

General Traumatology

1st Dpt. Of Surgery

University Hospital of St. Anne, Masaryk university, Brno

Polytrauma



“ What people die of ? “

1. Cardiovascular disease (IHD, strokes) 52%
2. Tumors 26%
3. Trauma (external causes) 7%
 - a. Traffic, work, sports, home, industria, criminal

★ Trauma under 40y on 1st place !

Terms and Definitions

Monotrauma - single system injury

Polytrauma - significant injury in at least two body regions (one of which or their combination is immediately life-threatening)

Body regions:

- Head, neck, and cervical spine
- Face
- Chest and thoracic spine
- Abdomen and lumbar spine
- Limbs and bony pelvis
- External (skin)

Injured systemes

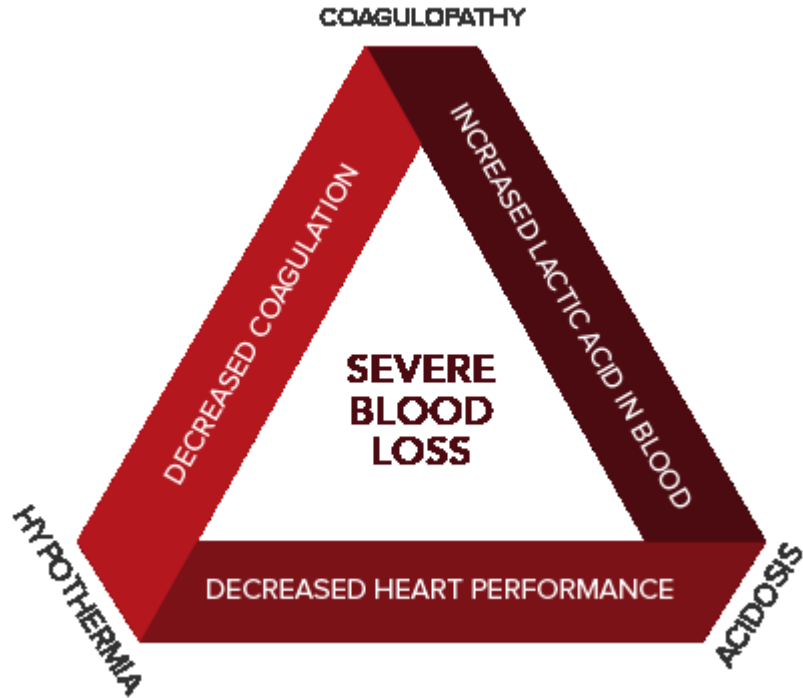
- Limbs 90%
- Skull and brain 72%
- Chest 53%
- Abdomen 29%
- Pelvis 24%
- Spine 10%
- Heart and vessels 10%

“Lethal triad”

1. Hypothermia

1. Acidosis

1. Coagulopathy



Approach to polytraumatised patient

Pre-hospital care (pre-medical, technical, medical)

Transport to the **trauma center**

Damage control

Definitive treatment

3 “R” rule

1. Right patient

1. Right hospital

1. Right time

Field triage (ATLS)

- **Vital signs and level of consciousness**
 - GCS < 13
 - Systolic blood pressure < 90
 - Respiratory rate < 10 or > 29 (or need for ventilatory support)
- **Anatomy of injury**
 - All penetrating injuries
 - Pelvic fractures
 - Two or more proximal long-bone fractures
 - Crushed, degloved, mangled, or pulseless extremity
 - Amputation proximal to wrist or ankle
 - Open or depressed skull fracture
 - Paralysis
- **Mechanism of injury**
 - Falls > 6 meters (second floor)
 - High risk auto crash (ejection, intrusion, death of another passenger, telemetry)
 - Motorcycle crash > 30 km/h
 - Auto vs. pedestrian/bicyclist > 30 km/h
- **Consider special conditions**
 - Age < 6y or > 55y
 - Cardiopulmonar comorbidity
 - Pregnancy
 - etc

Scoring systemes

- Glasgow coma scale
- Abbreviated injury scale (AIS)
- Injury severity score (ISS)
- AO classification
- Tscherne, Gustillo-Anderson

Pre-hospital medical care

1. “ABCDE”
2. Resuscitation
3. Secondary treatment
4. Transport to place of definitive treatment (trauma center)
 - Cervical spine immobilization
 - Immobilization of unstable fractures
 - Analgesia
 - Monitoring

Procedures in trauma patients

1. ABC
2. Urgent procedures
 - Tension pneumothorax, heart tamponade, urgent laparotomy for major bleeding, stabilisation of long bone/hip fractures
3. Acute (3-6 hours)
4. Delayed (1-2 days)
5. Planned (weeks)

Damage control

Resuscitation / surgery / orthopedics

- Analgosedation, OTI + ventilation, volume therapy (TU, FFP, crystalloids/colloids)
- Surgery - life saving procedures in unstable patient, time-limited (max 90')
 - Control of **bleeding, contamination**
 - **return to operating room** after stabilisation on ICU
- Stabilization of long bone fractures (pelvic fractures) - **external fixator**

Death following polytrauma

Trimodal distribution curve

- 1. Immediate death** (on scene) - 50-60%
 - Lethal injuries
- 2. Early death** - 30%
 - Within hours after admission (max. 24 hours)
 - **Potentially reversible** (disruption of airways, blood loss)
- 3. Late death** - 10-20%
 - days to weeks after injury
 - ARDS, sepsis, MOF, PE
 - **Potentially reversible**

Fractures and bone healing



Fracture

- Partial or complete break in the continuity of the bone.
- **Damage to the soft tissues with the breakage of the bone.**



Fractures

(classification basics)

- Traumatic x Pathologic x Stress
- Complete x Incomplete
- Closed x Open
- Extra-articular x Intra-articular

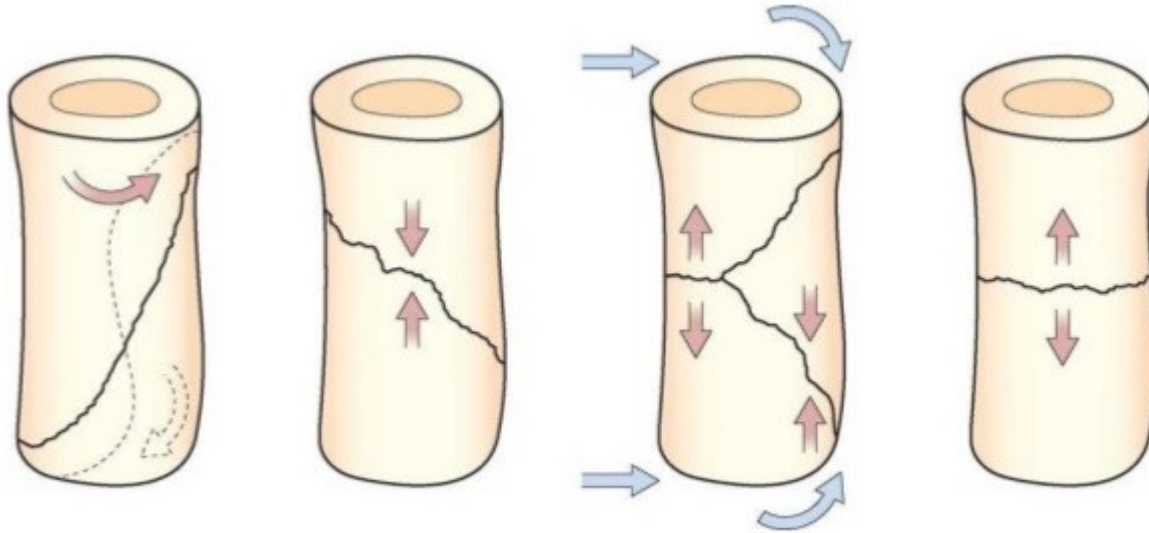
Classification of fractures

- X-ray descriptive / anatomical
- AO classification
- Specific classification systemes
 - e.g. proximal femur fractures (Pipkin, Garden, Pauwels)
 - Salter-Harris (pediatric fractures involving growth plate)
 - Tscherne (open fractures)
 - etc.

Mechanism of fractures

- Energy
 - High energy
 - Low energy
- Forces
 - Direct forces
 - Indirect forces

Some fracture patterns suggest causal mechanism...





Colle's Fracture
(Outward)



Smith's Fracture
(Inward)





X-ray descriptive classification

- **Location**
 - bone and were (diaphysis, proximal femur...)
- **Orientation / fracture pattern**
 - Transverse, oblique, spiral, segmental, comminuted (complex), avulsion, impaction/compression
- **Displacement of main fragments**
 - with contraction/distraction, axial angulation, rotation (twist), lateral displacement (translation)

How to describe this fracture ?

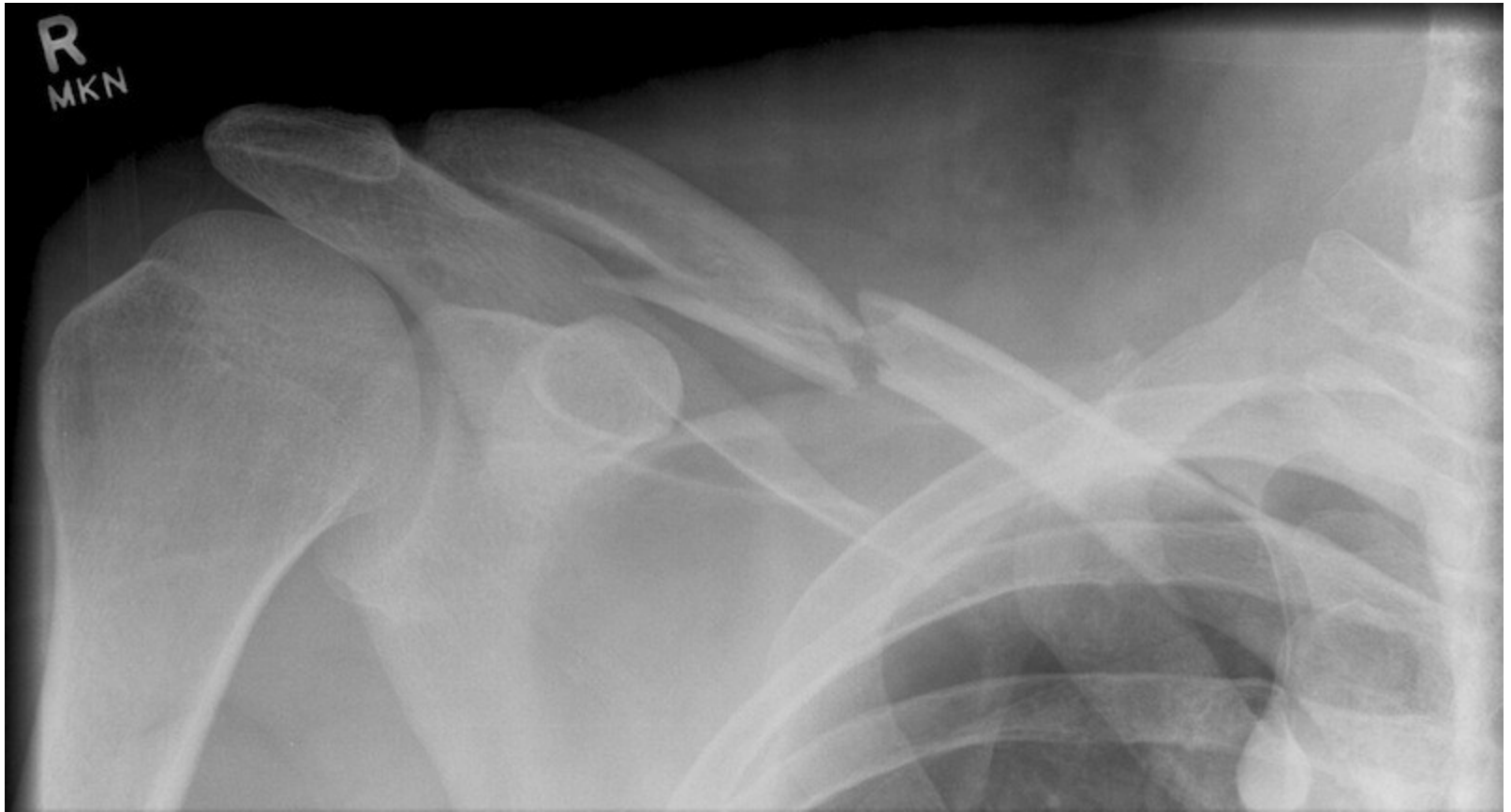












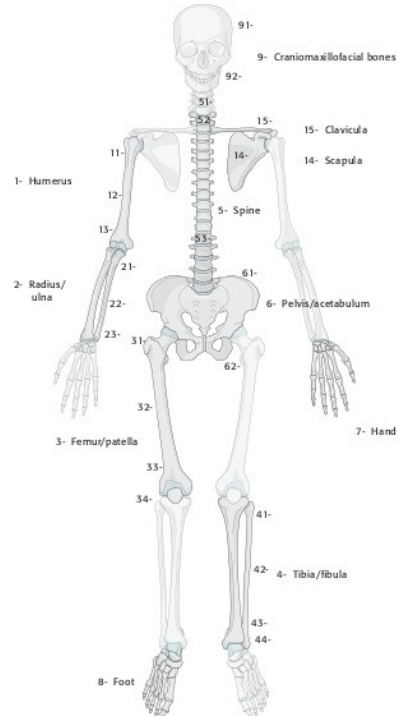




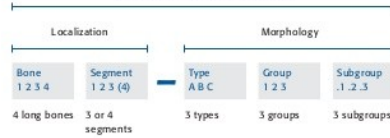
AO classification

AO/OTA system for numbering the anatomical location of a fracture in three bone segments (proximal = 1, diaphyseal = 2, distal = 3)

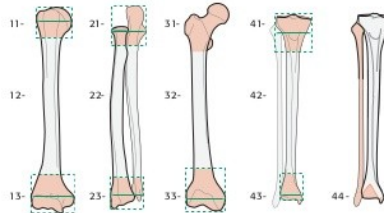
Alphanumeric structure of the Müller AO Classification of Fractures—Long Bones for adults



Diagnosis = "essence" of the fracture



Example 32-B2



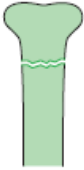


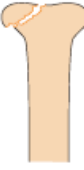
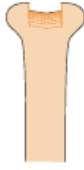
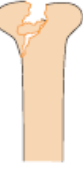
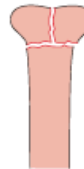

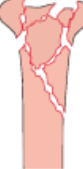
Anatomical location of the fracture. Anatomical location is designated by two numbers: one for the bone and one for its segment (ulna and radius as well as tibia and fibula are regarded as one bone). The malleolar segment (44-) is an exception. The proximal and the distal segments of long bones are defined by a square whose sides have the same length as the widest part of the epiphysis (exceptions 31- and 44-).

Diaphyseal fractures

Type	Group		
	1	2	3
A Simple	 Spiral	 Oblique	 Transverse
B Wedge	 Spiral	 Bending	 Multifragmentary
C Complex	 Spiral	 Segmental	 Irregular



Proximal / Distal epiphysis

Type	Group		
	1	2	3
A Extraarticular	 Simple	 Wedge	 Complex
B Partial articular	 Split	 Depression	 Split-depression
C Articular	 Simple articular, simple metaphyseal	 Simple articular, complex metaphyseal	 Complex articular, complex metaphyseal

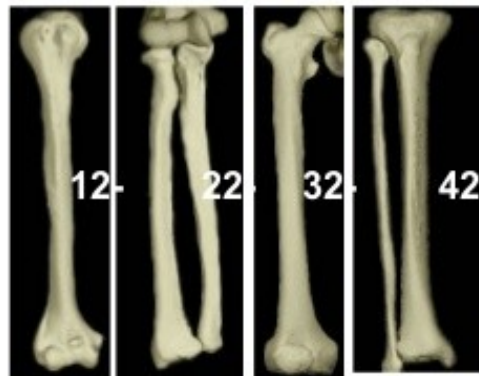
Which type of fracture?

Types A, B, C:

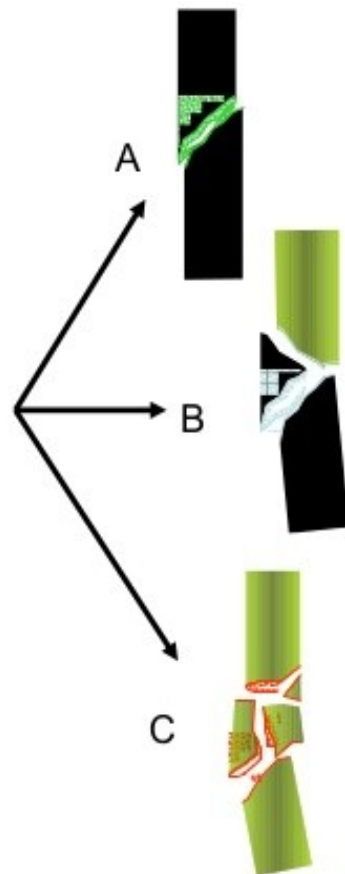
A = simple pattern

B = multifragmentary, wedge

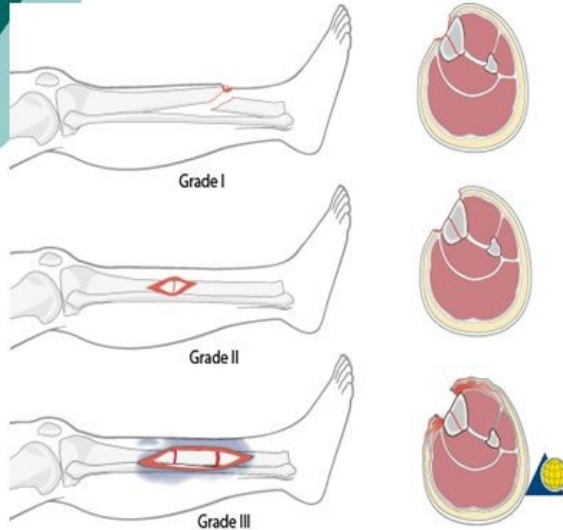
C = multifragmentary, complex



12
22
32
42



Gustilo and Anderson classification (Open Fracture)



Gustilo and Anderson Classification of Open Fractures

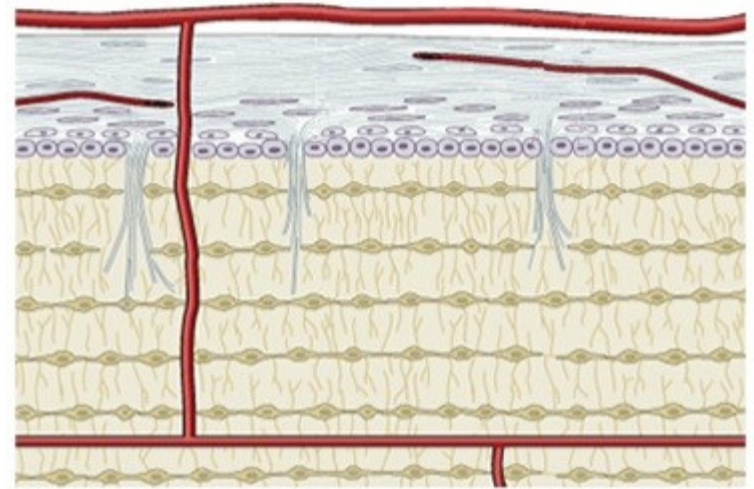
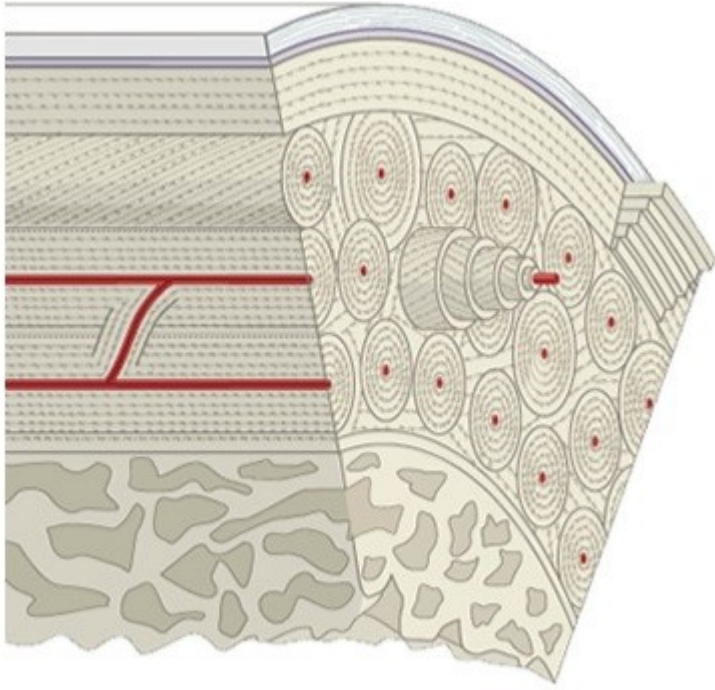
Fracture Type	Characteristics
Type I	Wounds <u>less than 1 cm</u> ; minimal contamination and soft-tissue injury; simple fracture pattern
Type II	Wounds <u>1 to 10 cm</u> ; moderate comminution and contamination
Type IIIA	<u>Minimal periosteal stripping</u> and soft-tissue coverage required
Type IIIB	Significant periosteal stripping at the fracture site; <u>soft-tissue coverage required</u>
Type IIIC	Indicates an associated <u>repairable vascular injury</u>

Gustilo and Anderson. (JBJS 1976)
Gustilo, Mendoza and Williams. (J. Trauma 1984)

Structure of bones

- Mineral component
 - Hydroxyapatite ($\text{Ca}_5(\text{PO}_4)_3(\text{OH})$)
 - strength, stiffness, and rigidity characteristic of bone
- Organic component
 - primarily type I collagen
 - tensile strength and resiliency
- Cortical / cancellous bone
- Periosteum
 - vascular supply - leading role for fracture healing !

Microanatomy of the bone



Bone healing

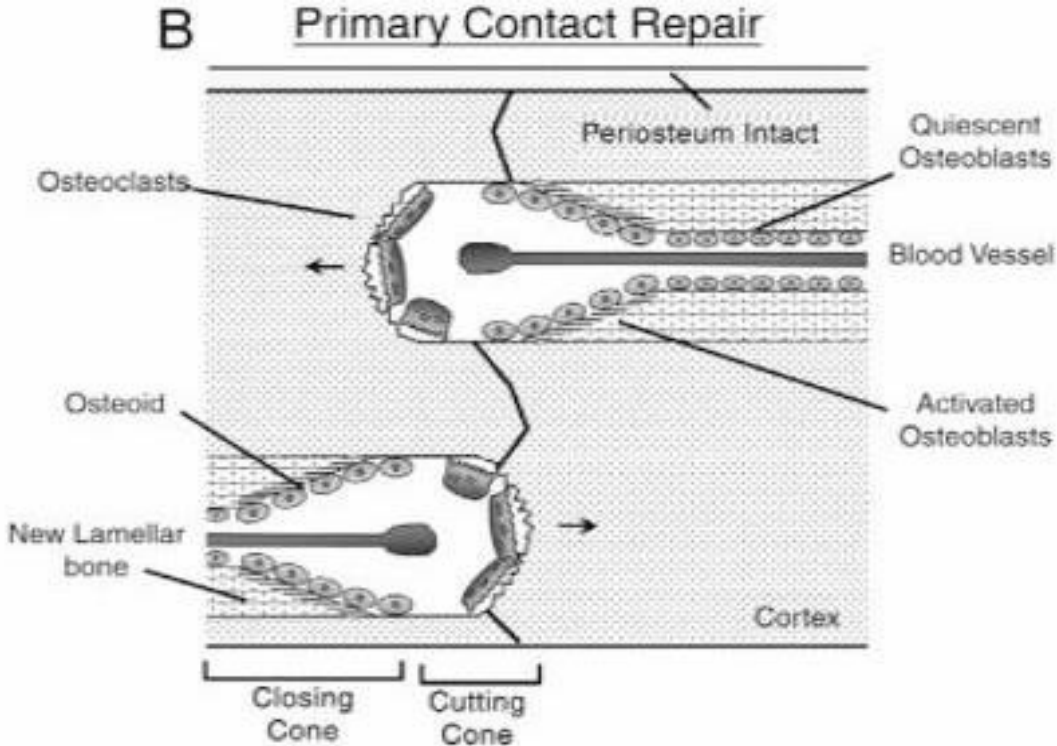
- **Primary (direct) bone healing**

- anatomic reposition and stable fixation
- by direct osteonal remodeling,
- no or minimal callus formation
- need more time to heal strong

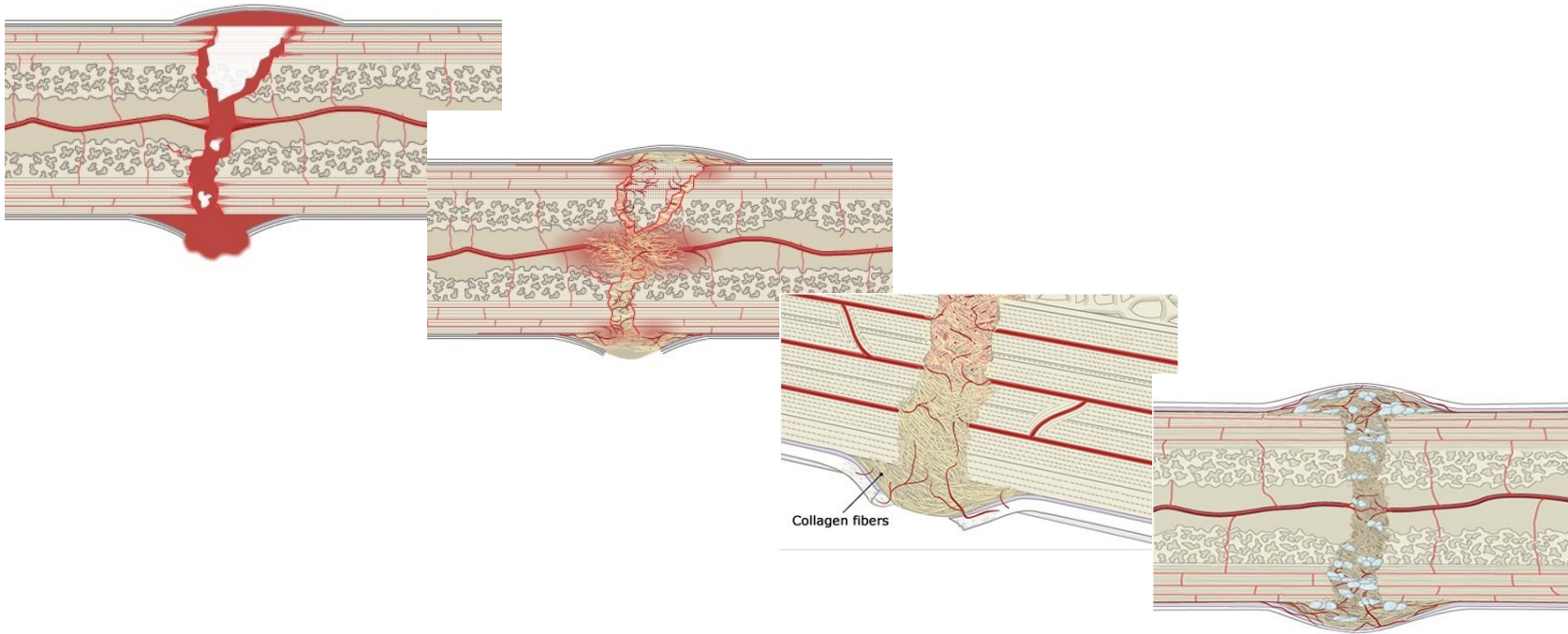
- **Secondary (indirect) bone healing**

- Physiological response of a bone to fracture
- **Sequence of bone healing**
 - Hematoma callus
 - day 1-5
 - Gelatinous callus day
 - day 5-10
 - Granulation callus
 - day 10-15
 - Endochondral ossification
 - day 15-21
 - Remodeling
 - day 21-

Primary bone healing – contact/direct



Secondary bone healing – gap/indirect



Indirect bone healing



Diagnostic approach

- Anamnesis
- Physical exam
 - definite x possible signs of fracture
- X-ray
 - at least 2 projections in perpendicular plane
 - special projections (Judet, Drasnar...)
- Ultrasound
 - including FAST
- CT
 - Intraarticular fractures
 - Cranial, spine, pelvic fractures
 - Doubts on X-ray...
- MRI
 - rarely in acute stage

Fracture management

(in general)

1. Reposition

- Closed x Open

2. Retention

- Plaster
- Internal fixation
- External fixation

3. Rehabilitation

Fracture management

- **Conservative treatment**

- undisplaced or minimally displaced stable fractures, incomplete fractures
- stable fractures after proper reposition and fixation
- (most) pediatric fractures

- contraindication of anesthesia and surgery

- **Osteosynthesis**

- displaced fractures
- unstable fractures
- (most) intra-articular fractures
- open fractures

Principles of osteosynthesis

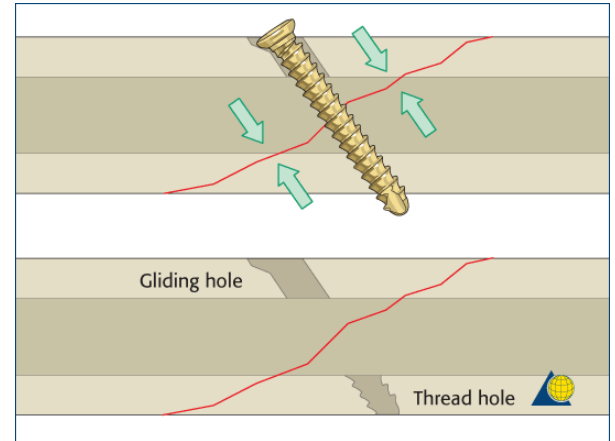
- **Absolute stability**

- **Primary bone healing process**
- Anatomic reposition, interfragmentary compression, minimal motion
 - Lag screw
 - Tension band
 - Compression plate

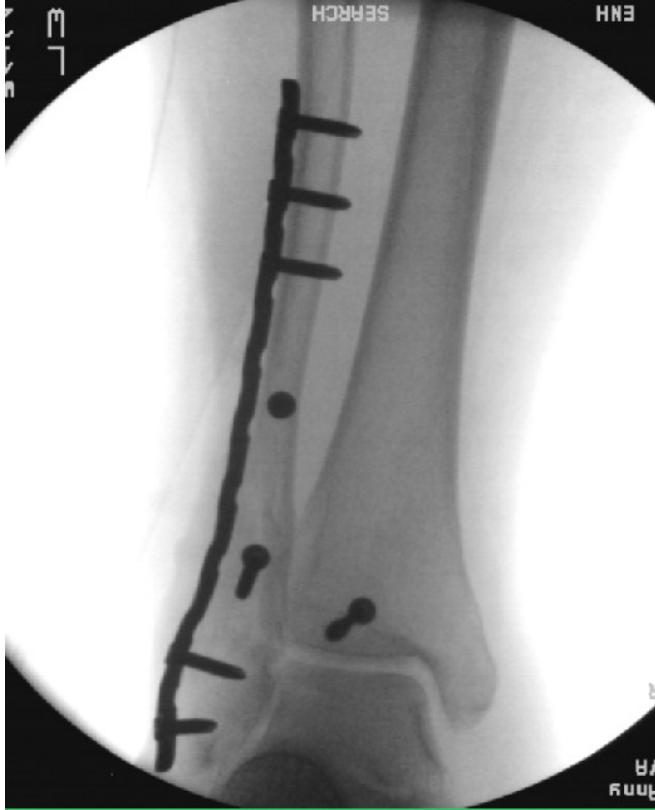
- **Relative stability**

- **Secondary bone healing process**
- Allows small degrees of motion between the fragments
 - Intramedullary nails
 - Bridge plating
 - External fixateur

Lag screw



Absolute stability





Relative stability



Complications of bone healing

1. Prolonged healing, pseudoarthrosis (“non-union”)
2. Aseptic necrosis
3. Infection (osteomyelitis)
4. Secondary dislocation

Open fractures

- Direct communication with external environment (damaged skin integrity)
- Trauma to the bone, soft tissues, risk of infection
- **Tscherne classification**
 - **Ist** - sharp bone fragment tear the skin from inside-out, a small wound /less the 5cm/, small soft tissue injury, low risk of infection
 - **IInd** - traumatic injury from outside-in, contusion of soft tissue, risk of bacterial infection
 - **IIIrd** - high energy trauma, soft tissue defects, risk of injury to large vessels and nerves, primary bacterial contamination
 - **IVth** - devastating injury, subtotal amputation, vessel and nerves injury, ischemia, bacterial contamination

Management (basics)

1. Pre-hospital care
 - reposition (if possible without force), sterile coverage, immobilization (vacuum splint)
2. ATB (broad spectrum) and TAT prophylaxis
3. Revision on aseptic operating room
 - only 25% of open fractures are contaminated before admission
 - debridement and lavage
 - primary skin closer / temporary closer
4. Stabilisation and fixation (Tscherne I,II - OS, external fixator)
5. Rehabilitation
6. (Reconstructive surgery)



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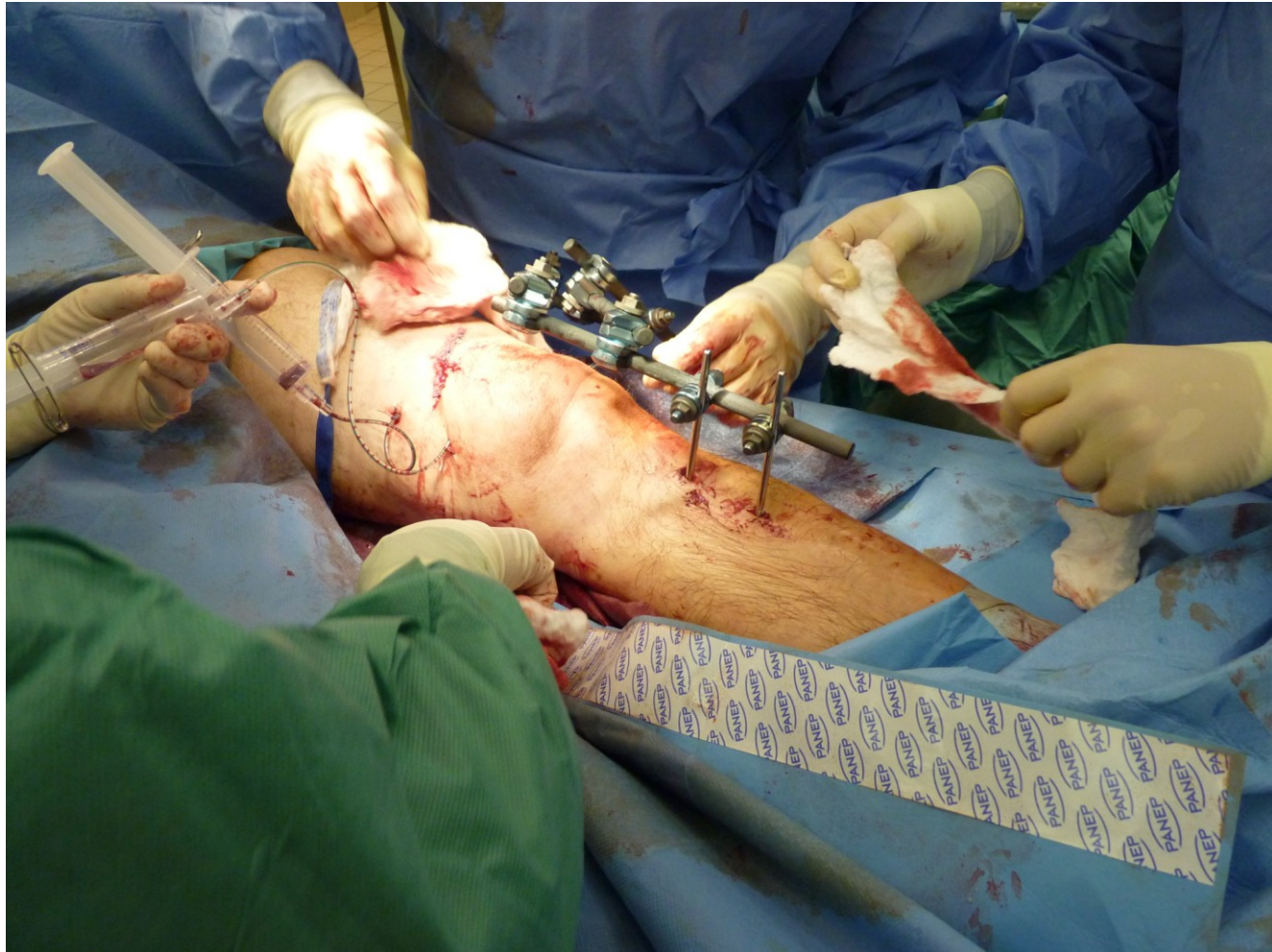
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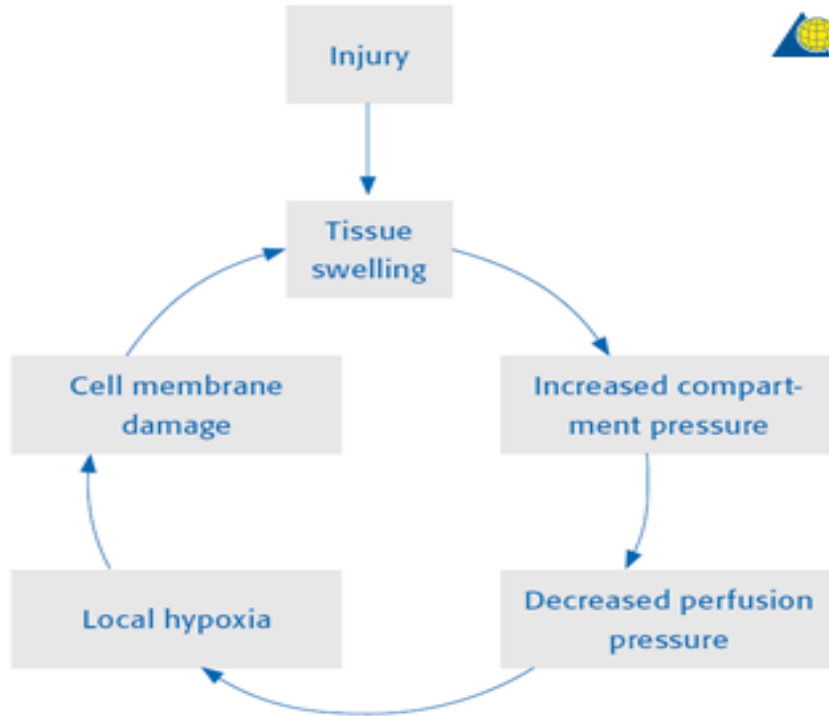
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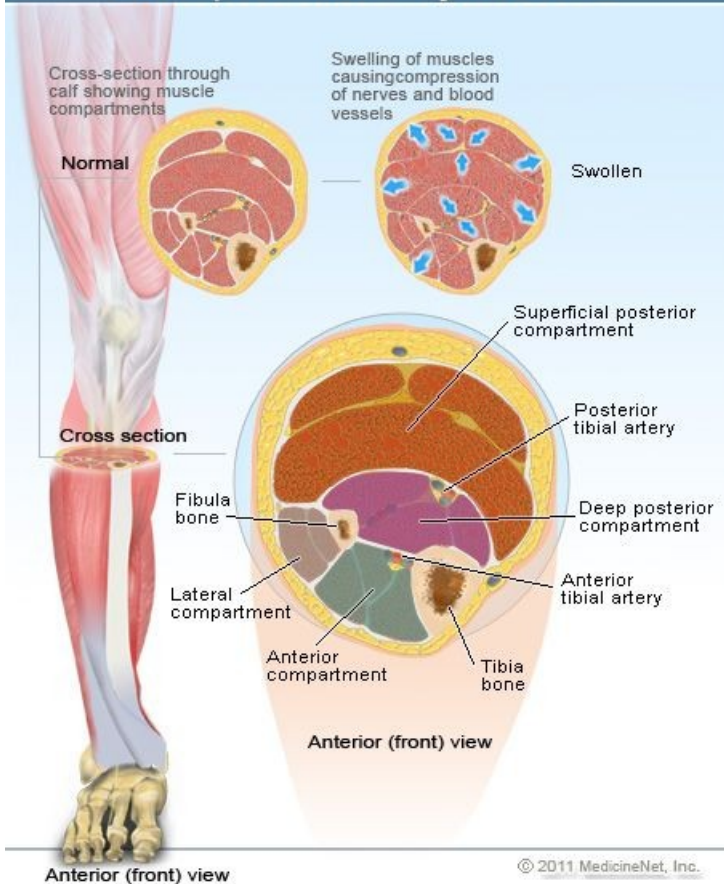




Compartment syndrome



Compartment Syndrome



Where can you expect compartment syndrome?

- Shank
- Thigh
- Gluteal region
- Forearm
- Arm
- Foot
- Hand

- Abdominal cavity!!!

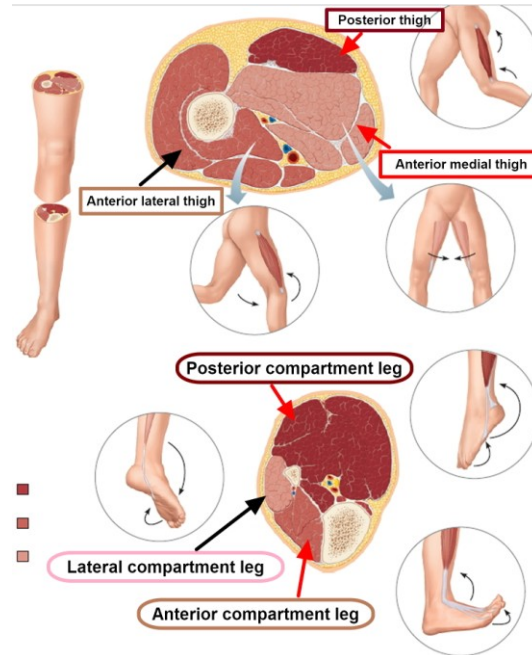
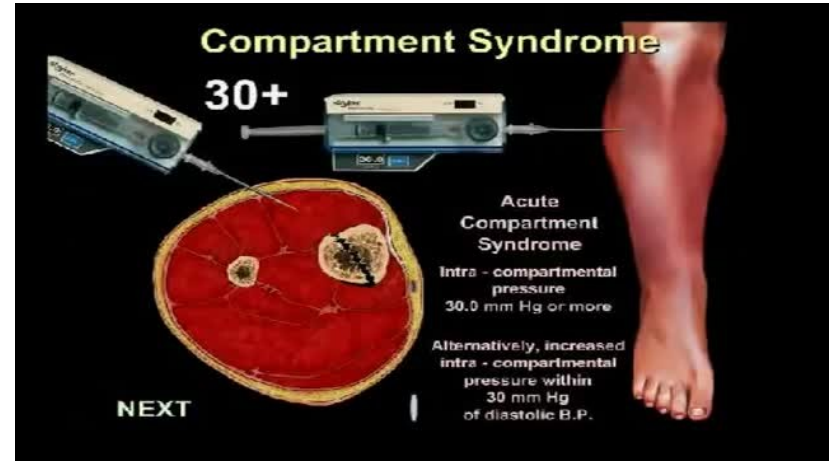


Figure 2 - Laparostomy

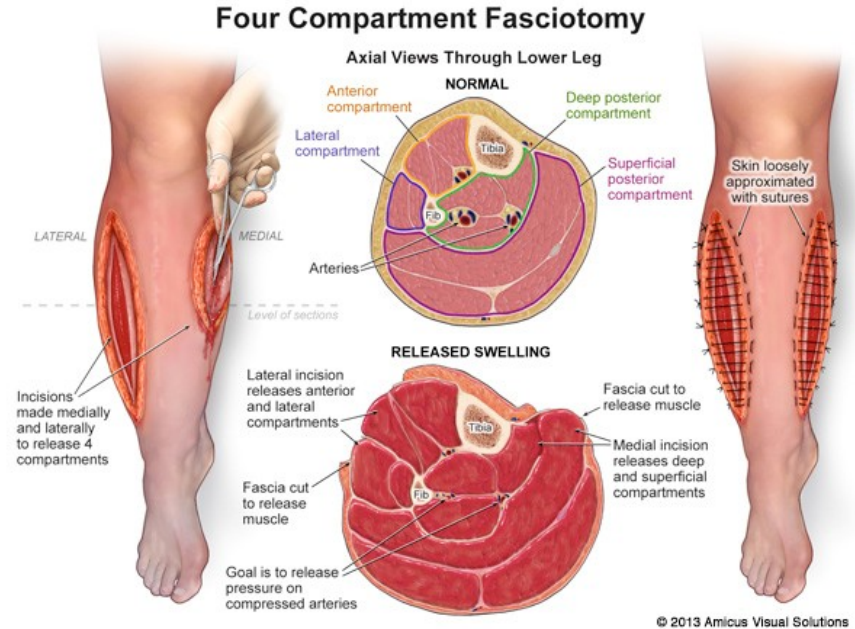
Diagnostic

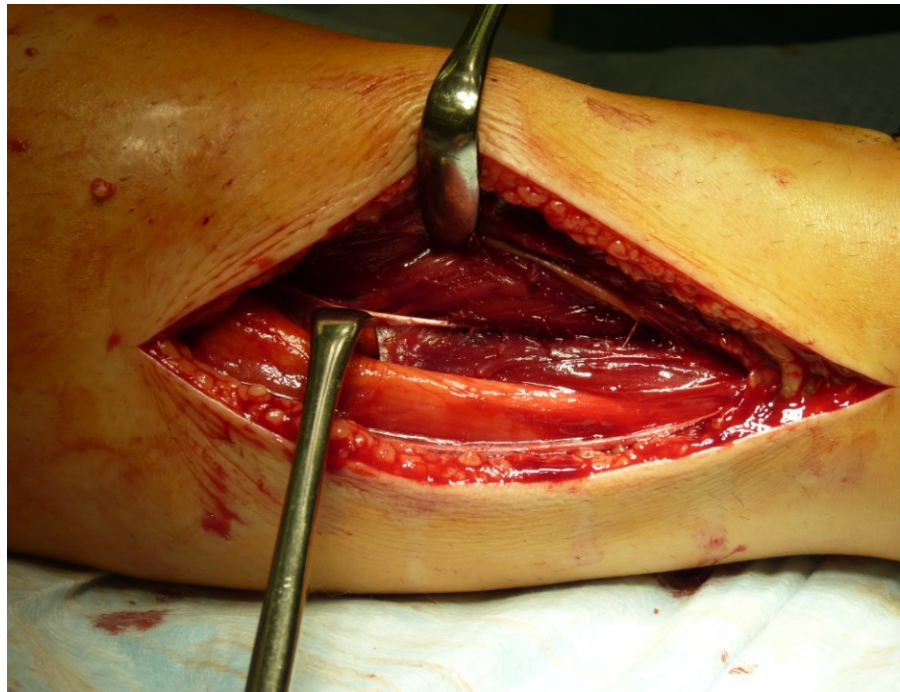
- Increased pain greater than expected, although adequate analgesia
- swelling, tenderness, blisters
- Neurological disability - altered sensation, paresthesia
- Pulsation peripherally intact!!!
- Measurement: more than 30-35mmHg
- Compartment syndrome is a clinical dg. and is not solely determined by pressure measurement!!!!



Treatment - fasciotomy!!! If you are considering fasciotomy, perform it!!!

- Dermatomyofasciotomy
- Releasing ALL compartments
- Identifying source of swelling /bleeding, necrosis/
- Debridement
- Covering:
 - dynamic suture
 - synthetic covering
 - NPWT
 -





Thank you for attention!

