TREATMENT OF OPEN FRACTURES

Presenter:
Dr Laszlo G Nöt

INVITATION

Upper extremity injuries

22nd of February 2018

Dean's Hall (1st floor)

REMINDER: FRACTURE CLASSIFICATIONS

1. Direction of the **force**: direct / indirect
2. Mechanism: bend / compression / contusion / shear
3. Exposition: closed / open
4. Fracture line: transversal, oblique (short or long), spiral, segment, comminuted
5. Type of dislocation
6. Consistency of the bone: traumatic, fatigue/stress, pathologic

OPEN FRACTURES

Definition:

The site of fracture and/or hematoma communicate with the outside due to soft tissue injury.

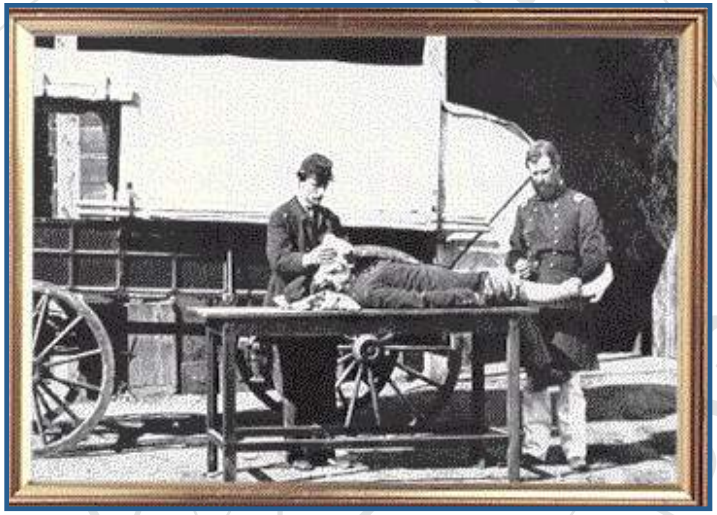
(AO-definition: “an open fracture is a soft-tissue injury which also involves the bone”)

Classification:

Based on measurement of soft tissue and periosteal injury

OPEN FRACTURES

HISTORY



- Treatment = amputation
- Mortality 75%
- Function in “survivors” poor

GUSTILO – ANDERSON CLASSIFICATION *

Type I:

- Wound size: less than 1 cm in length.
- Contamination: clean puncture *(from the inside!)*
- Soft-Tissue: little damage - no crush
- Fracture: usually simple transverse or short oblique. Very little comminution.
- Cause: indirect force
- Small energy injury

* Gustilo RB; Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg [Am], 58:453-8, 1976 June*

GUSTILO – ANDERSON CLASSIFICATION *

Type I:

GUSTILO – ANDERSON CLASSIFICATION *

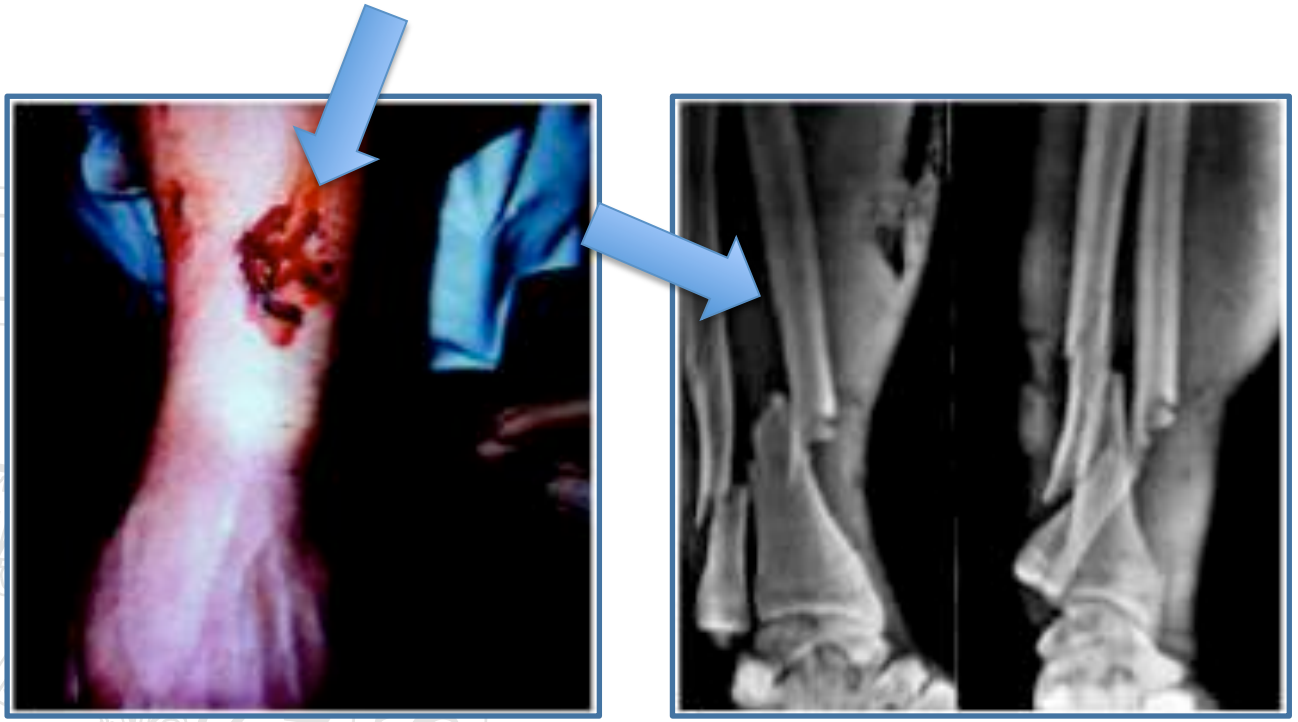
Type II:

- Wound size: more than 1 cm long.
- Contamination: moderate contamination.
- Soft-Tissue: No extensive soft-tissue damage, flap or avulsion. Slight or moderate crushing.
- Fracture: Moderate comminution.
- Cause: direct force
- High or moderate energy injury

Key word: `moderate`

GUSTILO – ANDERSON CLASSIFICATION *

Type II:



GUSTILO – ANDERSON CLASSIFICATION *

Type III:

- Laceration: extensive skin damage
- Contamination: high degree of contamination
- Soft-Tissue: extensive soft-tissue damage of skin muscle and neurovascular structures.
- Fracture: great deal of comminution and instability
- Includes: High Velocity Trauma, gunshot injuries, ope fracture caused by farm injury, open fracture with vascular injury requiring repair.
- High energy, direct force.

SUBTYPES **

Type III /A:

Adequate soft tissue coverage of a fractured bone is possible despite extensive laceration. **Periosteum: intact.**

Type III /B:

Extensive soft tissue injury or loss of soft tissue ⇒ **inadequate soft tissue coverage. Periosteal stripping** and exposure of bone.

Type III /C:

Any open fracture associated with an **arterial injury that requires immediate repair;** regardless of wound size or extent of soft tissue injury.

** Gustilo RB; Mendoza RM; Williams DN. *Problems in the management of type III (severe) open fractures: a new classification of type III open fractures. J. Trauma 24:742-746,1984.*

GUSTILO – ANDERSON CLASSIFICATION

Type III/A:

GUSTILO – ANDERSON CLASSIFICATION

Type III/B:

GUSTILO – ANDERSON CLASSIFICATION

Type III/C:

AO / ASIF Classification

AO Foundation Transforming Surgery–Changing Lives

Integument Closed:
IC1 No Skin Lesion
IC2 No laceration but Contusion
IC3 Circumscribed degloving
IC4 Extensive closed degloving
IC5 Necrosis from contusion

Integument Open:
IO1 Skin breakage inside out.
IO2 Skin breakage outside in <5cm contused edges.
IO3 Skin breakage >5cm. Devitalised edges. Circumscribed degloving.
IO4 Full thickness Contusion, abrasion, skin loss.
IO5 Extensive degloving

Muscle/Tendon Injury
MT1 No Muscle Injury.
MT2 Circumscribed muscle injury. One muscle group only.
MT3 Extensive muscle injury 2 or more Muscle groups.
MT4 Avulsion or loss of entire muscle groups, tendon laceration.
MT5 Compartment syndrome /Crush Syndrome.

Neurovascular Injury:
NV1 No neurovascular injury
NV2 Isolated nerve injury
NV3 Localised vascular injury.
NV4 Combined neurovascular injury
NV5 Subtotal or total amputation.

Ref: Muller M, Allgower M, Schneider R, Willeneger H. Manual of Internal Fixation. Techniques Recommended by the AO-ASIF Group 3rd Edition 1991 New York Springer-Verlag. pp151-156

OPEN FRACTURES ⇒ SEPTIC COMPLICATIONS

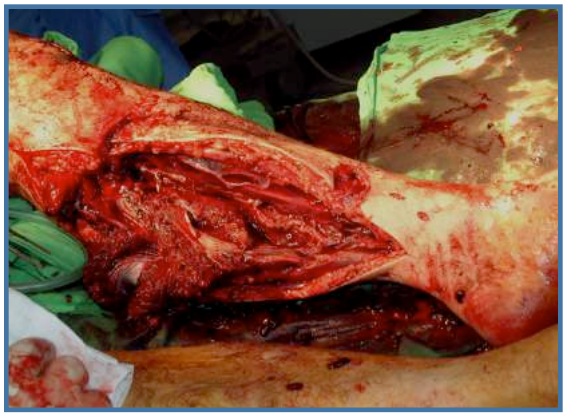
Incidence of septic complications

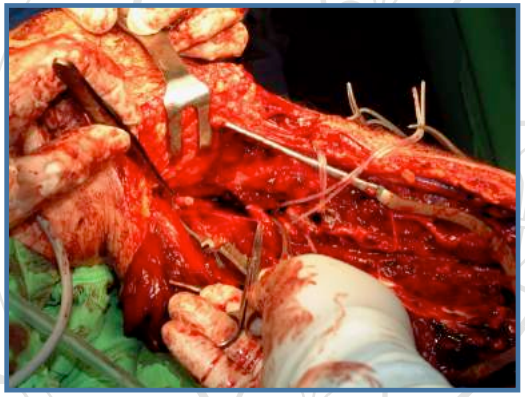
Type I	5 %
Type II	11%
Type III	**29 %**

(high rate: osteomyelitis, amputation)

OPEN FRACTURES – PLEASE, CLASSIFY THE FOLLOWINGS:

Note: ‘unfair’ request without any X-ray… ☺





OPEN FRACTURES

'TAKE HOME MESSAGE'

LOW GRADE ENERGY VS. HIGH GRADE ENERGY

BASIC PRINCIPLES OF TREATMENT

- **Debridement = gross decontamination:** clean and remove devitalized parts
- **Stable osteosynthesis** (possibly load stable)
- **Antibiotic prophylaxis** (local and systemic)
- **Soft tissue management:** possible coverage of the wound / bone by soft tissue with good blood supply
- ***If needed: second look, third look, change of method…***

MANAMEGEMENT OF DIFFERENT G-A. TYPES

- **Type I:** After proper soft tissue management can be treated as a closed fracture

- **Type II:** Soft tissue managment (excision, cleaning), unreamed nailing or plate fixation.
  Primary closure is possible.

- **Type III:** Soft tissue managment (excision, cleaning),
  unreamed nailing or plate fixation: up to III/B;
  OR external fixation

  - cover of the wound / bone: plastic surgery, flaps
  - reconstruction of vessels / nerves: microsurgery

OPEN FRACTURE & SEPTIC COMPLICATIONS

THERE ARE SEVERAL DIFFERENT TYPES OF CLASSIFICATIONS… AO, Gustilo-Anderson…

WHICH OF THEM SHOULD I LEARN FOR THE EXAM??

BASIC REQUIREMENTS for the EXAM:

Here are some hints to help…

OPEN FRACTURE & SEPTIC COMPLICATIONS

CLASSIFICATION NEEDS for the EXAM:

Here are some hints to help…

- **Gustillo – Anderson Classification**
- **and…**

That's all !!! ☺

TREATMENT OF BONE AND JOINT INFECTIONS

Presenter:
Dr Laszlo G Nöt

DIFFERENTIAL DIAGNOSIS OF ARTHRITIS

Class	Infection	Live organism present ?	Microbial structures present?	Example
Infection	Yes	Yes	Yes	Septic Arthritis
Reactive	Yes	No	Yes	Chlamydia, Yersinia, Salmonella, Shigella, Campylobacter
Inflammatory	No	No	No	Rheumatoid Arthritis

SEPTIC ARTHRITIS

DEFINITION OF SEPTIC ARTHRITIS:

Arthritis resulting from infection of one or more joints by a microorganism (usually bacterial).

BACTERIA FOUND IN BONE AND JOINT INFECTION

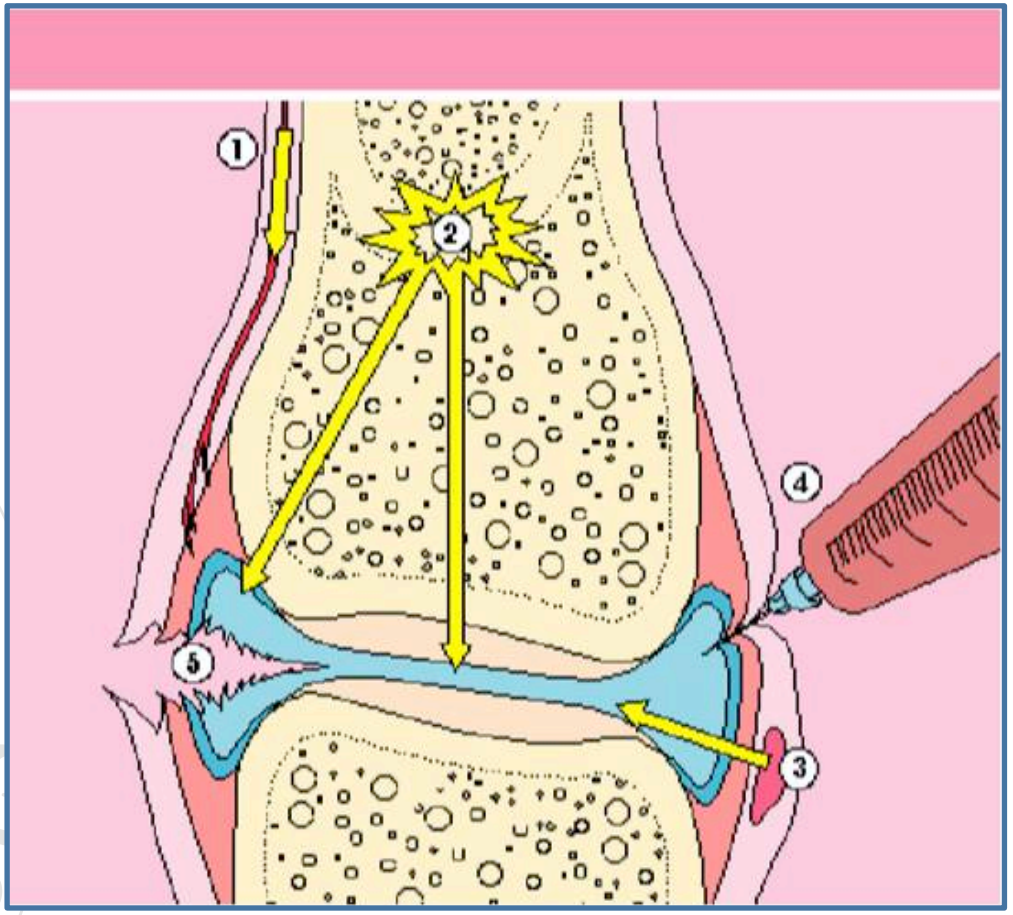
Bacteria	Acute Septic Arthritis	Prosthetic Joint Infection	Septic Bursitis	Osteomyelitis
Staphylococcus aureus	+++	+++	+++	+++
Coag negative Staph		+++		
Hemolytic Streptococcus	++	++	++	++
Other Streptococci	+	+		+
Skin anaerobes	+	+++		+
Gram-negative cocci	+			+
Hemophylus influenza	+	+		+
Gram-negative anaerobes	+	++	+	+
Pseudomonas aeruginosa	+	+		+
Salmonella	+	+		+
Intestinal anaerobes		+		
Mycobacteria	+	+		

RISK FACTORS

- Age > 80 years
- Comorbid conditions (especially diabetes)
- Joint damage from arthritis
- Prosthetic joint
- Skin infection
- Immune suppression (malignancy or treatment)
- Cirrhosis
- Chronic renal failure and hemodialysis
- IV drug abuse

PATHOGENESIS

1. Hematogenous
2. Dissemination from osteomyelitis
3. Spread from adjacent soft tissue infection
4. Diagnostic or therapeutic measures
5. Penetrating damage by puncture or cutting.



DIAGNOSIS

A, CLINICAL FEATURES:

- Joint swelling and pain
- Pain with range of motion, immobility
- Fever
- Signs of sepsis
- Distribution usually monoarticular
- Large joints most often involved

B, DIAGNOSTIC TESTS:

- Synovial Fluid Analysis: (WBC count > 50,000 PMNs > 90%)
- Blood test: FBC: WBC, ESR, CRP can all be increased
- Gram stain and culture
- Blood culture
- Radiology (specific changes usually occur later)

JOINT TISSUE DAMAGE

- Infiltration of joint by bacteria (direct damage)
- Aggressive Host Inflammatory Response
- Proliferation of synovial pannus
- Anaerobic acidic environment
- Action of Protease, Collagenase, and Elastase enzymes on cartilage and subchondral bone
- Mechanical forces on weakened structures

TREATMENT

A, Joint Drainage

- repeated needle aspiration
- surgical drainage
- open arthrotomy, synovectomy

The stage and extent of surgical intervention and the continuous fluid drainage are debated in the literature!

B, Antibiotic Therapy (i.v.)

C, Synovial Fluid and Blood Cultures

D, Serial Synovial Fluid Analysis

E, Extended Duration of Treatment (6 weeks)

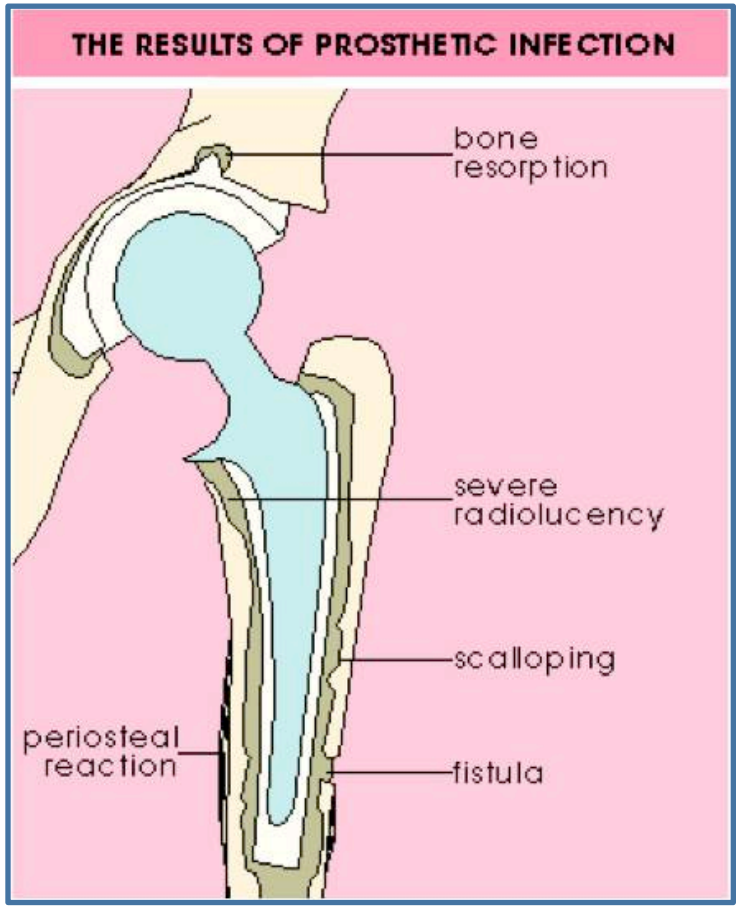
INFECTION IN PROSTHETIC JOINTS

A, Early onset infections:

- Usually directly related to surgical wound
- 75% Staphylococcus and Streptococcus species
- Symptoms tend to be acute

B, Late onset infections:

- Hematogenous spread
-Symptoms tend to be indolent



SEPTIC BURSITIS

- Superficial bursae are commonly affected (pre-patellar and olecranon bursae)
- Underlying joint infection is not common
- Acute or repetitive Trauma
- Staph aureus
- Drainage / Synovectomy
- Antibiotics

MAIN CHARACTERISTICS

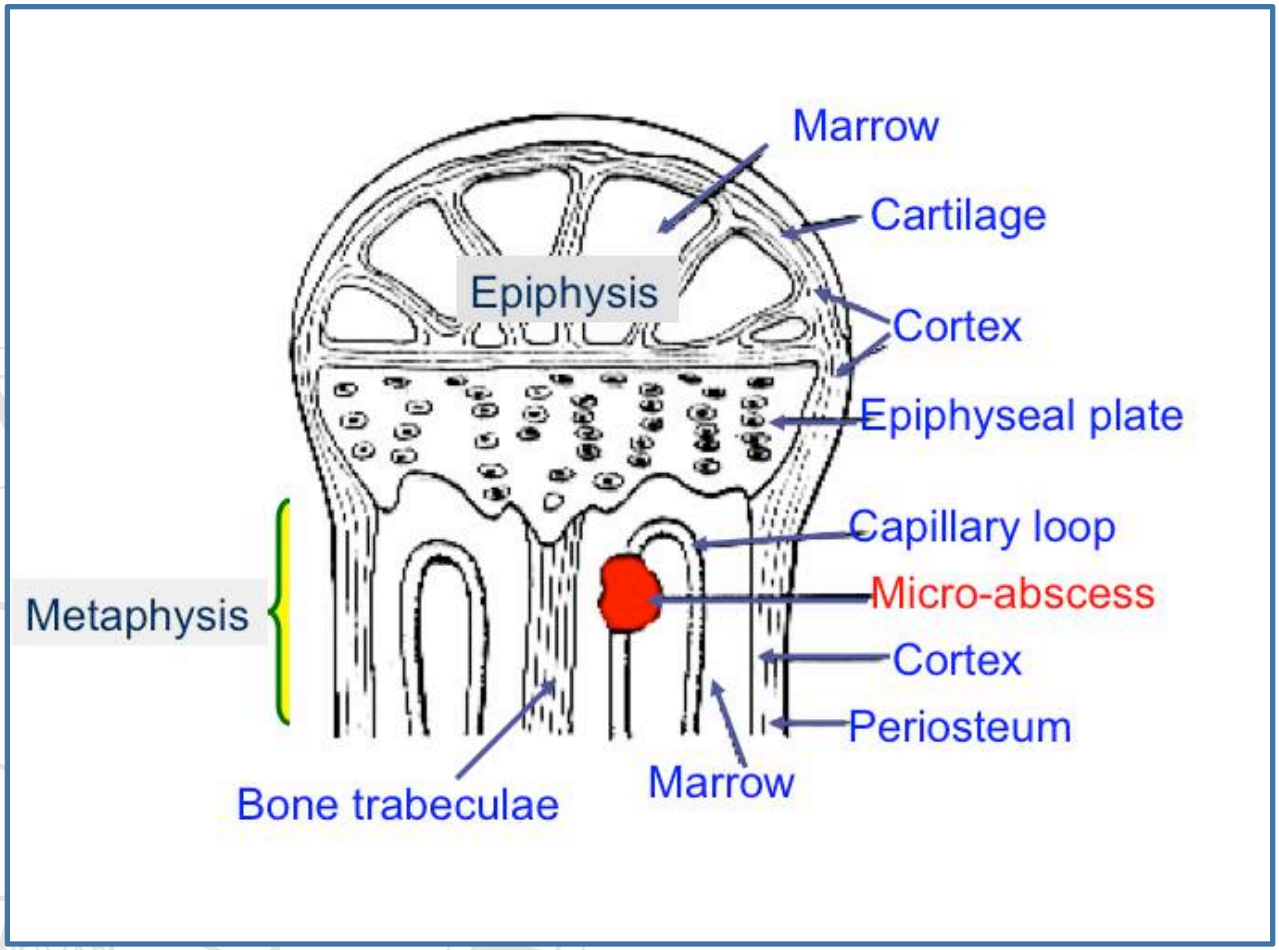
I. Acute:

- Children and young adults
- Children < 1 year often have osteomyelitis with septic arthritis and septicemia together.

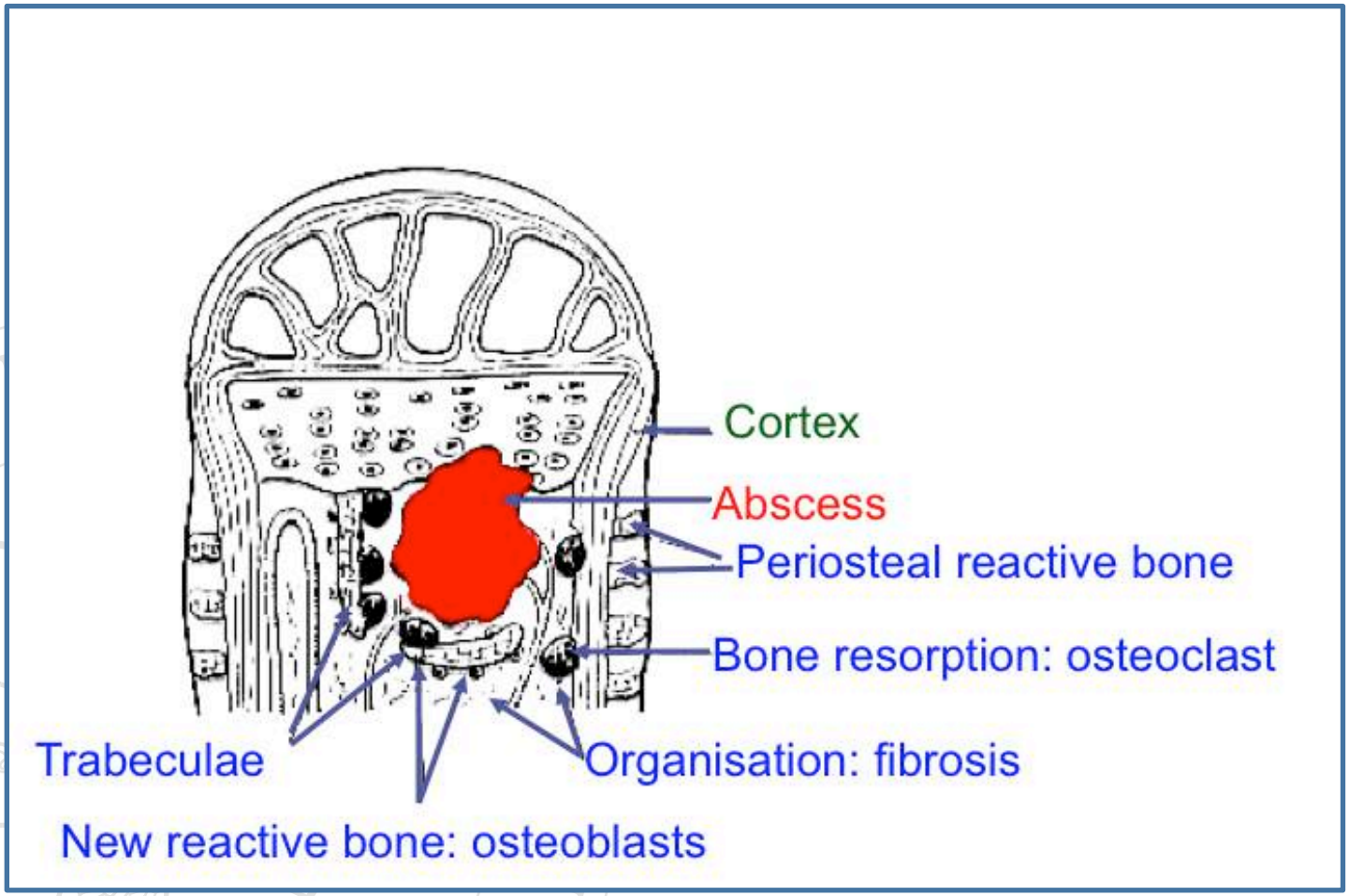
II. Chronic and Sub-acute:

- Most often follow trauma or surgery
- Prolonged antibiotic treatment
- Surgical debridement

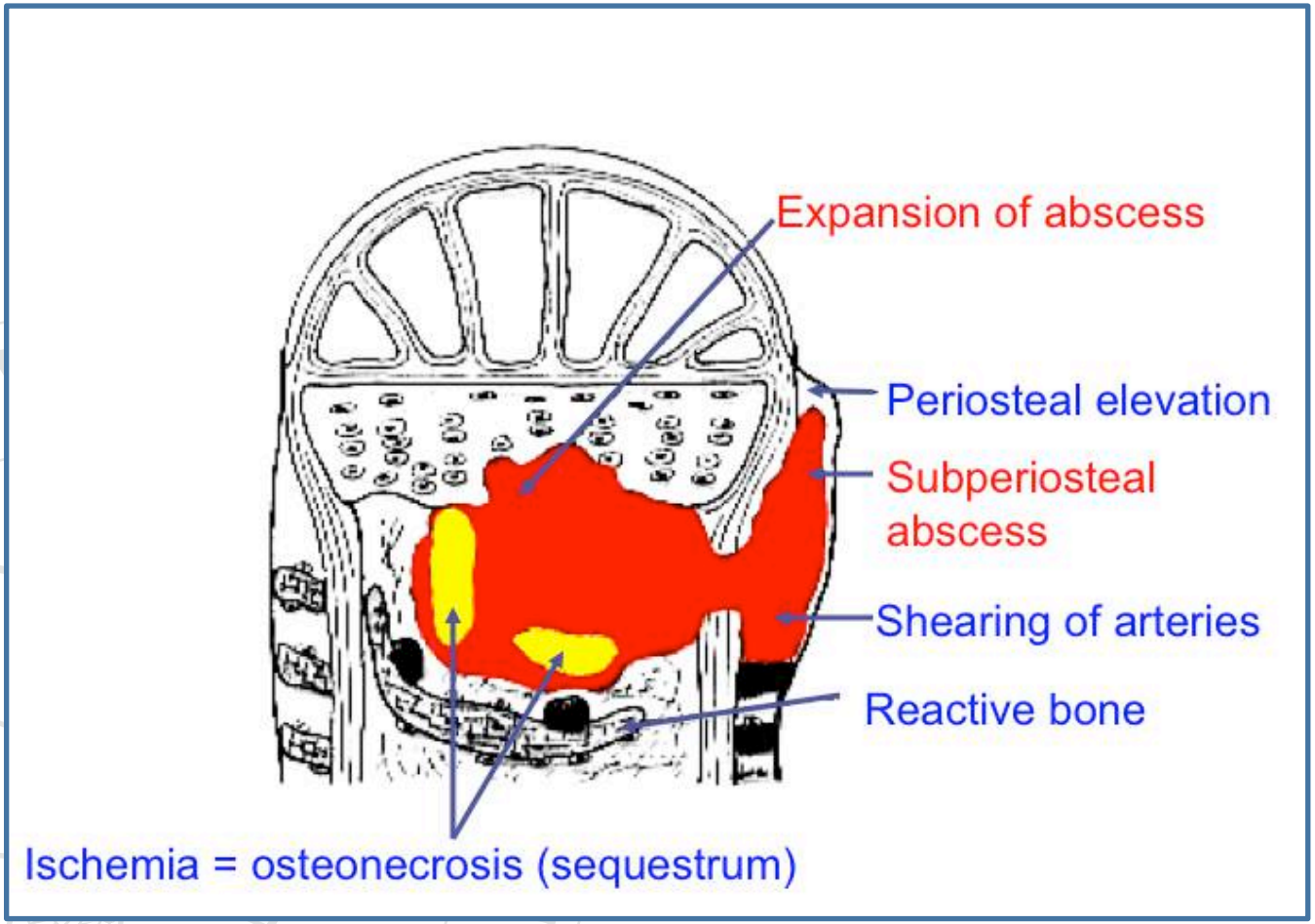
DEVELOPMENT OF OSTEOMYELITIS



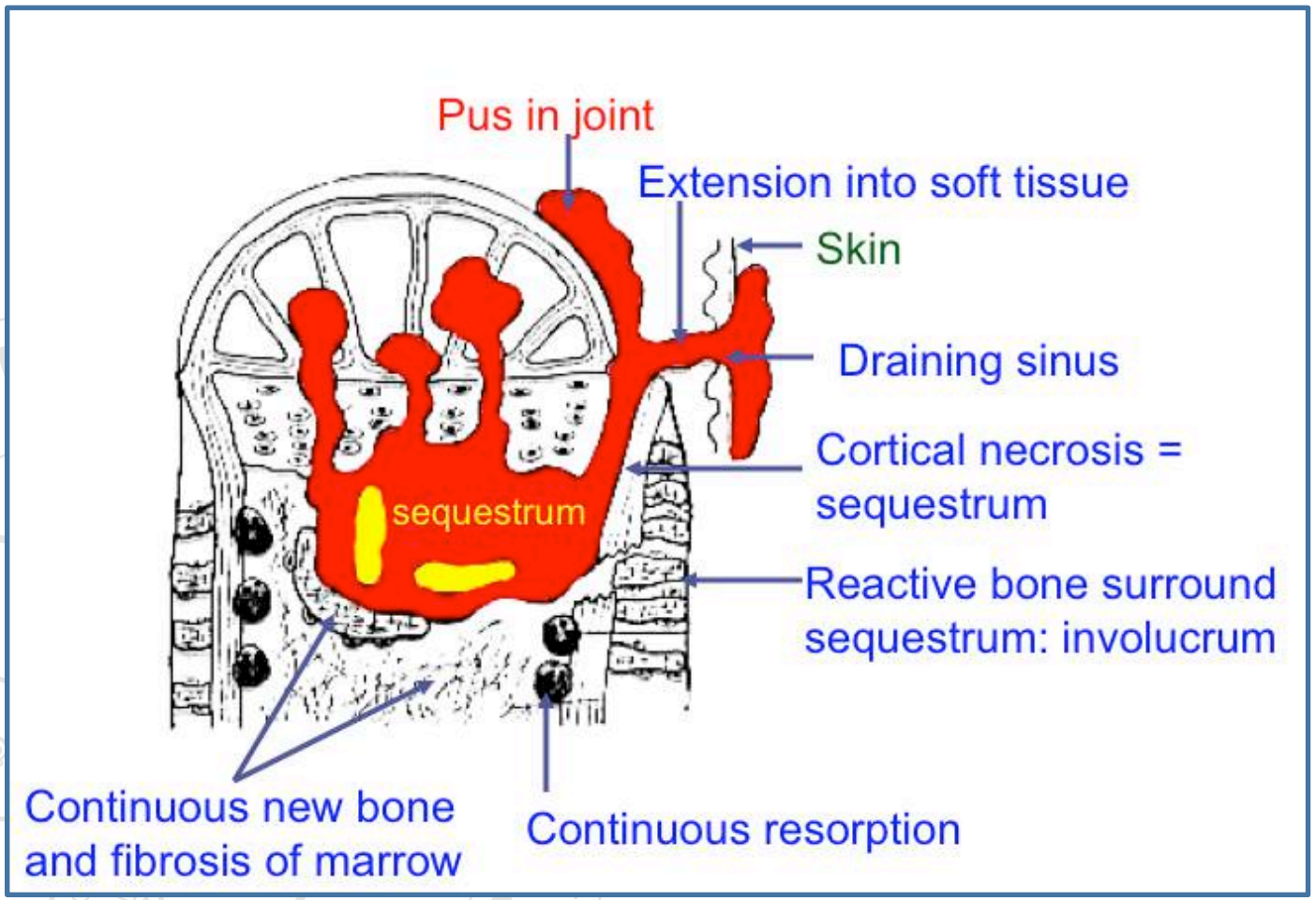
PROGRESSION OF OSTEOMYELITIS



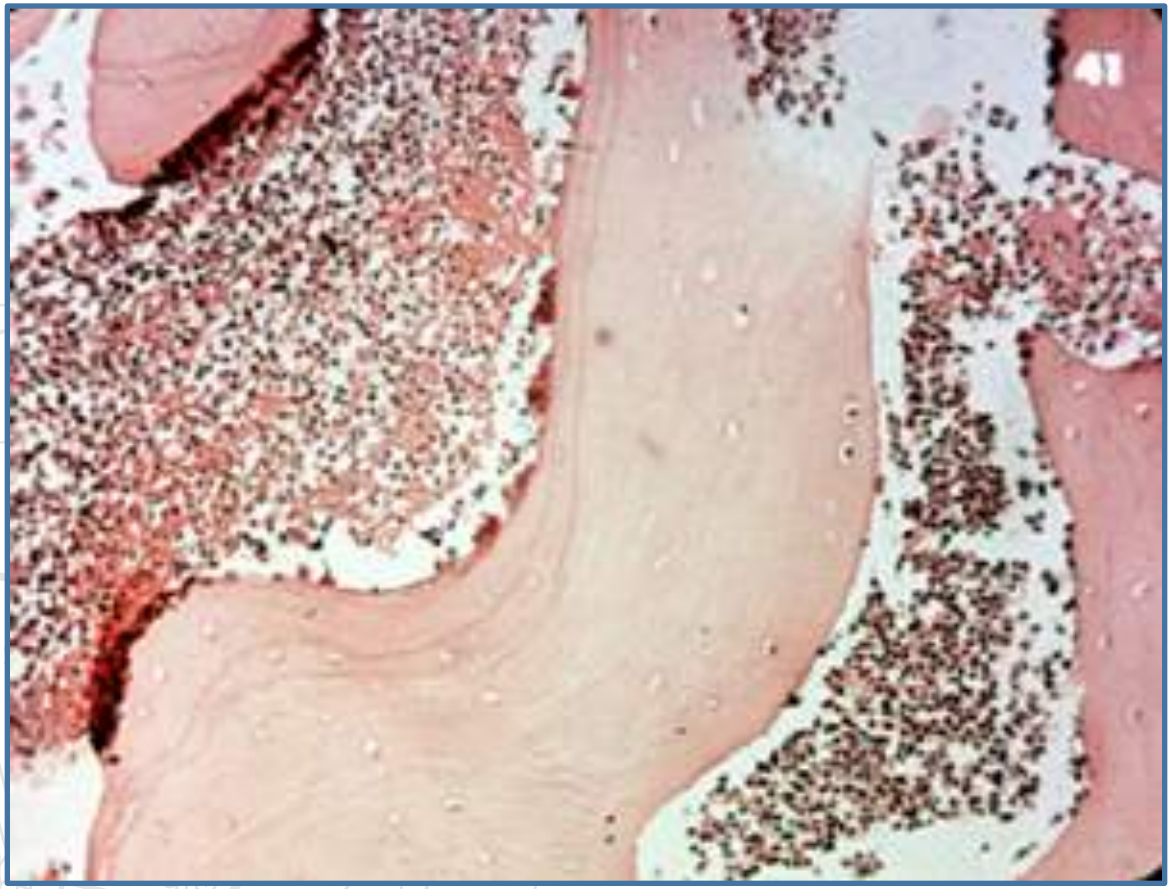
PROGRESSION OF OSTEOMYELITIS



PROGRESSION TO SEPTIC ARTHRITIS



HISTOLOGY



RISK FACTORS

- Comorbid conditions (especially diabetes)
- Corticosteroid treatment
- Prosthetic joint
- Skin infection
- Immune suppression (malignancy or treatment)
- Cirrhosis
- Chronic renal failure and hemodialysis
- IV drug abuse

OSTEOMYELITIS

EPIDEMIOLOGY:

- childhood: < 20 years
- adults: > 50 years

RISK FACTORS:

- usually in adults (see next slide)

BACTERIA:

- mostly Staph aureus (except newborns)
- rarely: virus, fungi, parasites

DIAGNOSIS

A, CLINICAL FEATURES:

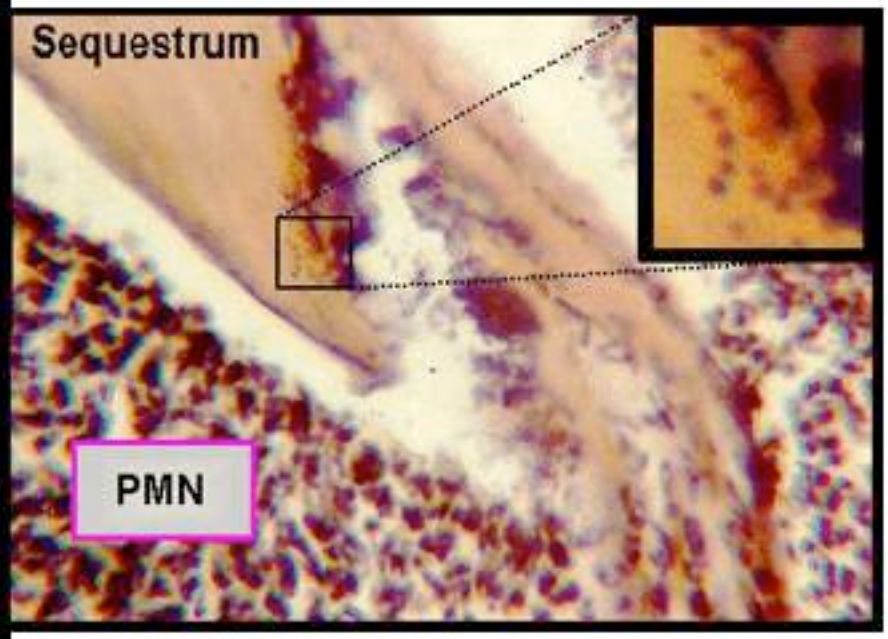
- Swelling, pain, redness, etc..
- Pain with range of motion, immobility
- Fever (not every time)
- Signs of sepsis (late phase)
- Systemic symptoms: fatigue, loss of appetite, etc..

DIAGNOSIS

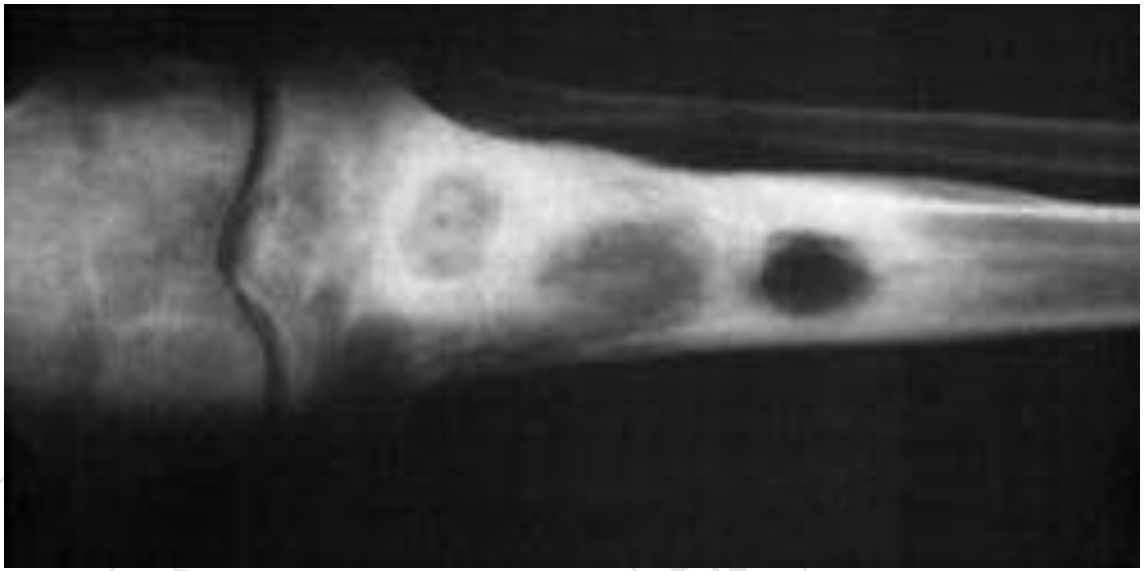
B, DIAGNOSTIC TESTS:

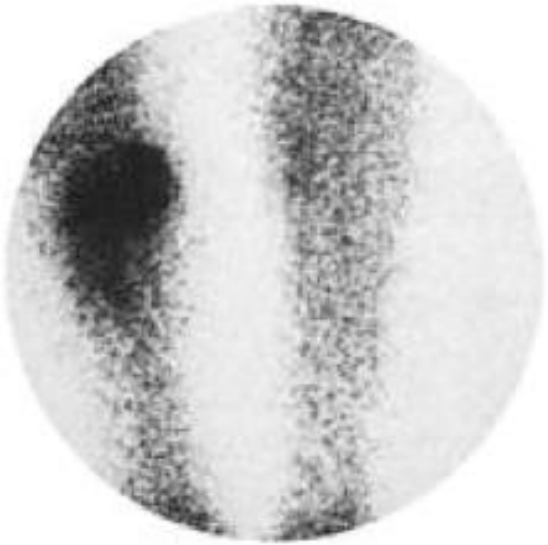
- Blood test: FBC: WBC, ESR, CRP
- Blood culture
- Radiology (positive: only after weeks: lysis, density, loss of mineral contents, sequesters,
- Scintigraphy, isotope-labeling: Tc, Ga, ^{111} In labeled WBC scan early stage (after 5-7 days)
- CT-scan (sternum, spine)
- MRI (sensitive, excellent from very early to late stages)

DIAGNOSIS



DIAGNOSIS





Conventional X-ray and bone-scintigraphy

DIFFERENTIAL DIAGNOSIS

Best diagnostic tools: directly collected microbiological samples and blood culture!!

- Tumor: osteoid osteoma, chondroblastoma, Ewing-sarcoma metastasis, lymphoma
- Trauma
- Myositis ossificans
- Erythema nodosum
- Cellulitis
- Eosinophil granuloma

TREATMENT

- wide-spectrum, then specific-spectrum **antibiotic treatment** (long-term) for 6-8 weeks

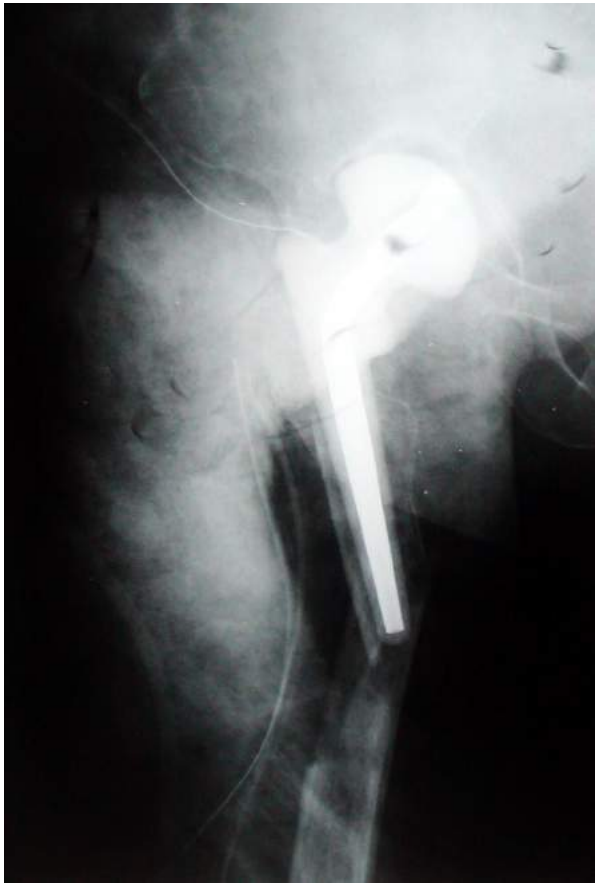
- generally **surgical intervention** is needed (especially in chronic cases):

  - radical debridement
  - AB-impregnated PMMA-chain
  - cancellous-bone graft, pedicle-bone graft, tissue flaps, etc…

- **after prosthesis implantation**:
  - early-stage: AB-therapy
  - late-stage with septic-loosening: removal of prosthesis, spacer + later revision arthroplasty or resection arthoplasty

CASE REPORT I.

CASE REPORT I.



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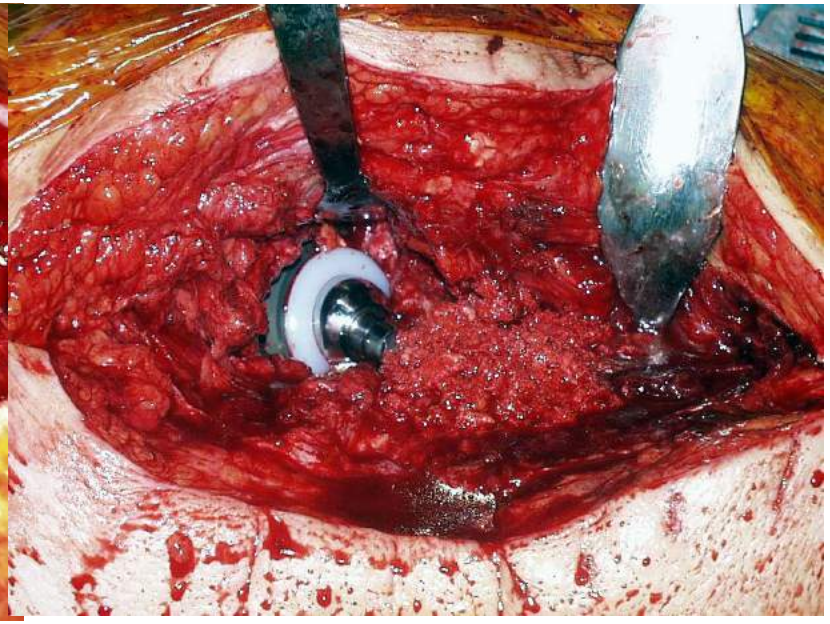
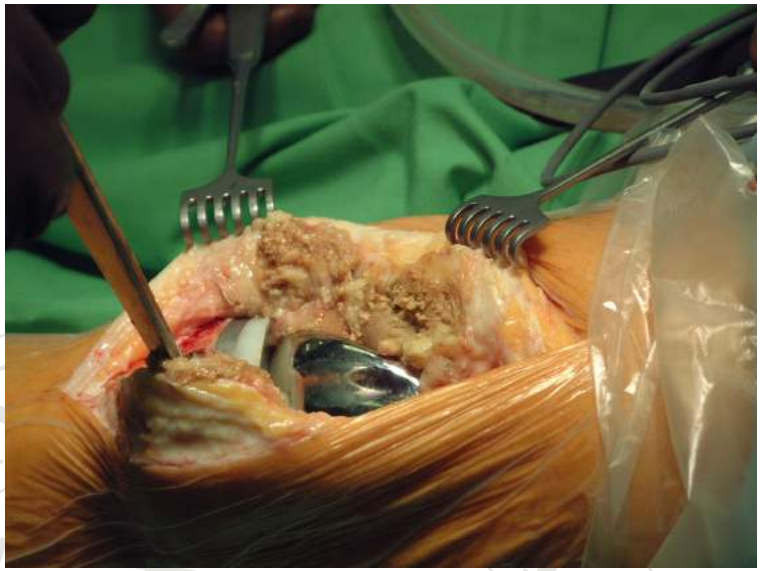


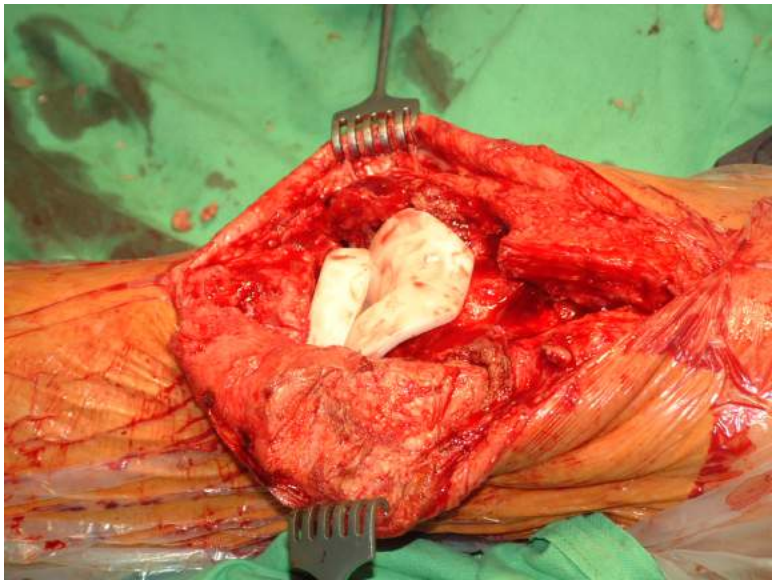
CASE REPORT I.

CASE REPORT I.

CASE REPORT II.

CASE REPORT II.





CASE REPORT II.

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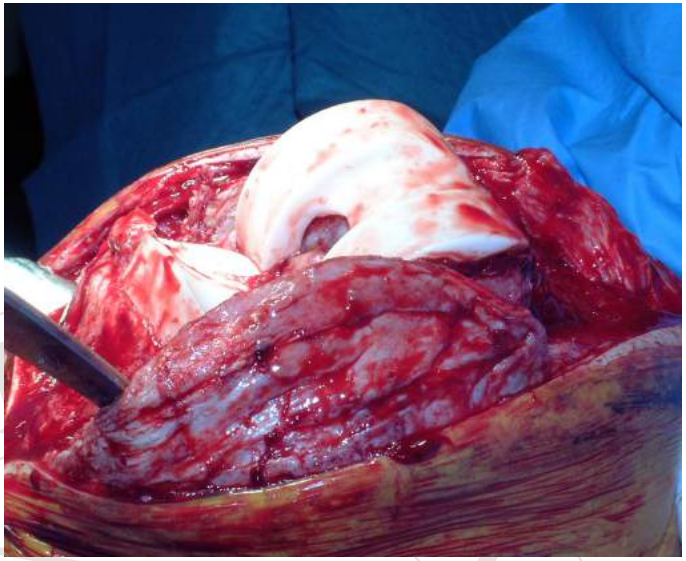

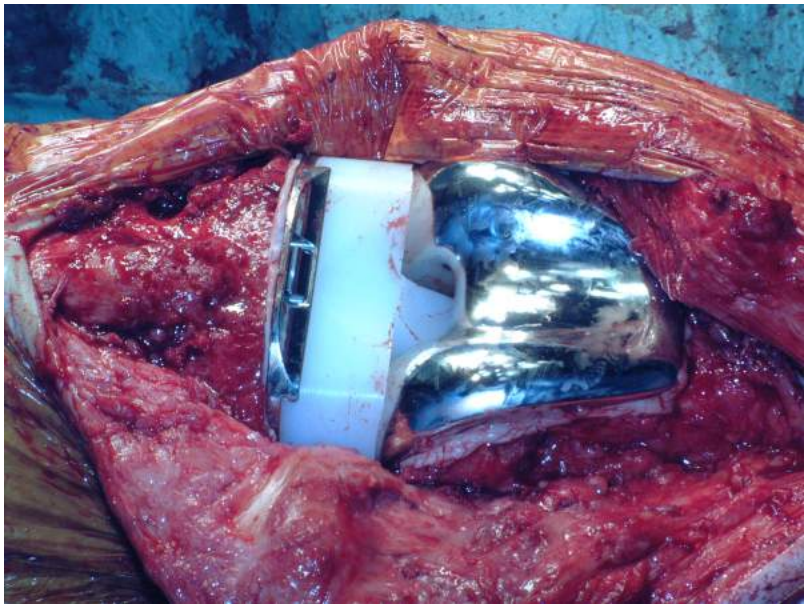

OPEN FRACTURE & SEPTIC COMPLICATIONS

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SUPPLEMENTARY LEARNING MATERIAL:

AO Osteomyelitis Treatment Demonstration (see in a separate pdf file)

INTERESTING ON-LINE TUTORIAL:

1. Go to the following website: https://aotrauma.aofoundation.org
2. Type into the 'search' field: osteomyelitis-infection after ORIF
3. Watch: Video Tutorial: "osteomyelitis-infection after ORIF " (10 minutes)

…OR READ THIS UP-TO-DATE ARTICLE:

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3229263/

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THANKS FOR YOUR ATTENTION!