PLEASE CLICK ON THE FOLLOWING LINK TO WATCH THE LECTURE ONLINE:-

HTTPS://WWW.YOUTUBE.COM/WATCH?V=7Y9LUNWENOE&LIST=PLUBRB5B7FA_EYBVGZ4XB_AQLGCXLIEYRA&INDEX=10

Management of open fractures

AO Trauma Basic Principles Course

Learning objectives

- Specify the goals and principles of open fracture management
- Outline the classification of open fractures and the implications for treatment
- Describe the initial management of open fractures
- Outline the definitive management of soft tissues and the fracture
- Select appropriate techniques to provide stability in open fractures
- Discuss the issue of early soft-tissue coverage
- Appreciate the necessity to collaborate with soft tissue reconstruction surgeons

Goals

- Prevent infection
- Restore function
- Achieve union

Three interdependent goals!

Outcomes

- Define and classify open fractures
- Predict prognosis
- Achieve a rational treatment plan

Classifications

- Gustillo and Anderson
- AO

Gustillo and Anderson

Grade	Wound	Contamination	Soft-tissue damage	Bone injury
I	< 1 cm	Clean	Minimal	Simple, minimal comminution
II	> 1 cm	Moderate	Moderate, some muscle	Moderate comminution
IIIA.	> 10 cm	High	Severe with crushing	Soft-tissue cover possible
IIIB.	> 10 cm	High	Severe loss of cover	Requires reconstructive surgery
IIIC.	> 10 cm	High	**Vascular injury requires repair**	Requires reconstructive surgery

Ganga Hospital score

THE JOURNAL OF BONE & JOINT SURGERY (BRITISH)

A score for predicting salvage and outcome in Gustilo type-IIIA and type-IIIB open tibial fractures

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Limb-injury severity scores are designed to assess orthopaedic and vascular injuries. In Gustilo type-IIIA and type-IIIB injuries they have poor sensitivity and specificity to predict salvage or outcome.

We have designed a trauma score to grade the severity of injury to the covering tissues, the bones and the functional tissues, grading the three components from one to five. Seven comorbid conditions known to influence the management and prognosis have been given a score of two each. The score was validated in 109 consecutive open injuries of the tibia, 42 type-IIIA and 67 type-IIIB. The total score was used to assess the possibilities of salvage and the outcome was measured by dividing the injuries into four groups according to their scores as follows: group I scored less than 5, group II 6 to 10, group III 11 to 15 and group IV 16 or more.

A score of 14 to indicate amputation had the highest sensitivity and specificity. Our trauma score compared favourably with the Mangled Extremity Severity score in sensitivity (98% and 99%), specificity (100% and 17%), positive predictive value (100% and 97.5%) and negative predictive value (70% and 50%), respectively. A receiver-operating characteristic curve constructed for 67 type-IIIB injuries to assess the efficiency of the scores to predict salvage, showed that the area under the curve for this score was better (0.988 (± 0.013 SEM)) than the Mangled Extremity Severity score (0.938 (± 0.039 SEM)). All limbs in group IV and one in group III underwent amputation. Of the salvaged limbs, there was a significant difference in the three groups for the requirement of a flap for wound cover, the time to union, the number of surgical procedures required, the total days as an in-patient and the incidence of deep infection ($p < 0.001$ for all). The individual scores for covering and functional tissues were also found to offer specific guidelines in the management of these complex injuries.

The scoring system was found to be simple in application and reliable in prognosis for both limb-salvage and outcome measures in type-IIIA and type-IIIB open injuries of the tibia.

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The Gustilo-Anderson classification[1,2] is the most widely used means of assessing open injuries, but it has many limitations.[3] Following the original classification; the type-III injuries were further divided into type-IIIA to describe adequate soft-tissue cover of the fracture despite extensive skin loss, type-IIIB which denoted extensive soft-tissue loss, periosteal stripping and exposure of bone, and type-IIIC which described an open fracture with an associated arterial injury requiring repair.[3] The definition has since undergone many modifications and there is no uniformity in its description worldwide.[4-7] Type-IIIB injuries, which are the most challenging, have a wide spectrum. No guidelines can be drawn using the classification for either management or prognosis (Fig. 1). In type-IIIB injuries the skin, muscles, nerves and bones are injured to varying degrees. Although the classification focuses mainly on the soft-tissue injury,[4-6] the extent of the damage to the muscles and bones may be under-represented and of such severity that it influences the final outcome (Fig. 2). The classification is subjective and the inter-observer agreement is also only moderate to poor, highly case-dependent and varies with the experience of the surgeon.[8,9] There is a growing opinion that this classification is not an adequate basis for making decisions for treatment or for comparing published results.[3,7-11]

The classification does not address the question of salvage, but reconstruction of a severe type-IIIB injury can be challenging. The many

The “big 5” in open fracture care

- Treat as an emergency
- Debridement and redebridement
- Stabilize fracture and soft tissue
- Early closure
- Antibiotics

- Skilled resuscitation
- Expert assessment
- Operating room fast
- Adequate debridement
- Appropriate antibiotics and dressing
- Stabilize fracture and soft tissues
- Delayed closure within 72 hours

The “big 5”

- **Treat as an emergency**
- Debridement and redebridement
- Stabilize fracture and soft tissue
- Early closure
- Antibiotics

Treat as an emergency

- General:
  - ATLS 1° survey
  - ATLS 2° survey
  - Tetanus
  - Status of chest, head, cardiovascular system

Treat as an emergency

- Local
  - Do not expose unnecessarily (3–4x increase in infection rate)
  - Saline dressing, alignment, and splintage

Treat as an emergency

- Distal
  - Neurovascular status

The “big 5”

- Treat as an emergency
- **Debridement and redebridement**
- Stabilize fracture and soft tissue
- Early closure
- Antibiotics

Debridement

- Clinical assessment of tissue necrosis
- Highly subjective
- Two discreet phases:
  - Wound irrigation
  - Removal of all necrotic or devitalized tissue including bone

Irrigation

- Gustillo → 10 liters
- Not absolute!
- Warm sterile saline or tap water
- Beware pressure systems
- Remove all foreign material
- “The solution to pollution is dilution”

Debridement

- Not a science, but an art!
- Experience with time
- Sequential
  - Skin
  - Fat and fascia
  - Muscle
  - Bone
- Beware low blood pressure and tourniquet!

Debridement

- No delay!
- Timelines are controversial
- Pitfalls:
  - Insufficient exposure
  - Too cautious
  - Poor planning

Redebridement

- May be difficult to determine the viability of marginal tissue
- → Planned redebridement and secondary wound closure
- Conclusions from “LEAP” study group: The time from the injury to operative debridement is not a significant independent predictor of the risk of infection
- Timely admission to a definitive trauma treatment center has a significant beneficial influence on the incidence of infection after open high-energy lower extremity trauma

Lower Extremity Assessment Project (LEAP)

- Exclusion if t/f longer than 24 hours
- Had to speak English or Spanish
- No psychiatric disorder
- Not on active military duty

?

Treatment = “aggressive debridement, antibiotics, fracture stabilization, early soft tissue cover”

Primary wound closure is dependent on contamination and tension

Advances

- Antibiotic pouches
- Vacuum dressings
- New dressings (silver)
- Hydro-scalpel

Negative pressure wound therapy (NPWT)

- Therapy not dressing
- Manages exudate
- Prevents colonization
- Promotes granulation


V.A.C. VersaFoam™ Small Dressing
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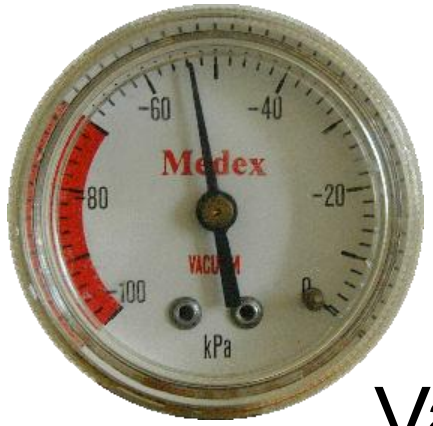
Vacuum components

Tubing

OpSite or Tegaderm

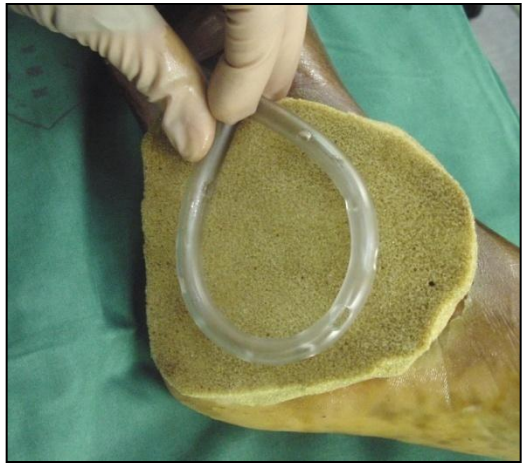
Granuflex seals



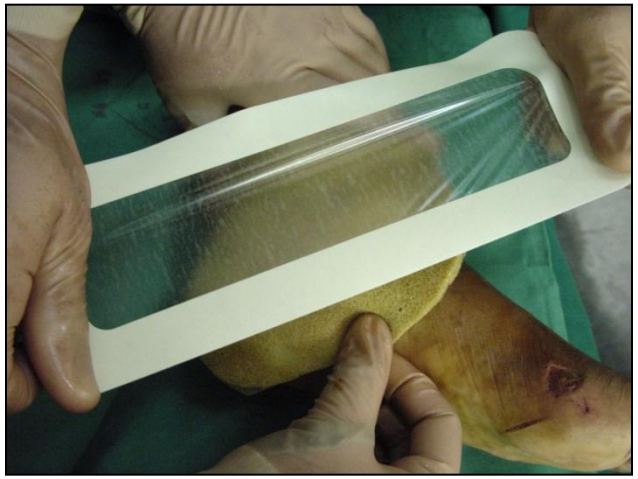
Vacuum

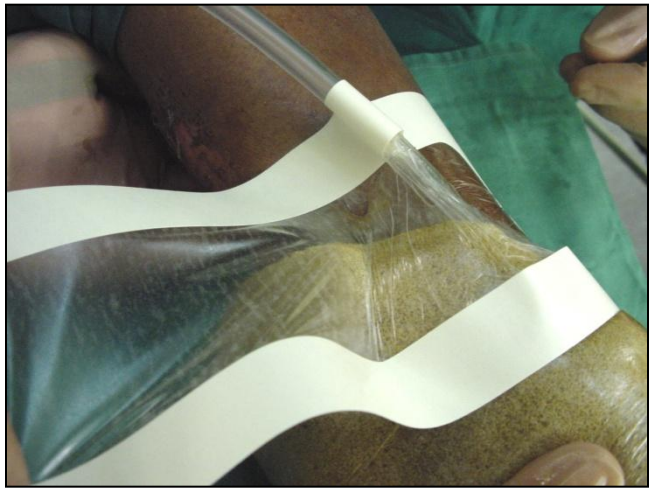
Open-cell foam

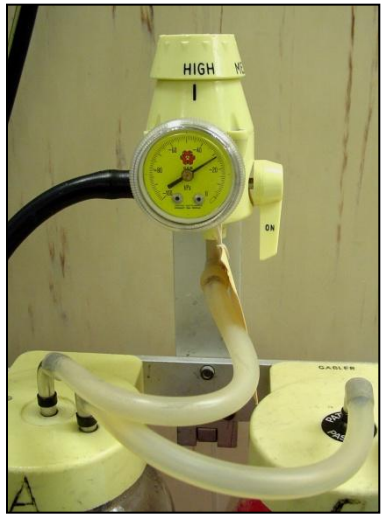
Vacuum dressings

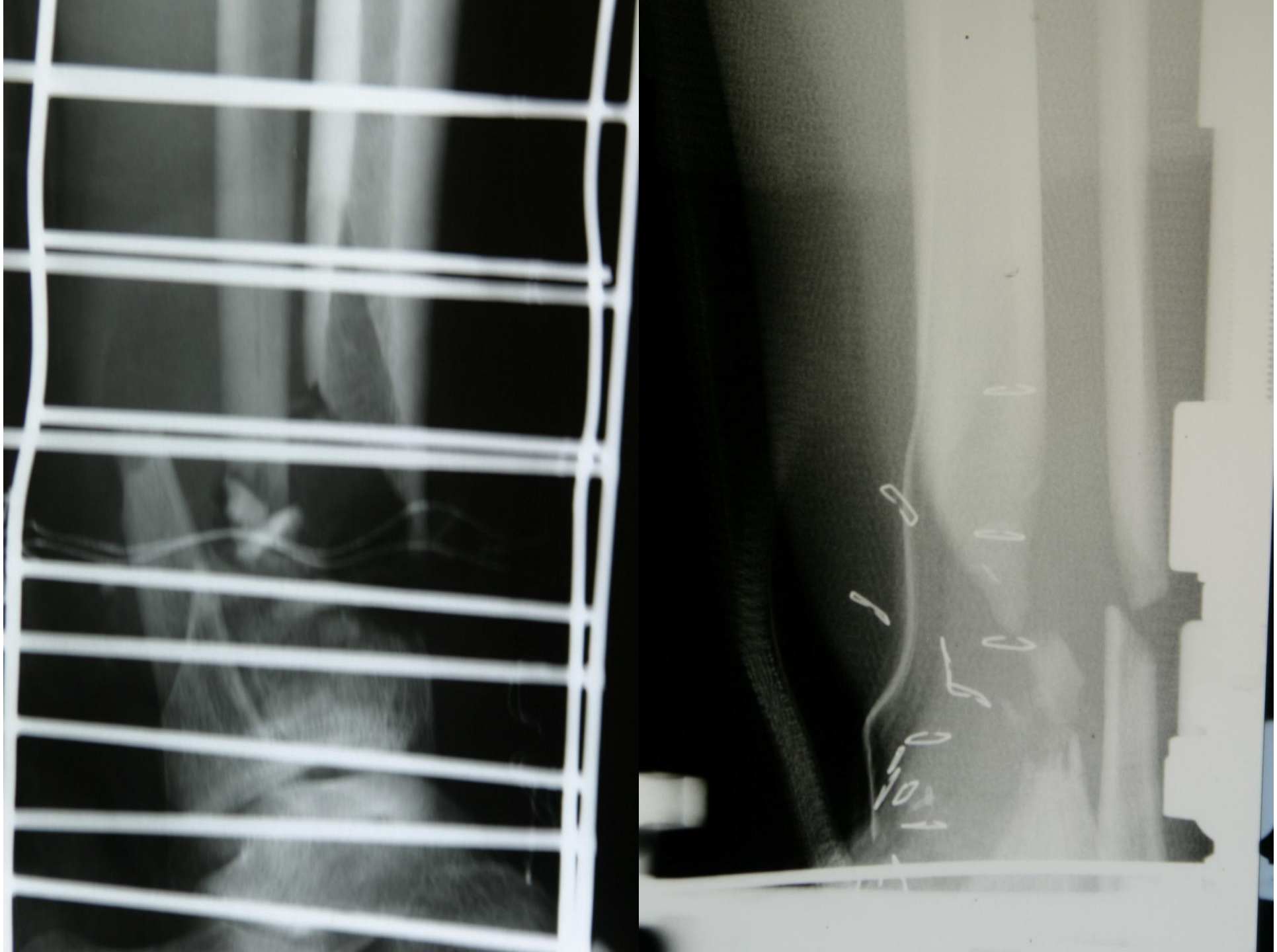


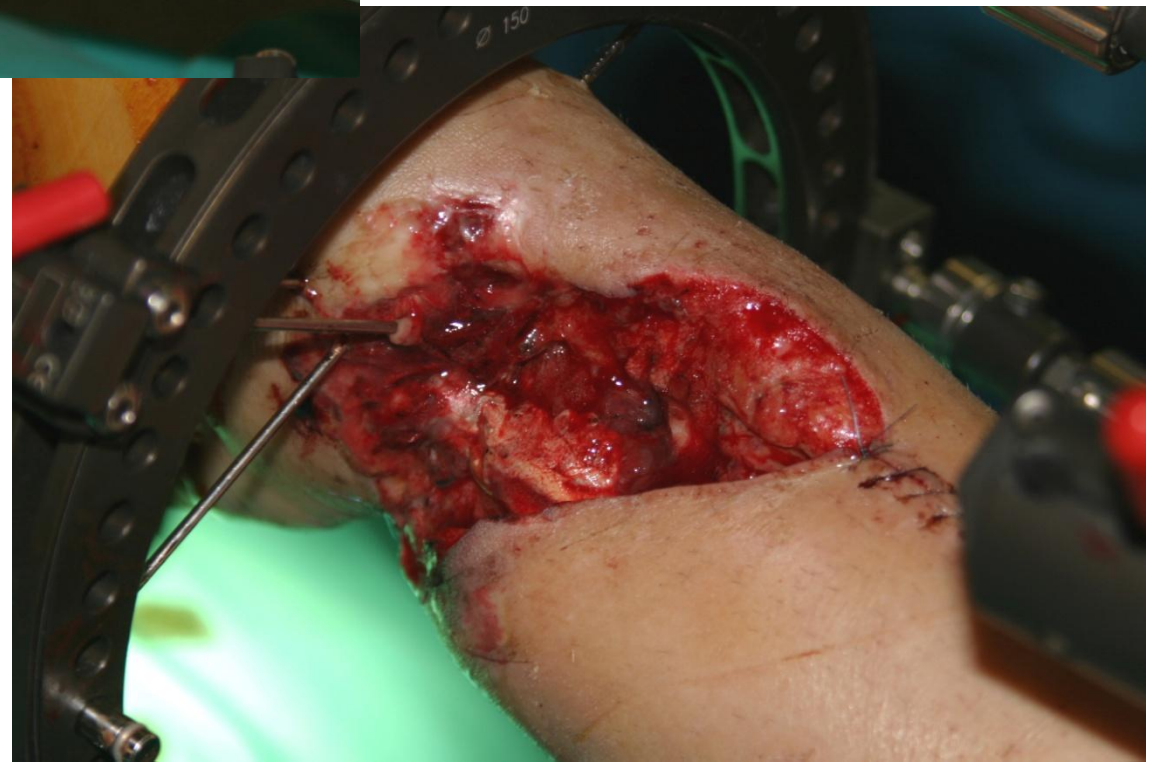
Vacuum dressings












DAY 5


Day 35

18 months

The “big 5”

- Treat as an emergency
- Debridement and redebridement
- **Stabilize fracture and soft tissue**
- Early closure
- Antibiotics

Stabilize soft tissue and fracture

- External fixation:
  - Plan pins
  - Consider temporary versus to completion
  - Understand mechanics

- Internal fixation:
  - Depending on grade, contamination, and delay

“Melville et al.JAAOS January 2010, vol18,no1 and no2”

The “big 5”

- Treat as an emergency
- Debridement and redebridement
- Stabilize fracture and soft tissue
- **Early closure**
- Antibiotics

Closure

- Primary closure

  → Never unless articular

  → Dependent on contamination and tension

- Delayed primary closure → Grade 1 & 2 (3)
- Split skin graft or local/free flap
- Close cooperation with plastic surgeons

Free flap in open fractures

Cover in	72 hours	72 hours – 3/12	≥ 3/12
Number of patients (532)	134 (25%)	167 (31%)	231 (44%)
Flap failure	1 (0.75%)	20 (12%)	22 (9.5%)
Infection	2 (1.5%)	**29 (17.5%)**	10 x
Time to union	6.8 months	12.3 months	2 x
Time in hospital	27 days	130 days	4 x
Number of anesthetics	1.3	4.1	4 x

The “big 5”

- Treat as an emergency
- Debridement and redebridement
- Stabilize fracture and soft tissue
- Early closure
- **Antibiotics**

Antibiotics

- Prophylactic antibiotic therapy proven
- 13.9–2.7% decrease in sepsis rate

~80%

- Open fractures are contaminated by definition

“early treatment”

Antibiotics

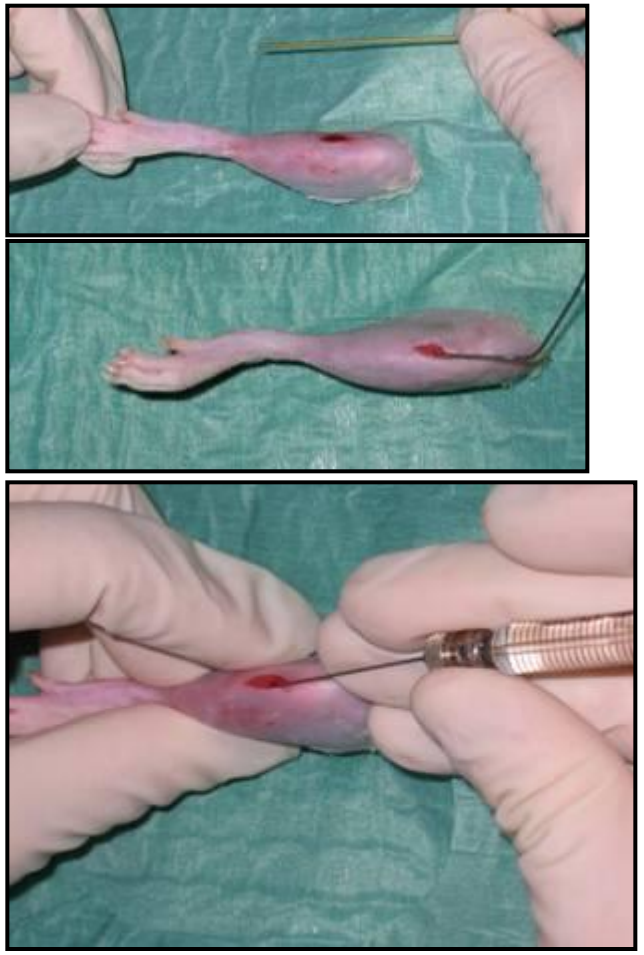
- How? Intravenous (plus local?)
- Which? Protect against Staphylococci
- How long? 24–48 hours (until skin coverage?)

Proportional to severity of injury!

Antibiotic coated nail—preclinical testing—*in vivo*

Rat tibia infection model (Charité, Berlin)

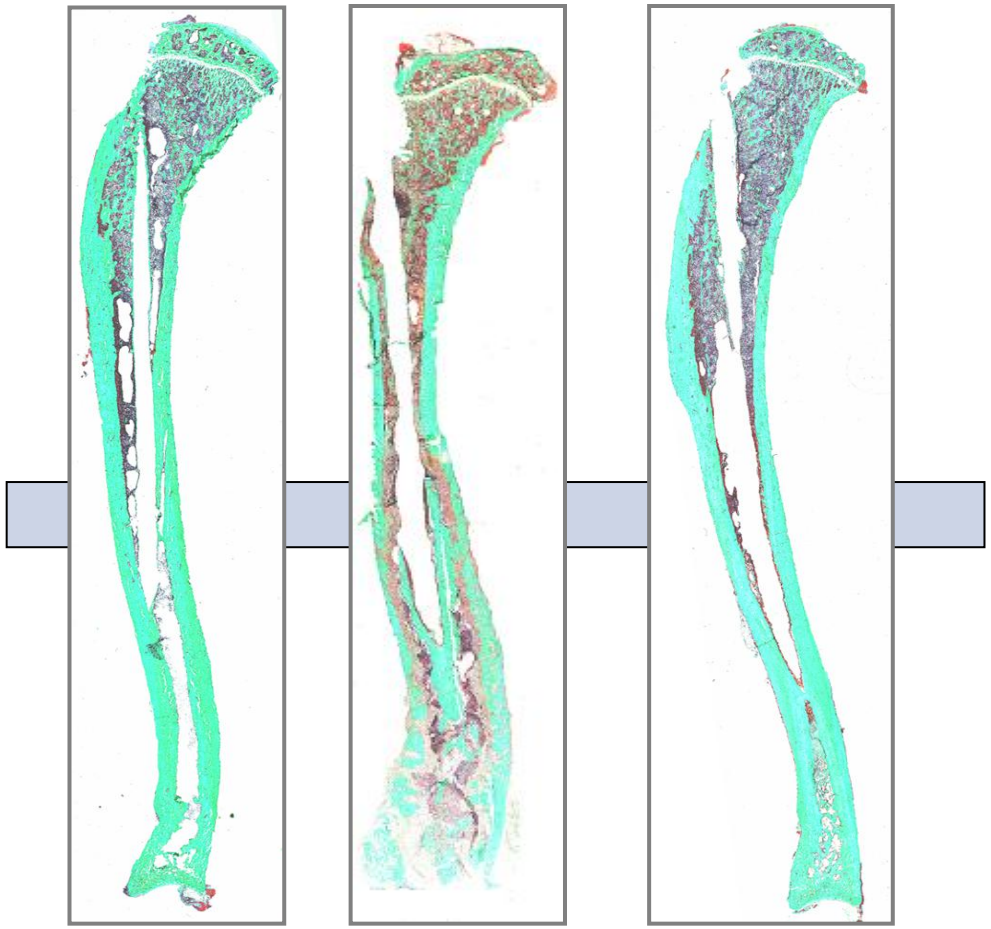
- Reaming of rat tibia with K-wire
- Inoculation with 10^3 CFU of Staph. Aureus
- Insertion of PROtect coated K-wires versus uncoated K-wires
- Control: no inoculum
- 6 weeks implantation
- n=10 per group



Preclinical testing—*in vivo*

Rat tibia infection model

- Histological evaluation:
  - No inflammatory reactions or other adverse events occurred after 6 weeks of implantation in PDLLA + gentamicin coated group
  - No signs of infection in test group versus massive bone resorption and destruction in uncoated group



Control | Uncoated | PDLLA + gentamicin sulfate coated

Preclinical testing—*in vivo*

Rat tibia infection model

- Radiological evaluation:
  - No signs of infection in test group versus clear signs of bone resorption in uncoated control group
  - Bacterial colonization
- Coated group:
  - 3/10: 0 CFU, sterile
    7/10: 182 ± 101 CFU
  - Uncoated group:
  - 10/10: > 1000 CFU

Control | Uncoated > 1000 CFU | PDLLA + gentamicin sulfate coated, 42 CFU

Take-home messages

- Skilled resuscitation
- Expert assessment
- Operating room fast
- Adequate debridement
- Appropriate antibiotics and dressing
- Stabilize fracture and soft tissues
- Delayed closure within 72 hours

Take-home messages: the “big 5”

- Treat as an emergency
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