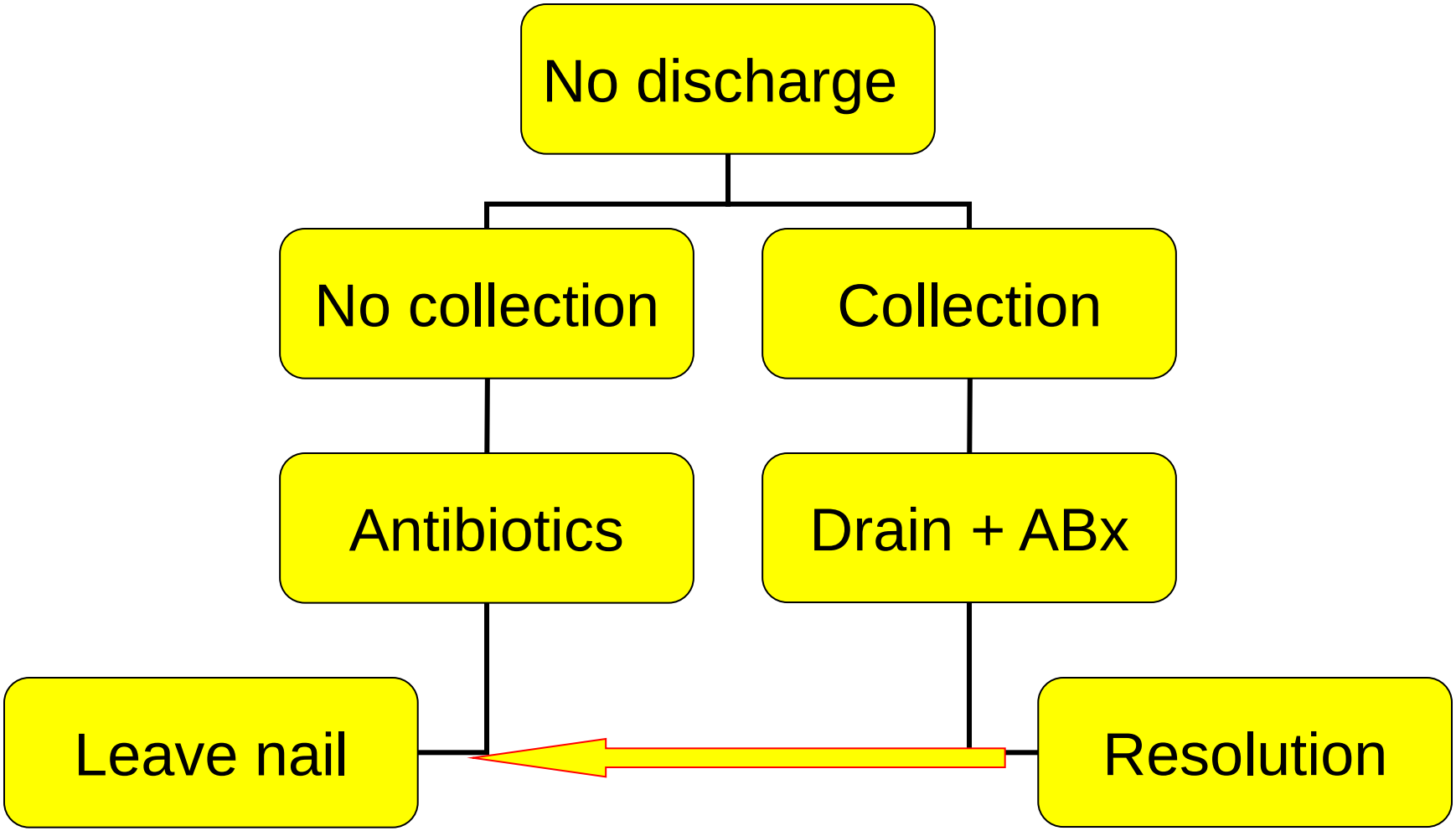
- Aim for high concentration of antibiotics locally-Avoid systemic toxicity
- Therapeutic levels may last 90 days
- Local gentamycin concentration 200 times levels achievable systemically*

**Wahlig H JBJS Br 1978*

Infected non-union

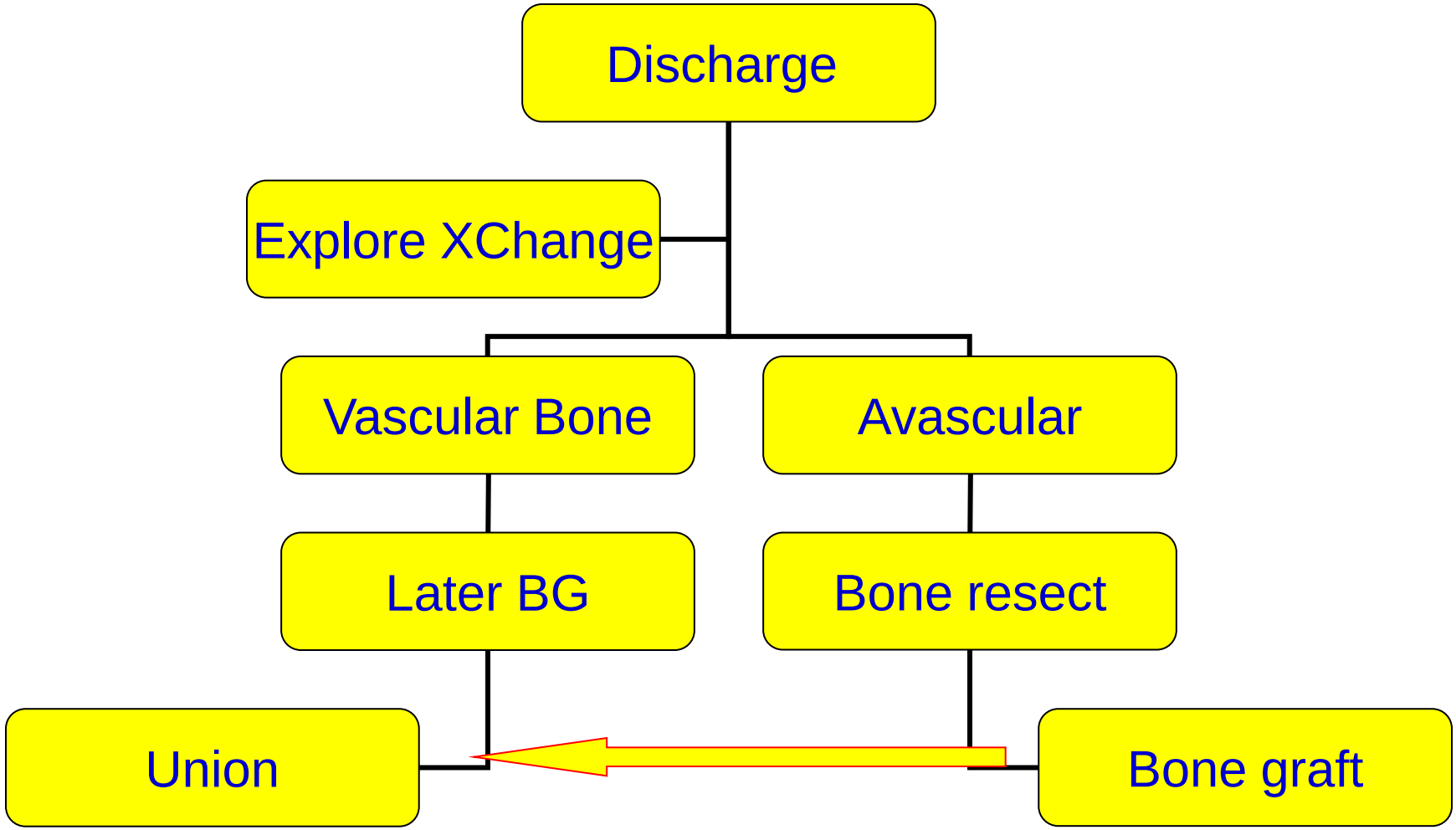
- Antibiotic should be
- Water soluble
- Wide spectrum
- Heat stable
- Available in powder form
- Commonly used 2.4g Tobramycin in 40g Palacos
- Volumetric ratio 24mls antibiotic to 120mls Palacos

Protocol for management of Infection with IM Nail



Court-BrownJBJS Br 1992

Protocol for management of Infection with IM Nail



Court-BrownJBJS Br 1992

Equipment

- Cement gun
- 3.2g Tobramycin
- 1-2g Vancomycin
- Palacos 40g
- 40F chest drain
- Intramedullary reamers
- 3mm Ball-tipped guide wire

Antibiotic laden Rod

- Use tube that you can cut with knife
- Cut chest tube before cement sets
- Shape into Herzog bend at top
- Use ball tip to prevent rod coming out
- Measure length from nail removed
- Overream 2-3 mm for easy insertion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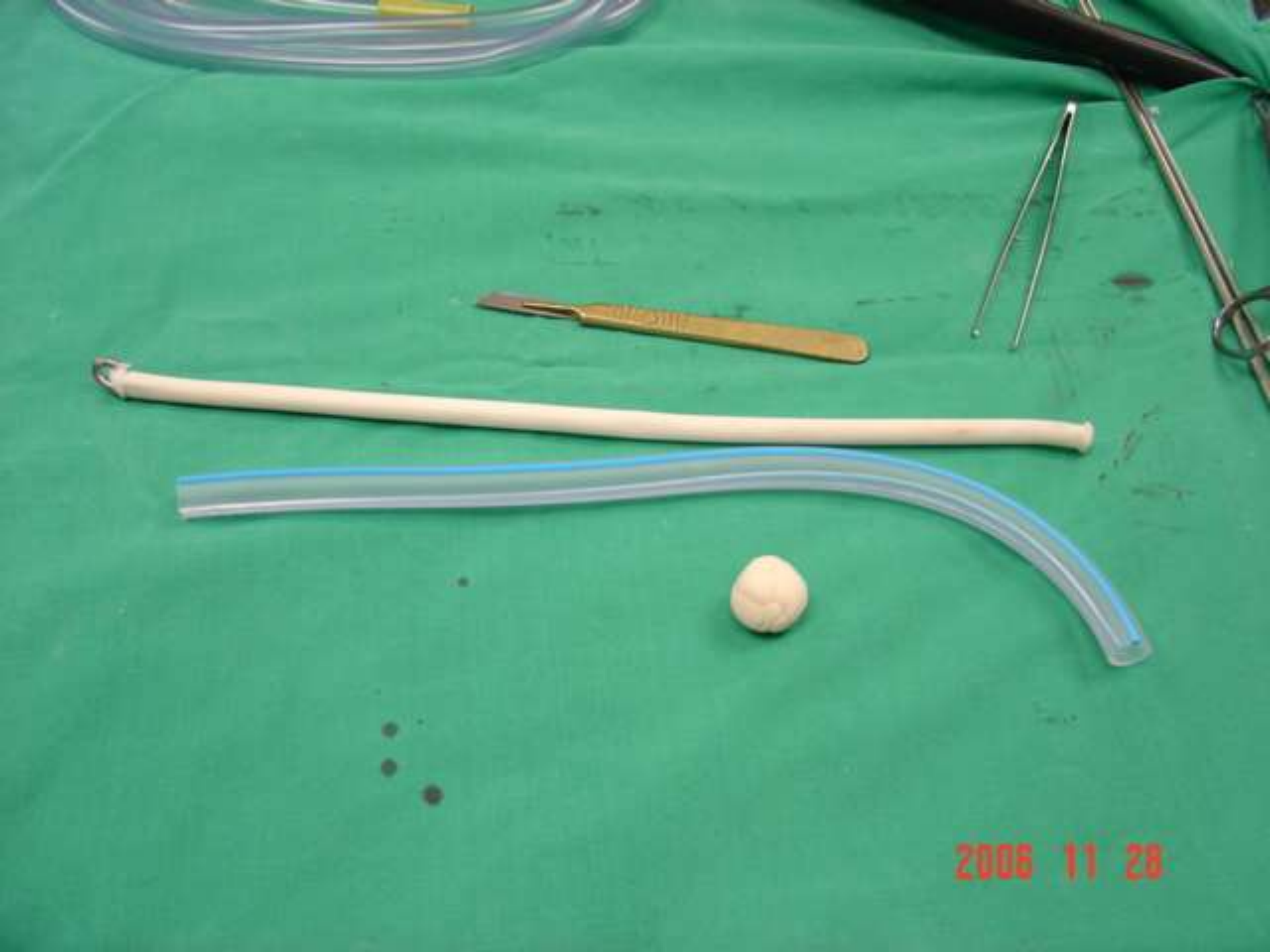
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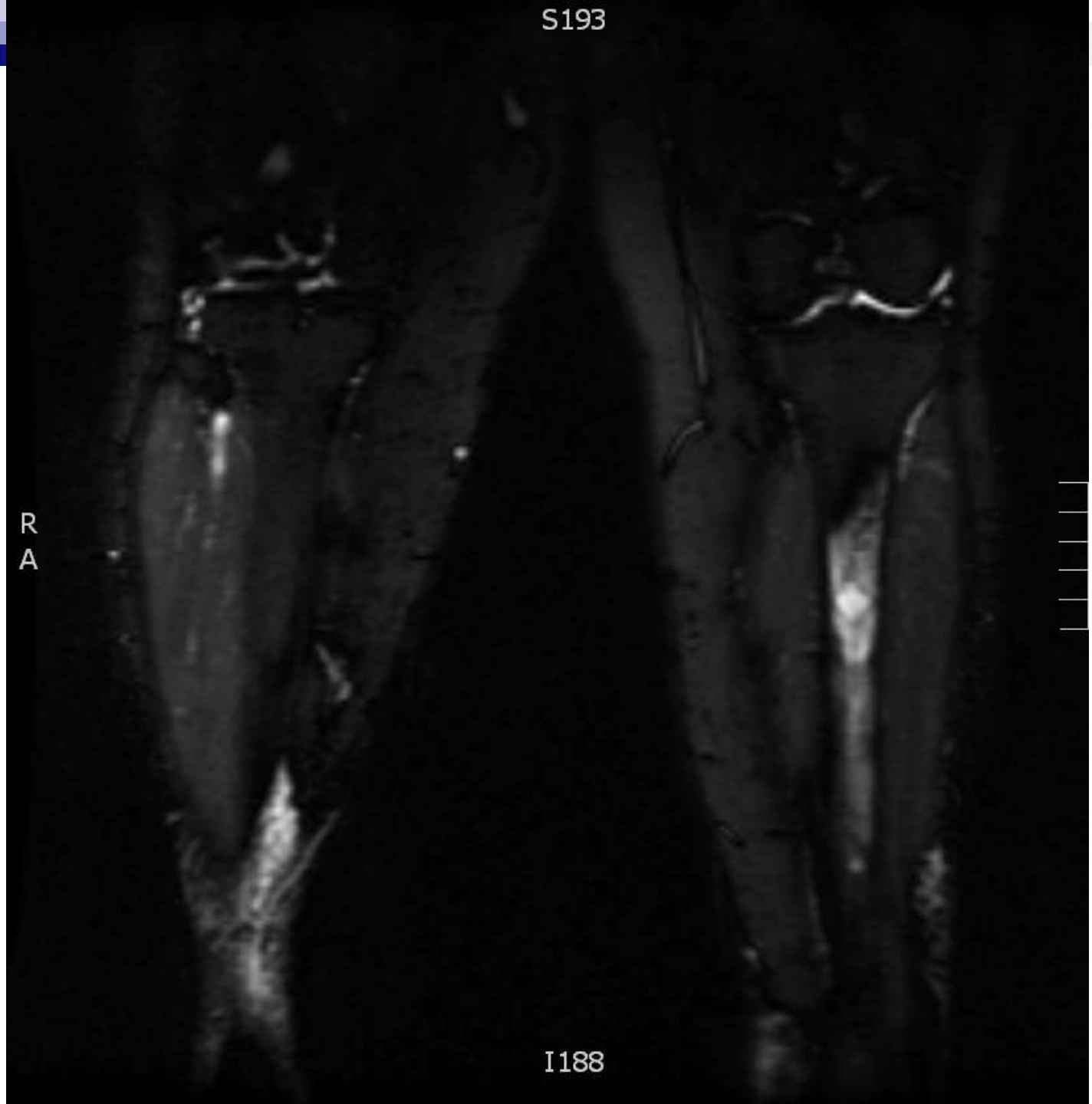
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Summary

- Incidence of infection after operative fixation of closed fractures should be < 1-2%
- Appropiate “behaviour” helps to reduce the risks
- In case of acute infection immediate action is mandatory
- Thorough debridement of all dead tissue
- Implants providing stability may remain “in situ”
- Mechanical stability and vital tissues are essential to obtain bony union
- Prophylactic single dose antibiotics are effective, but cannot replace poor surgery