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Polytrauma: MSS, pelvis

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Polytrauma definition



- **Polytrauma:** Simultaneous injury to multiple body regions or systems, at least one of which directly affects life of the injured patient.
- **Multiple injuries:** Usually multiple injuries to the limbs with less severe involvement of other regions (contusions...)
- **Sever monotrauma:** Life-threatening condition in isolated injuries (CC injuries, injuries to the heart, spleen, pelvis...)



Polytrauma



„ Polytrauma and combined injuries require specific treatment tactics and they force us to establish the dominant from the beginning of treatment injuries and subordinated them to the priorities of the treatment procedure. „



Polytrauma



- Head: brain contusion
IC haemorrhage
skull fractures
- chest: ribs fractures, sternal fractures
intrathoracic injuries
- abdomen: diaphragm injuries
intraabdominal and retroperitoneal injuries



Polytrauma- severity of the injuries



- MSS (musculoskeletal system)
 - pelvis
 - long bone fractures
 - intraarticular fractures with dislocation
 - extremities dilaceration
 - spine fractures with/without spinal cord injuries



Pelvis- instability



- Unstable pelvic injuries are rarely isolated.
- Pelvic injuries are often associated with polytraumatized patients.
- Unstable pelvic injuries lead to significant blood loss.
- Significant mortality with unstable pelvic injuries.



shock



„ We defined shock as a life-threatening decrease in blood flow through the organs, which prevents the adequate supply of oxygen and nutrients to the tissues and causes a subsequent disruption of cellular functions. „

- **Haemorrhagic shock** (body response to severe trauma)

- course, levels of the shock:

1. Reaction to a reduced volume /hypovolemia/
2. SIRS



shock



- Haemorrhagic hypotension
- hypotonic tachycardia
- pallor
- cold perspiration
- restlessness
- Rapid thready pulses
- Slow capillary return

Shock index (Allgower): pulses and sBP ratio

$60/120=5$ normal value

$100/100=1$ risk of shock- blood loss 30%

$120/80=1,5$ manifested shock- life-threatening

humerus	200-1000 ml
forearm	400 ml
foreleg	500-1000 ml
femur	1000-2000 ml
pelvis	1000-3000 ml
chest	500-2000 ml
abdomen	500- 2000 ml



Blood loss classification



- I. grade- blood loss up to 15%
 - slight tachycardia
- II. grade- blood loss 15-20% (1000 ml)
 - tachycardia, tachypnoea, decrease in diuresis to 20-30 mL/h
- III. grade- blood loss 30-40% (2000 ml)
 - diastolic in diastolic pressure , decrease in diuresis to 10-20 mL/h
- IV. grade- blood loss more than 40% of volume
 - diuresis less than 10 mL/h, shock index more than 1,3



What is the reaction to bleeding?



- >20-30% causes a washout of catecholamines, vasopressin, aldosterone, cortisol and endorphin
- **Centralisation of the blood stream** – preferential supply of the brain, heart and spinal cord before the kidneys, GIT, skin and muscles...

Note: . In case of severe injury to the CNS, lungs, heart, the defence reaction is suppressed and therefore the immediate consequences of reduced oxygen transport and tissue hypoperfusion are manifested

- **Microcirculation disorder:** - constriction of arterioles and postcapillary venules
 - slowed flow, increased in blood viscosity and aggregation



SLUDGE BLOOD PHENOMENON (muddy blood)- irreversibility

SIRS, MODS, MOF, DIC, ARDS



- **SIRS (systematic inflammatory response syndrome)**

„ syndrome of the bodies systemic inflammatory response to various noxae without presence of infection.“

- at least two symptoms (acute changes in condition, not as a manifestation of another disease)

temperature $>38^{\circ}\text{C}$ alebo $<36^{\circ}\text{C}$

heart rate $>90/\text{min}$

tachypnoea $>20/\text{min}$, $\text{PaCO}_2 < 4,3 \text{ kPa}$

leucocytosis >12 or $<4 \cdot 10^9 / \text{l}$ or $> 10\%$ immature neutrophils



SIRS, MODS, MOF, DIC, ARDS



- **MODS (Multiple organ dysfunction syndrome)**

It is a syndrome in which organs are unable to ensure homeostasis without therapeutic intervention. Affects any organ (kidney failure, liver failure, ARDS, DIC, stress ulcer...)

- **MOF (Multiple organ failure)**

It is an extreme form of MODS. It does not have generally recognized diagnostic criteria.

- **DIC (Disseminated intravascular coagulation)**

A coagulation disorder is acquired in which haemostasis is activated with the formation of coagulation factors and bleeding.



SIRS, MODS, MOF, DIC, ARDS



- **ARDS (acute respiratory distress syndrome)**

Reaktion of the pulmonary endothelium to inflammatory mediators (so called shock lung). Exudative pulmonary oedema occurs due to increase capillary permeability.

- **Lethal triad**

- Hypothermia (core temperature <34 induced coagulopathy and $<$ thrombin)
- Coagulopathy (blood loss leads to lack of coagulation factors and DIC)
- Metabolic acidosis (increase of lactate in ischemic tissues)



Damage control surgery



„ DCS represent temporary, life-saving operations in the polytraumatized patient. The duration of the operation should not exceed 90 min., because then there is a significant increase in postoperative complications.“

- include:
 1. Damage control surgery (DCS)- laparotomy, thoracotomy
 2. Damage control orthopaedics (DCO)- pelvic and extremities
 3. Damage control Resuscitation (DCR)



Damage control surgery



- Goal of procedures:
 1. Simplification and shortening of surgical control of bleeding and contamination
 2. stabilization of potentially fatal problems of the first operative revision

Stone, 1983: the first described procedures with improved results in the treatment of polytraumatized patients...



Damage control orthopedics



- Minimally invasive techniques for primary stabilisation of the pelvis and extremities fractures in cases of haemodynamically unstable patients.
1. Bleeding control
 2. Control of ongoing immunological influence



Damage control orthopedics



- External fixator- primary tool for temporary fixation of the pelvic and extremities fractures
- advantage:
 1. sufficient stability
 2. mini-invasive
 3. wound care
 4. preventing complications (infection)



ATLS



- The advance Trauma Life Support Program (ATLS)
- ATLS teaches that each injured patient should receive the same orderly sequences of evaluations and interventions, according to the mnemonic A-B-C-D-E



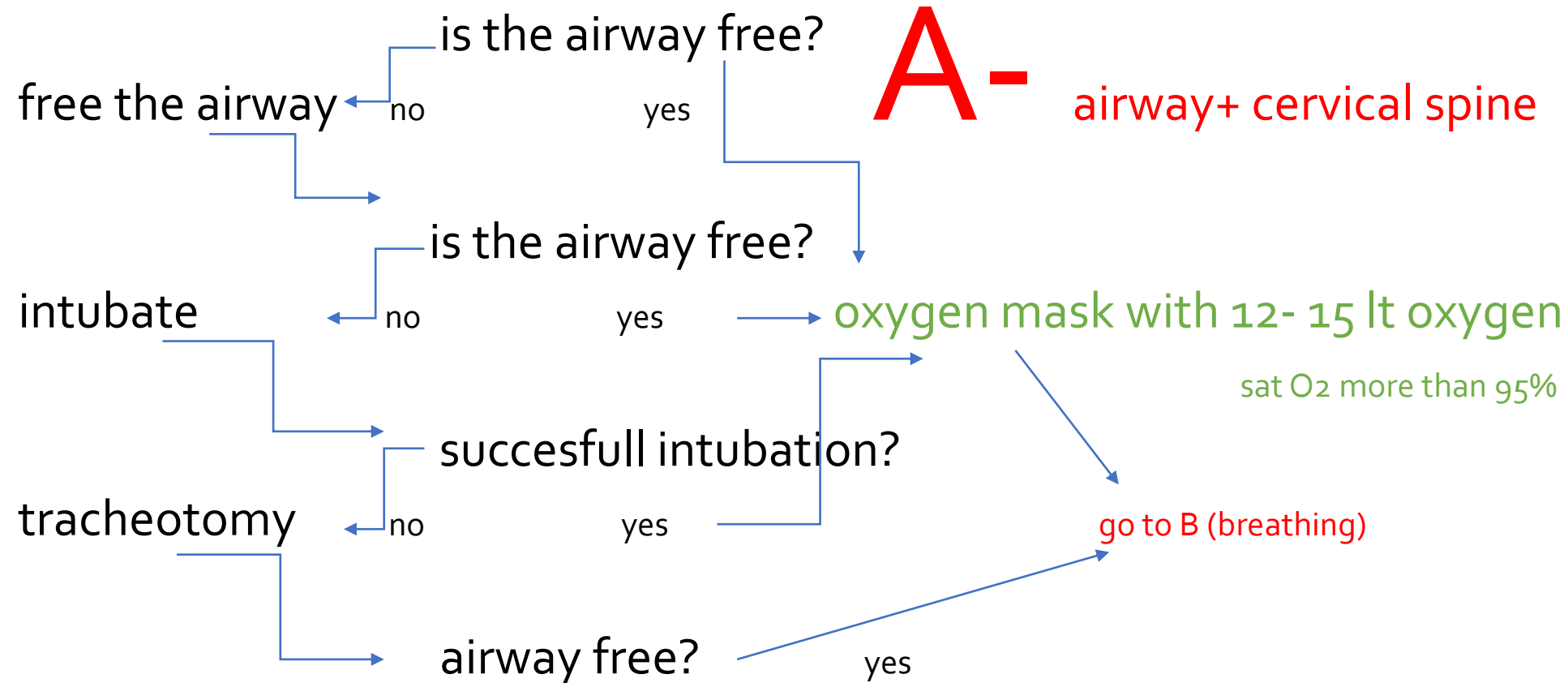
ATLS



- **A**- Airway
- **B**- Breathing
- **C**- Circulation and bleeding control
- **D**- Disability (neurologic status)
- **E**- Exposure (undressing) and Environment



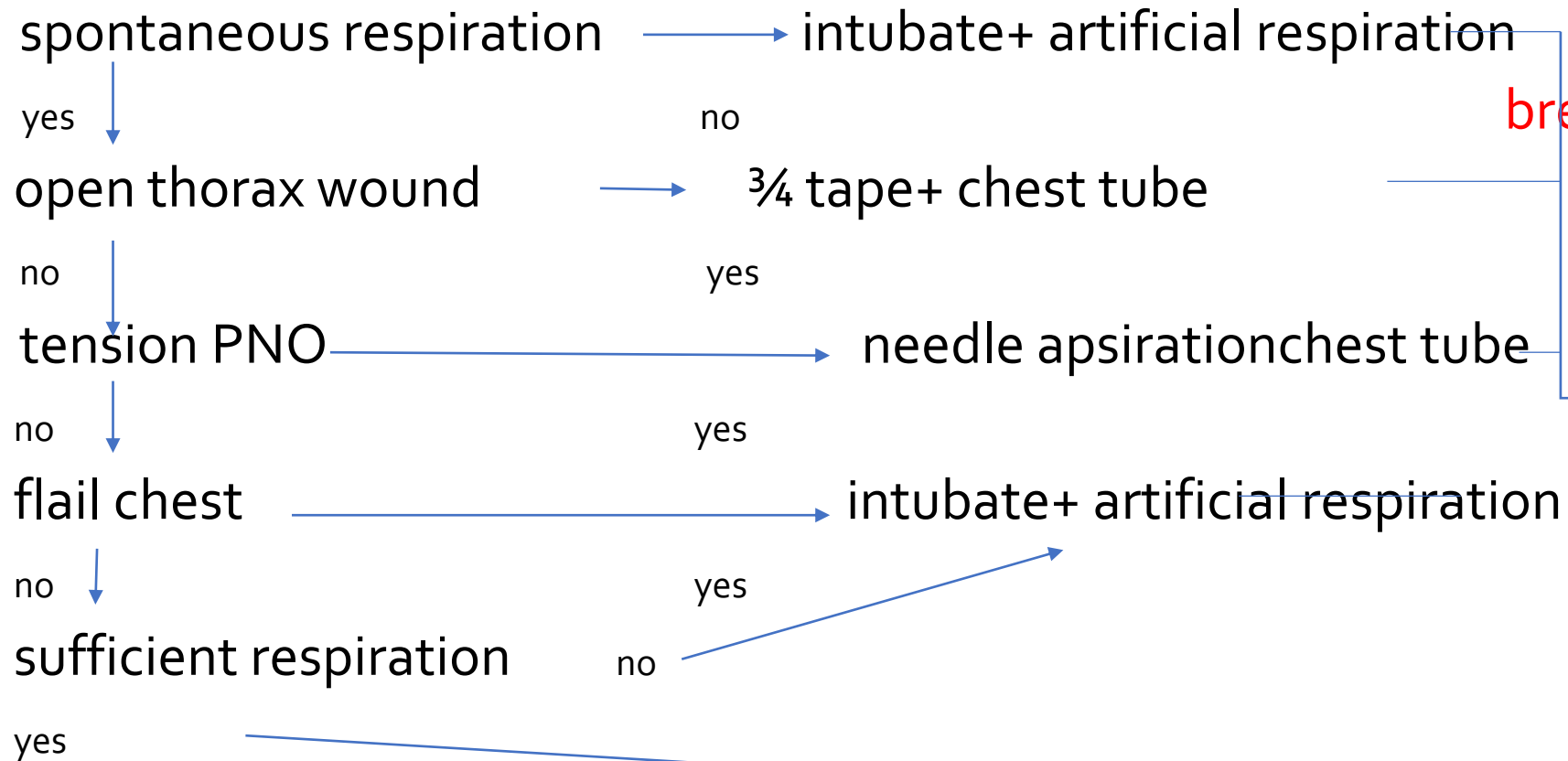
ATLS (A)



ATLS (B)



B



breathing

adequate ventilation:

- resp. rate 10-29/ min
- bilateral ventilation
- no flail chest



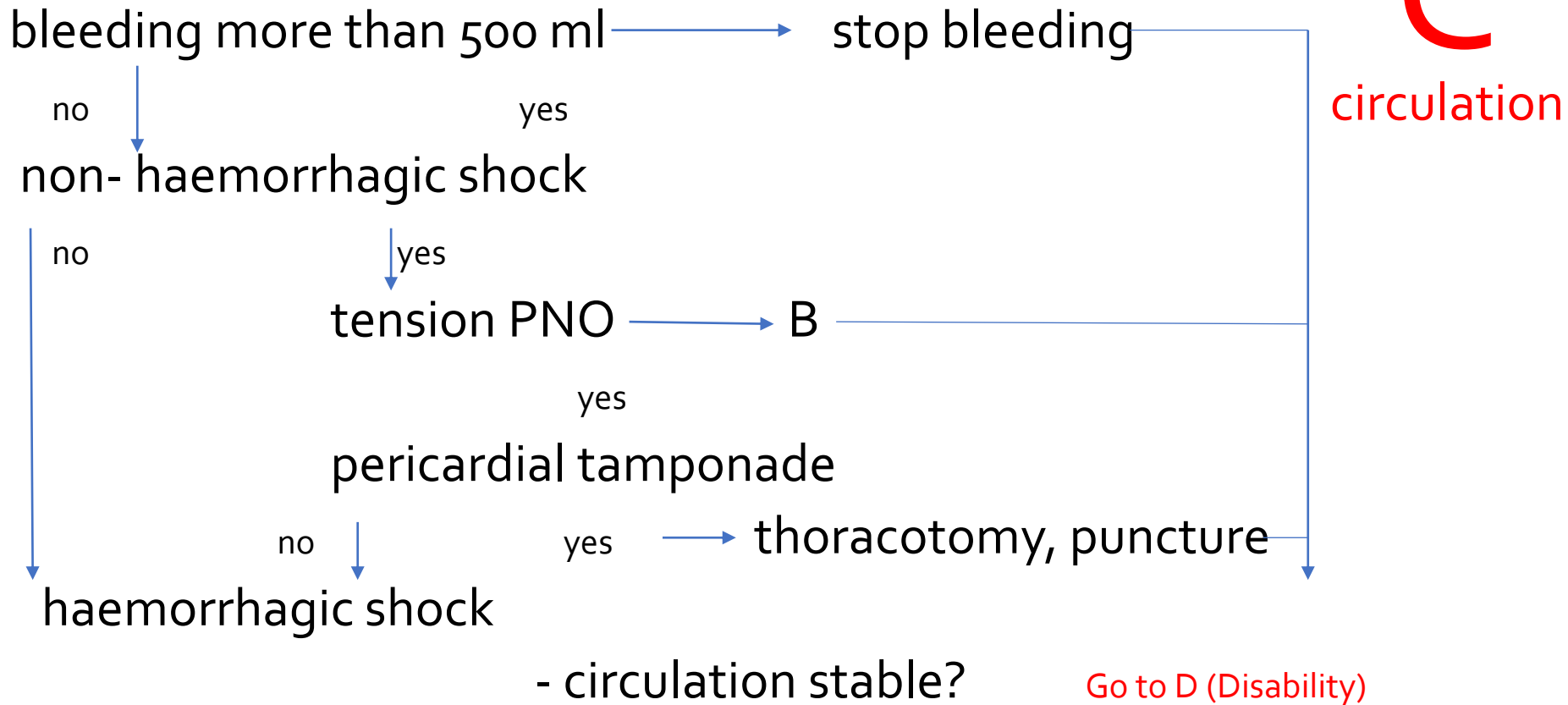
ATLS (C)

- Skin pale, cold
 - Tachycardia
 - tachypnoea
 - Mental status
-
- Hypotension severe shock

bleeding? - chest
- abdomen
- pelvic
- prox. extremities
- external



ATLS (C)



ATLS (D)



- Rapid neurological evaluation in all polytrauma patient **disability**
- In the meantime, the patient is completely immobilized using head blocks, cervical collar and long spine board
- **Glasgow Coma Scale:** **eye response**
verbal response
motor response



ATLS (D)



- Unequal pupil size
 - *n. oculomotorius* compression by increased IC pressure
 - ipsilateral IC compression
- patients with GCS less than 8 need endotracheal intubation
- If deterioration is observed: CT scan of the brain and neurological examinations needed



ATLS (E)



- Exposure and environmental control
- Prevent hypothermia
 - Warmed liquids to 40° C
 - Room temperatures is raised to 28° C
 - Warm covers are used to prevent loss of body heat
 - Skin should be dry and cleansed of blood and ultrasound gel



ATLS



- A-B-C-D-E are basic elements in primary survey.
- Periodic evaluation with the same sequences are necessary
- Immediate reassessment if the patients conditions worsens .



ATLS



- **Primary survey** is completed, if the patients vital functions are stable.



after resuscitation and patients stabilization **!!!**

- **Secondary survey**- systematic patient examination



Acute phase



- X-ray thorax → pozit. → Chest tube or thoracotomy
- X-ray pelvis → pozit. → Pelvic stabilization
- FAST → pozit. → laparotomy



FAST



- DEFINITION: Focused Assessment with Sonography in Trauma
- Quick USG examination of the presence of free fluid in the cavities (thorax, abdomen, pericardium)
- Represent initial examination at the emergency department





- **Skiagraphy**- X-ray chest and heart (acute phase)
 - X-ray pelvis (acute phase)
 - X-ray abdomen (pneumoperitoneum?- lost meaning)
 - retrograde uretrocystography
- **Ultrasonography**
 - FAST (peritoneum, retroperitoneum, pleural space, pelvis)
 - classical USG of the abdomen- more sensitive as FAST
- **CT**
- **MRI**- apart from neurological indications, there is no diagnostic algorithm
- **Angiography, interventional radiodiagnosis**



CT examination



- CT- Computer Tomography
- Gold standard
- advantages:
 - quick
 - quality diagnostics (better image quality and reconstructions)
 - dynamic in phases (extravasation)
- CT polytrauma- contrast CT is a golden standard



CT



1. cavities- brain, thorax, abdomen
2. pelvis
3. Skeletal injuries- spine, extremities
4. Contrast examination- arterial phase (bleeding)
 - venous phase contrast deposits
 - CT uretrography, cystography)



Trauma team



- basic
 - anaesthesiologist
 - trauma- orthopaedic surgeon
 - surgeon
 - nurses from anaesthesiology+ surgery
- Another specialist
(thoracic or vascular surgeon, neurosurgeon, maxillo-facial surgeon...)
(pneumologist, specialists...)



Pelvis ring- instability

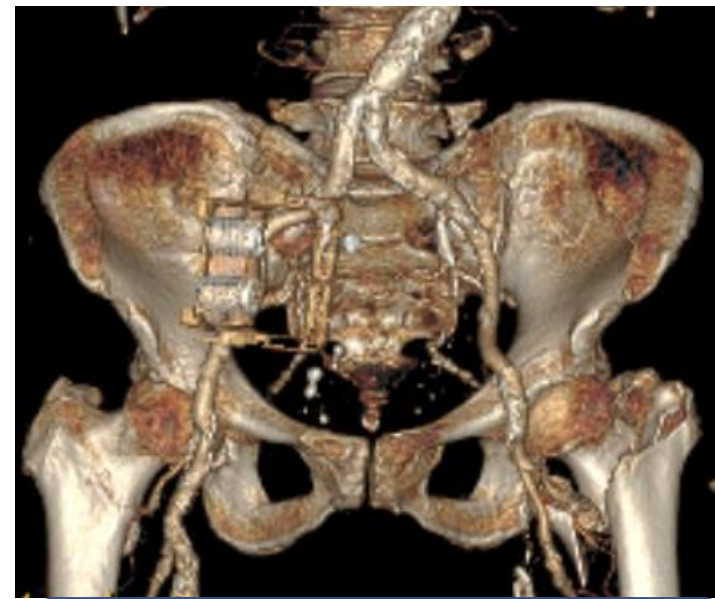


- Unstable pelvic injuries are rarely isolated.
- Pelvic injuries are often associated with polytraumatized patients.
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Pelvis

- Anatomy: - two hemipelvis and sacrum
- symphysis a SI joints
- ligaments
- Segments
 - **anterior**
 - **posterior**



symphysis
pubic rami



Iliac bones
SI joints
sacrum



Acute management and reconstruction of the pelvic ring



- Pelvic ring stability
- Fixation methods



Stability- pelvic ring



„ Stability is the ability of anatomical structures (pelvic ring) to resist to physiological forces without deformation. „

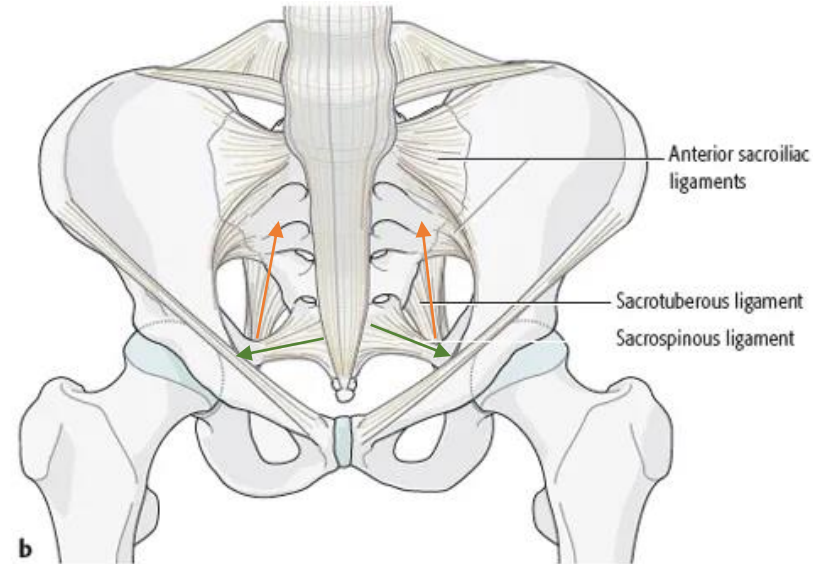
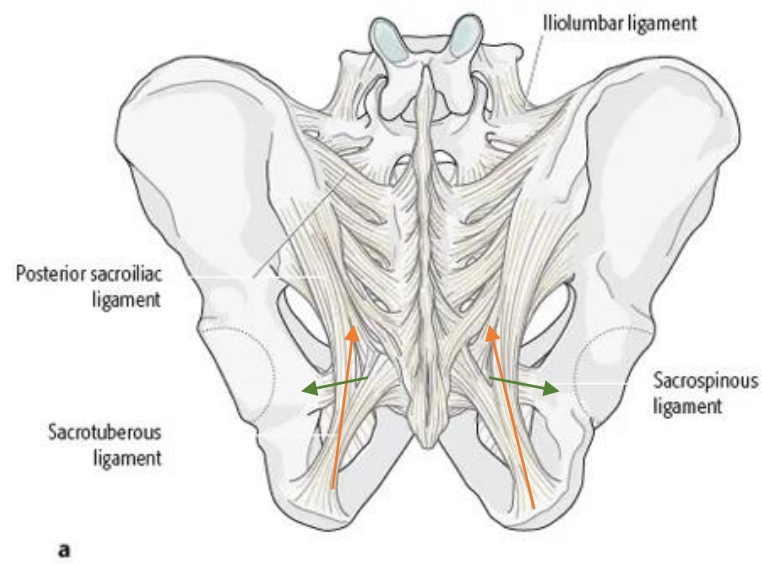
Marvin Tile



Pelvic ring stability



- Importance of the posterior complex- ligaments and bones (80 % of the load)



AO- OTA classification



Stable posterior segment
Type **A**



Partial posterior instability
Type **B**



Complete posterior instability
Type **C**



Young-Burgess classification

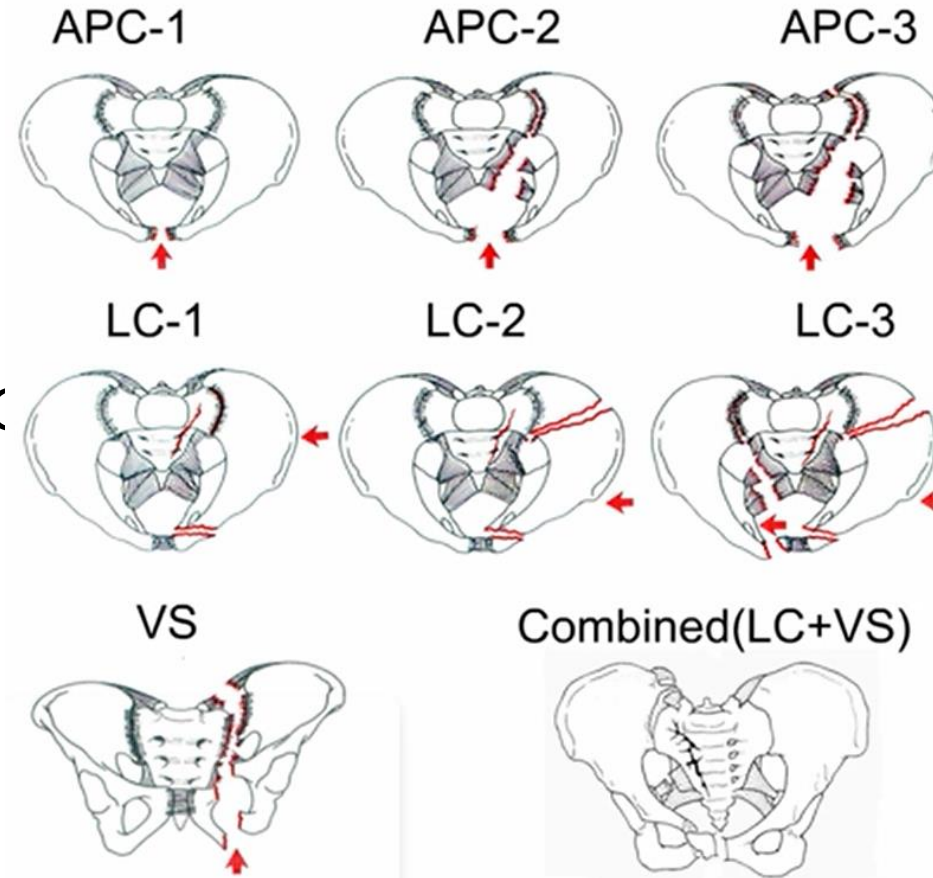


- Based on posterior complex injuries and mechanism

- Usable

- Higher number= more serious injuries

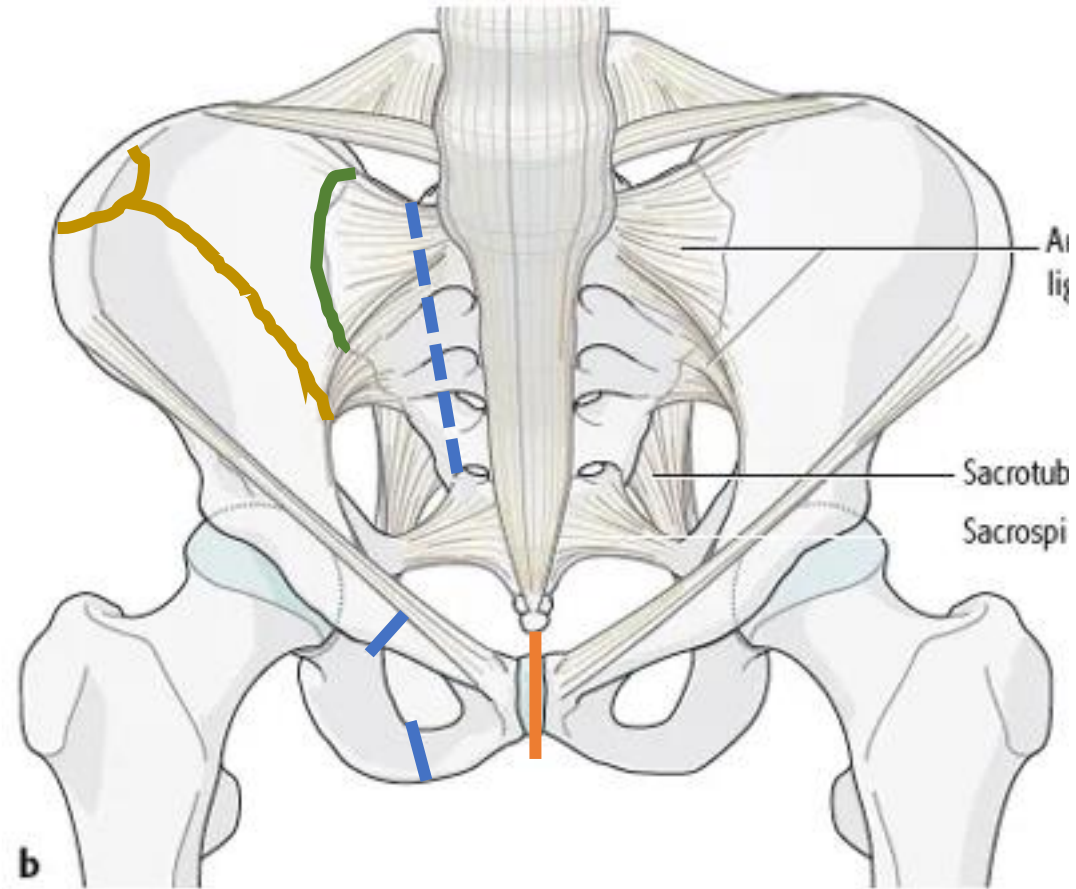
- MP- antero-posterior compression APC
 - lateral compression LC
 - vertical displacement VS
 - combined (LC+VS)



Pelvic ring injuries



- anterior segment
 1. Symphyseolysis
 2. Pubic rami fractures
- posterior segment
 1. Iliac crest fractures
 2. SI joint instability
 3. Sacral fractures



Treatment options



- SKELETAL INJURIES

Temporary fixation: **External fixator or C-clamp**

Definitive: plates, screws, Exfix

- ASSOCIATED INJURIES

bleeding: extraperitoneal packing v.s. angioembolisation...

Uropoetic tract: PK, epicystostomy, urethral and bladder sutures...

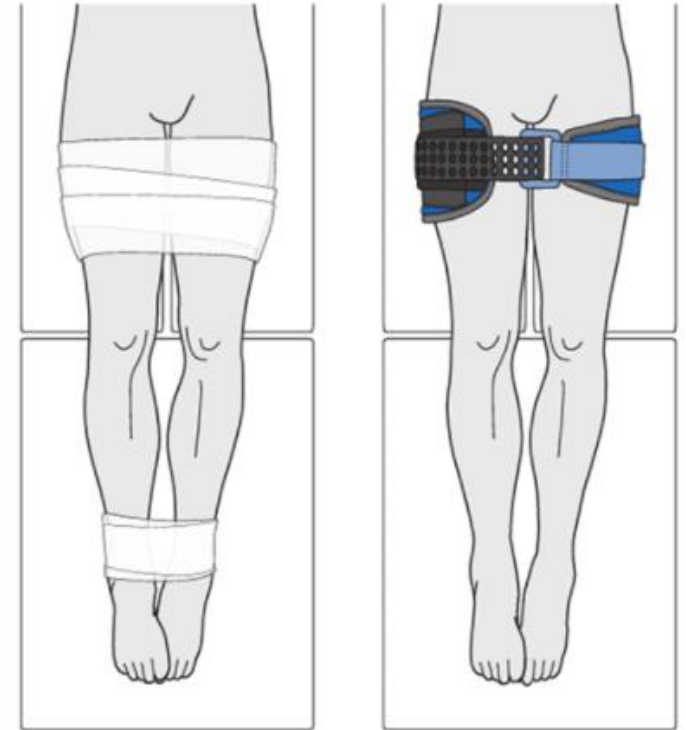
GIT: colostomy...



Pre-hospital care

- Pelvic binder
- Lower extremity Intrarotation and pelvic compression

- Note.: if there is a suspicion of an injury to the pelvic ring, it is always necessary to wear a pelvic belt !!!



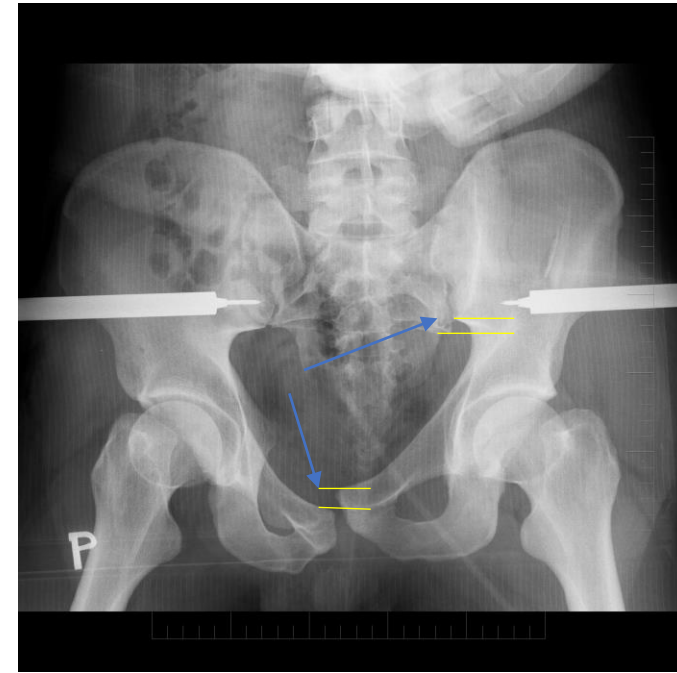
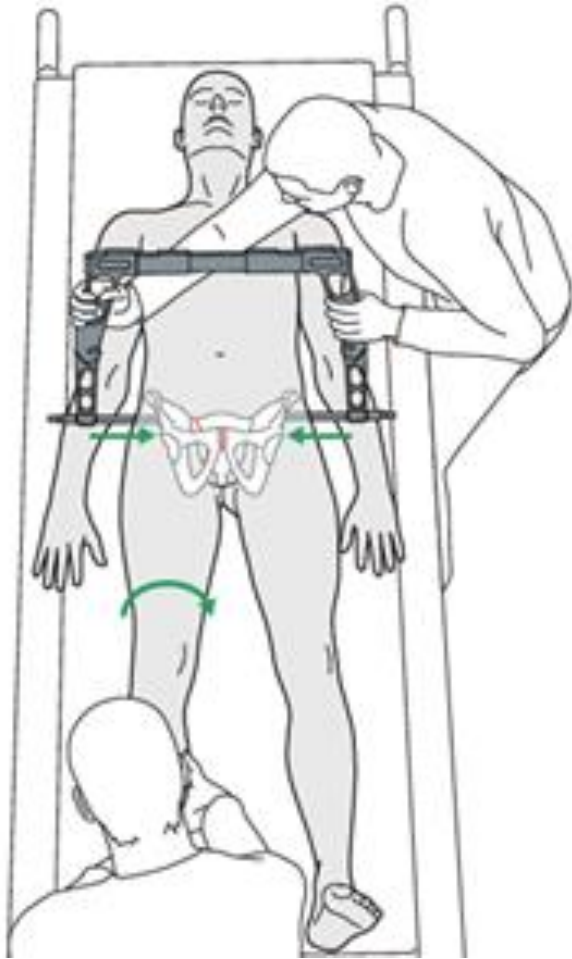
C- clamp



- Rapid application
- Effective stability of the posterior complex
- Stabilisation before laparotomy and packing
- contraindication: - sacral comminution (sacral roots compression!)
- iliac fractures



/C- clamp/



External fixator /ExFix/



- Indication: - hemodynamic instability
 - patients with laparotomies, packing (supraacetabular)
 - patients with epicystostomy, colostomy, open fractures
- contraindication- X-ray unavailability?
 - insertion points fractures



Pelvic packing v.s. angio- embolization



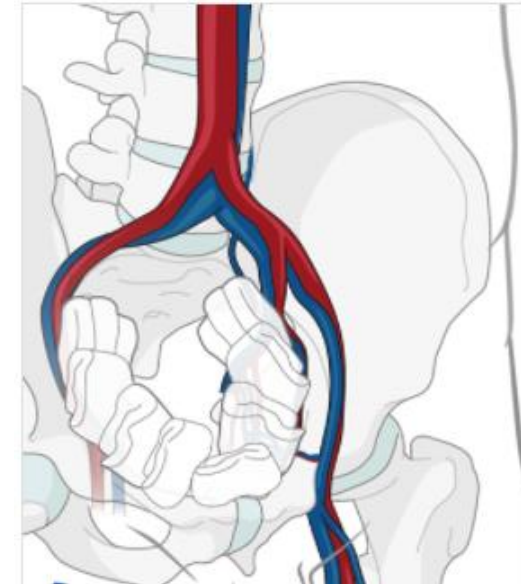
- How to make the right decision? „ 10 % arterial v. s. 90% venous “
 - Embolization-longer procedure
 - availability
 - arterial bleeding (active leak, CT+ contrast)
 - packing- faster- more invasive procedure (revision 24-48 h)
 - component of the laparotomy
 - venous bleeding (presacral plexus)
- we can combine...



Extraperitoneal pelvic packing



- Incisions: - horizontal /Pfannenstiel/
- vertical /laparotomy/



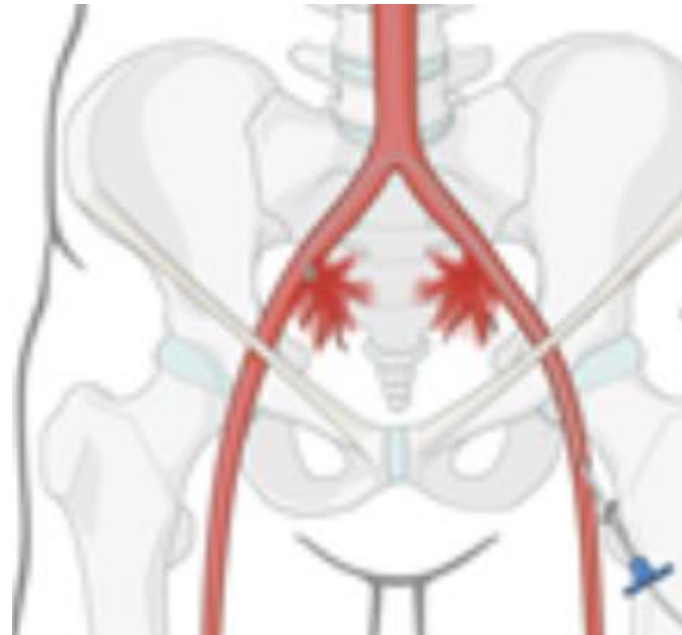
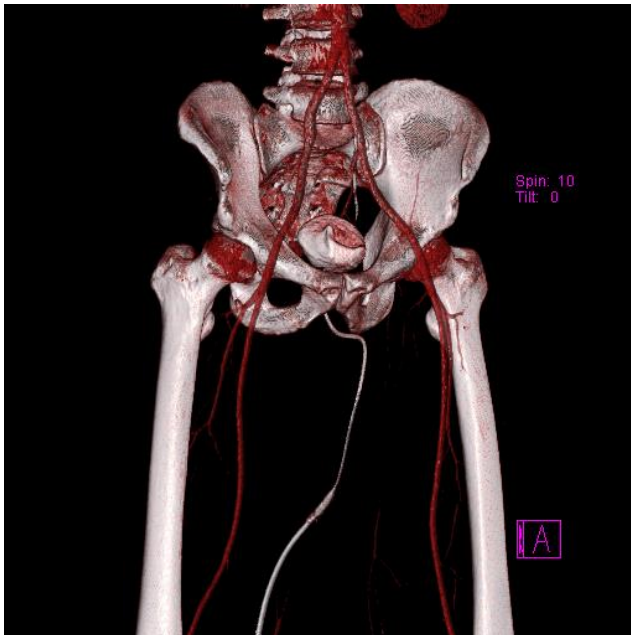
- Filling the retroperitoneal space with drapes for the purpose of tamponade
- Mechanical stability is part of the procedure- ex fix, c-clamp
- osteosynthesis symphysis, SI...



Angio-embolization

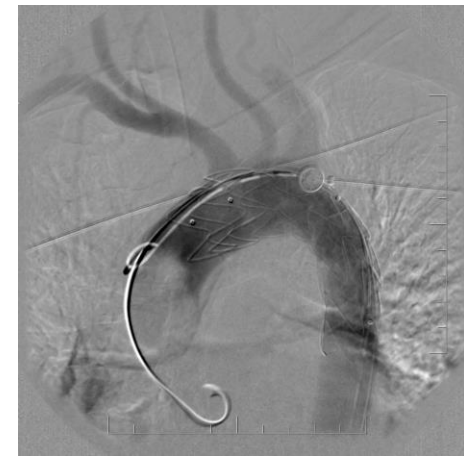
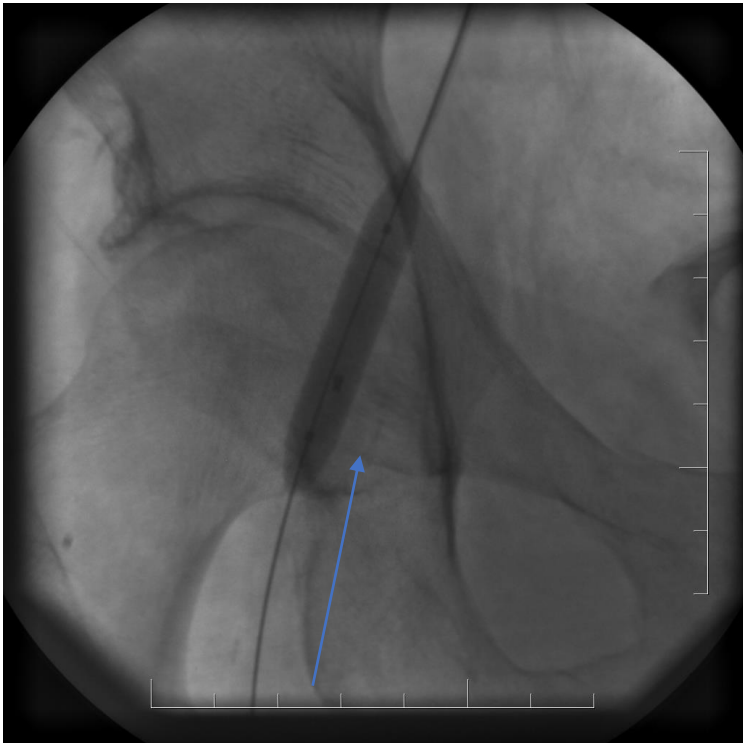


- Enables adequate identification and treatment (embolization) of arterial sources of bleeding through catheter inserted through the femoral vessel.
- Risk of gluteal and perineal ischemia



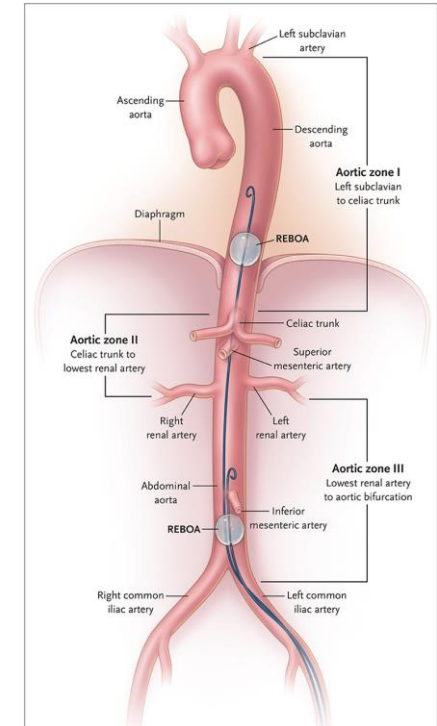
Angio-embolization

- Arterial sources of bleeding (selective or non-selective)
 1. large vessels (e.g. AII)
 2. aorta (TEVAR)



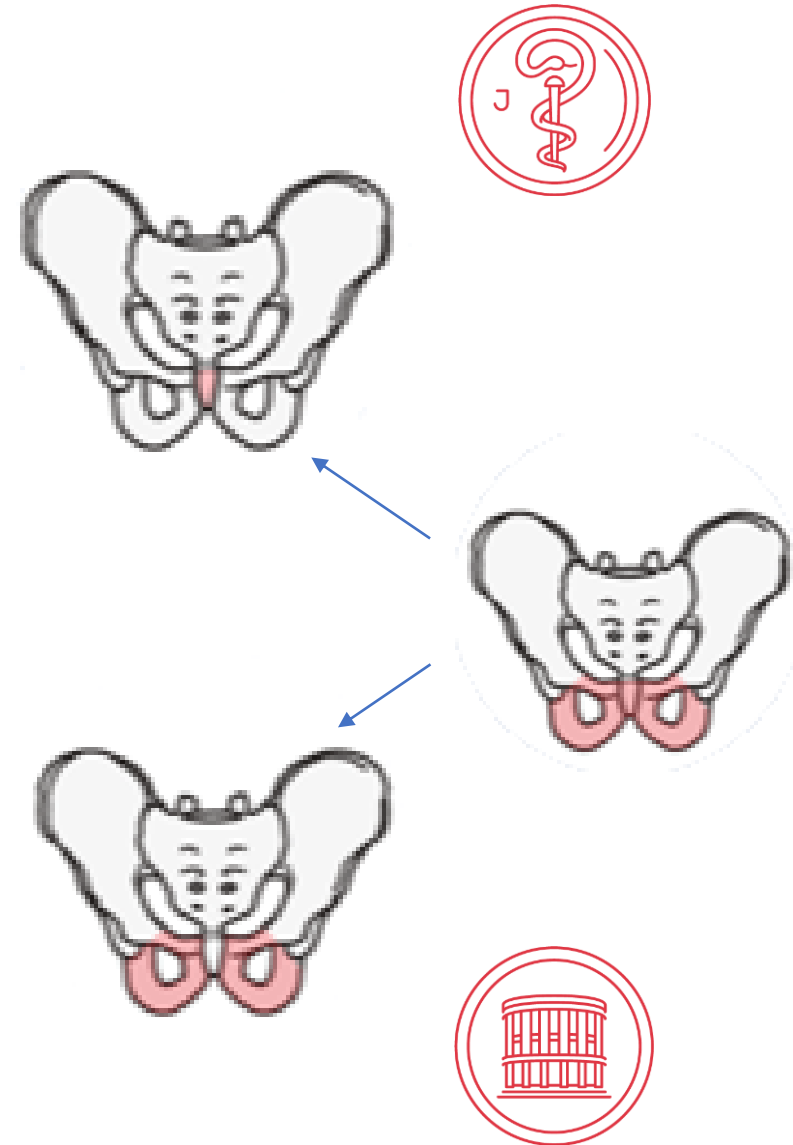
REBOA

- Resuscitative Endovascular Balloon Occlusion of the Aorta
- Temporary possibility of occlusion of bleeding cavities and organs
- Indication- extremely unstable patient
- The need for rapid subsequent surgical intervention (ischemia)

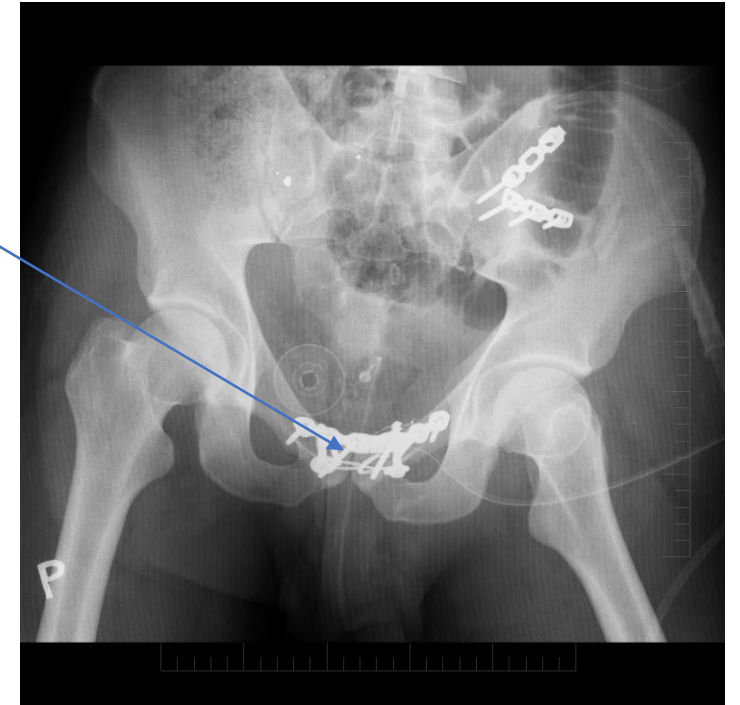
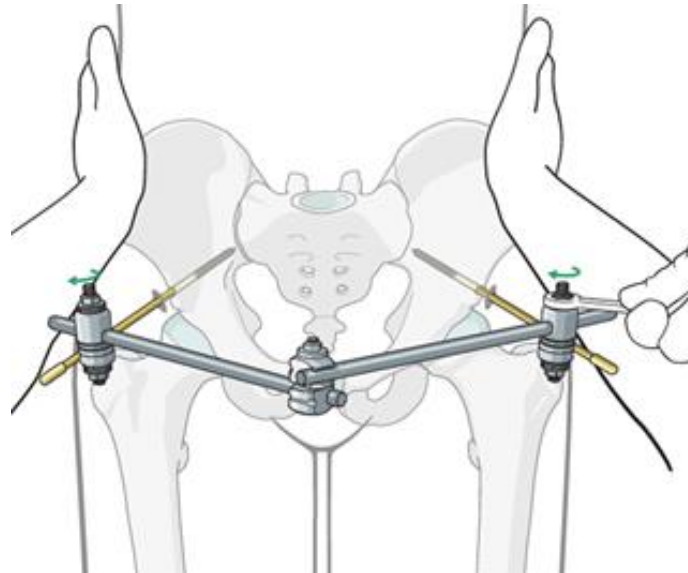
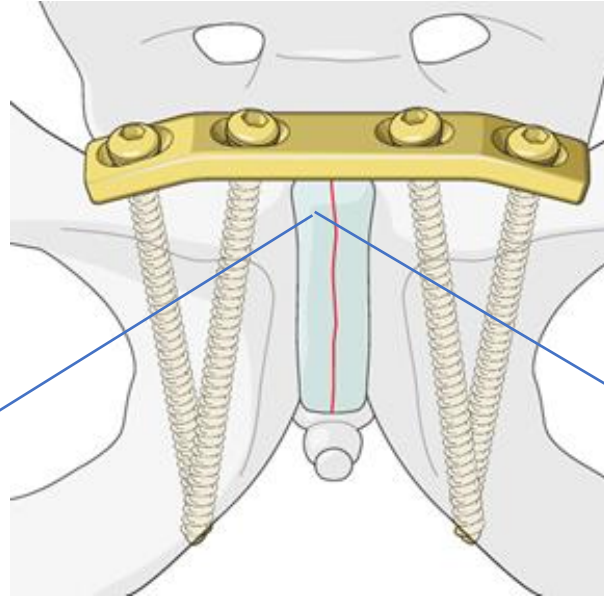
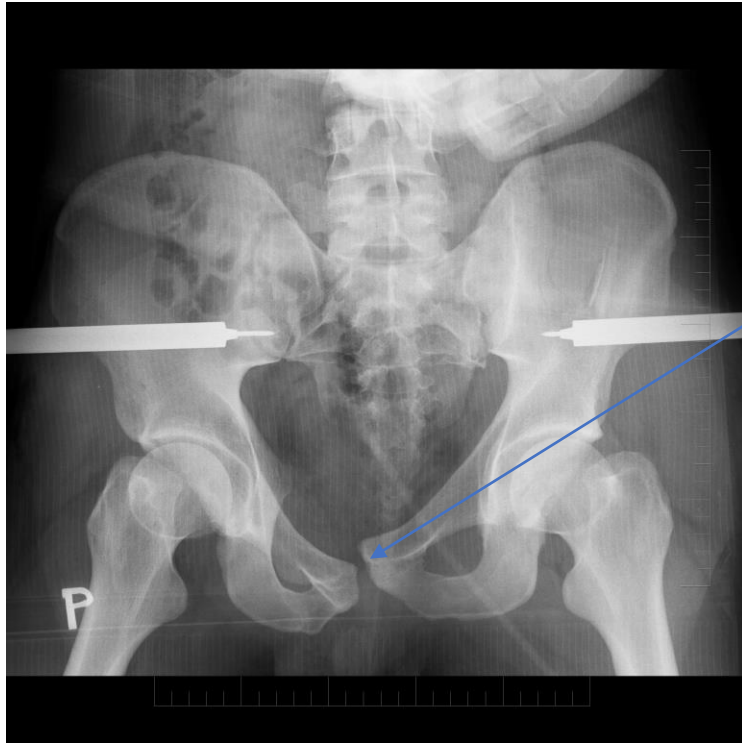


Anterior pelvic segment

- **Symphyseolysis**
 - plating- gold standard
 - cerclage wires, ExFix- minimally invasive method
- **Pubic rami fractures**
 - Exfix- temporary or definitive method of fixation
 - plating
 - screws- minimally invasive method



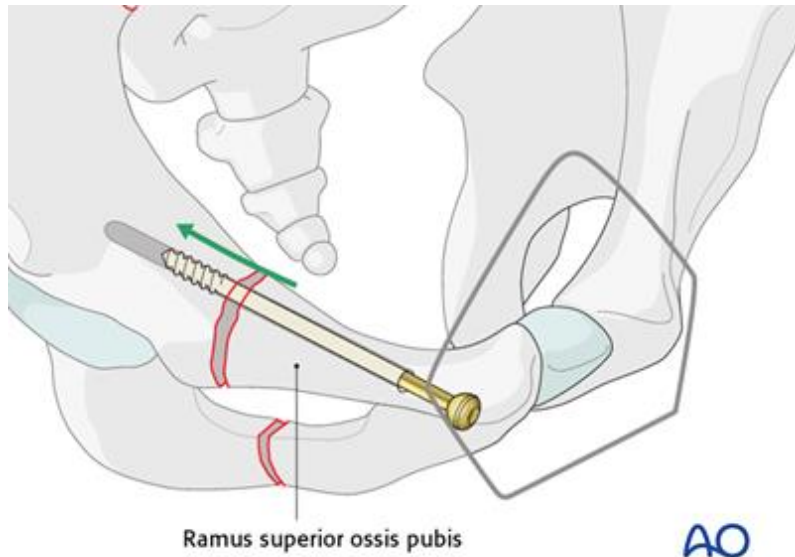
symphyseolysis



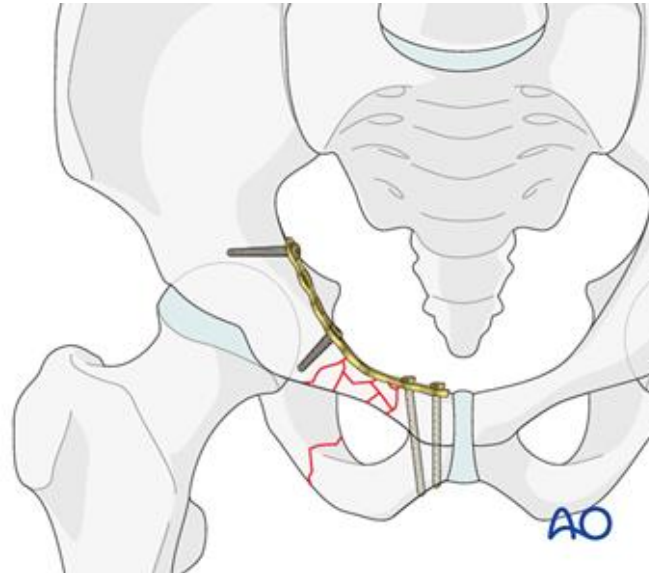
Pubic rami fractures



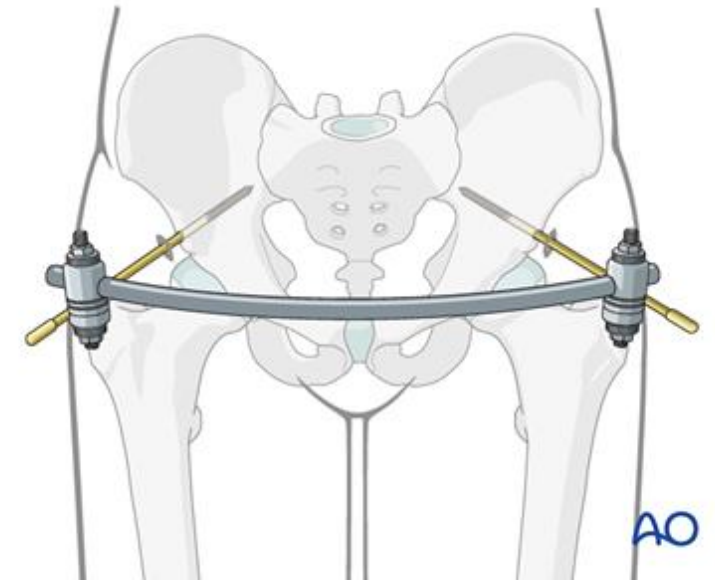
pubic screws



plating

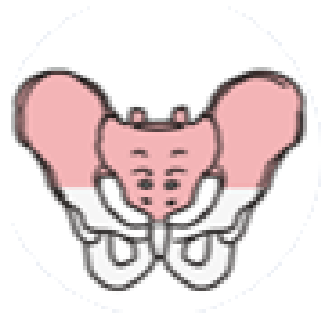
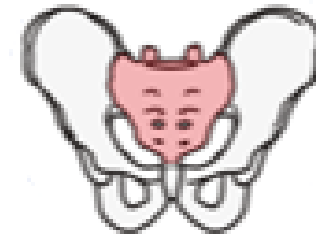
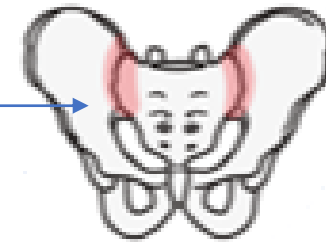
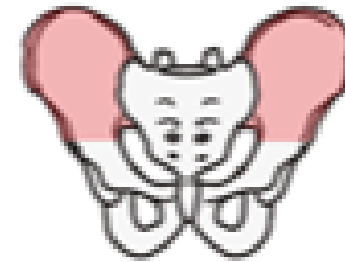


external fixator



Posterior pelvic segment

- Iliac crest fractures
- Dislocation and fracture-dislocation SI joint
- Sacral fractures

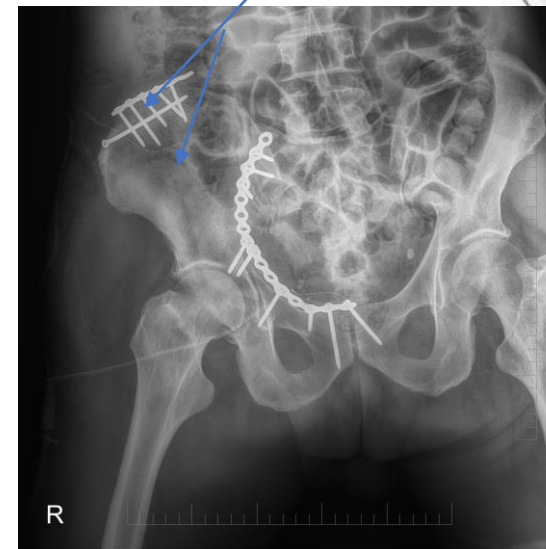
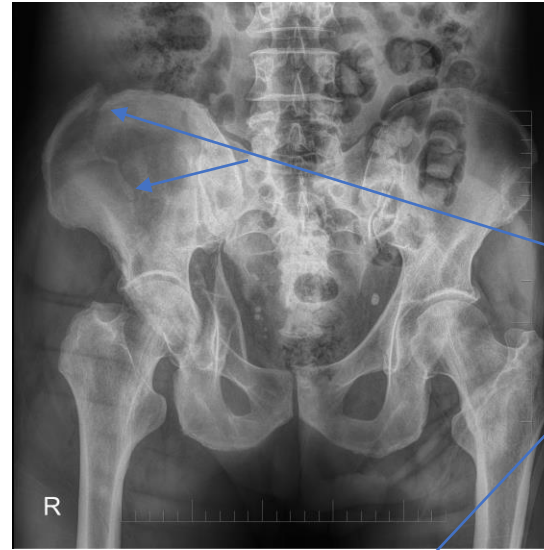
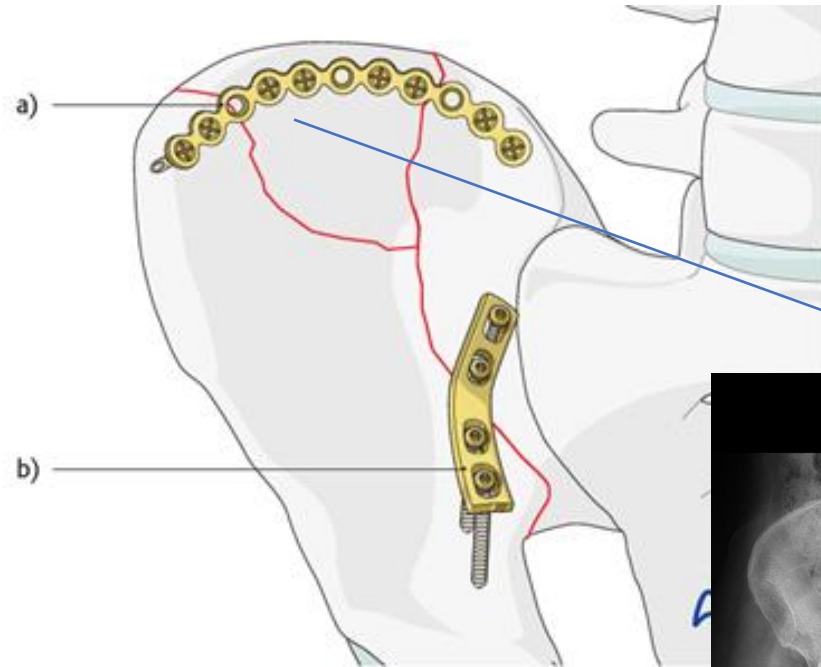


Iliac fractures

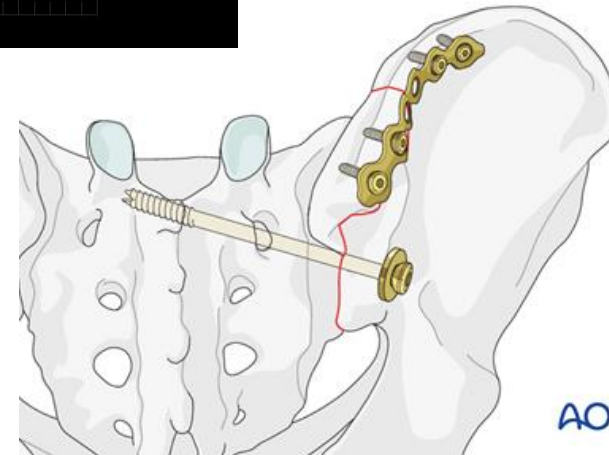
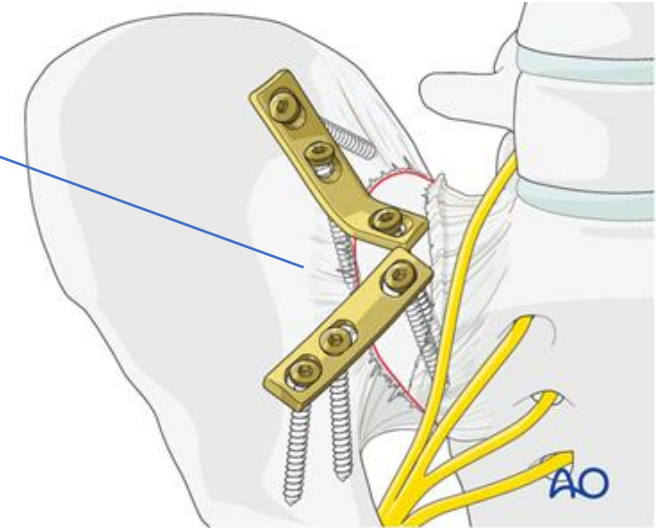
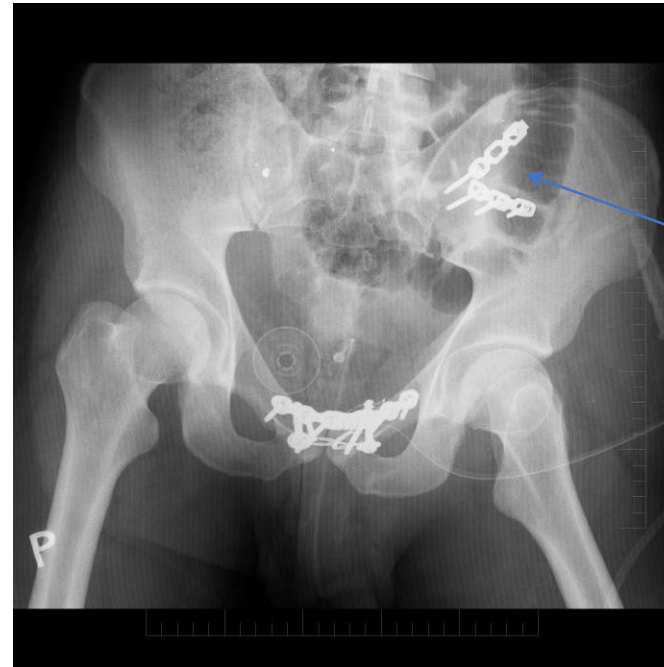
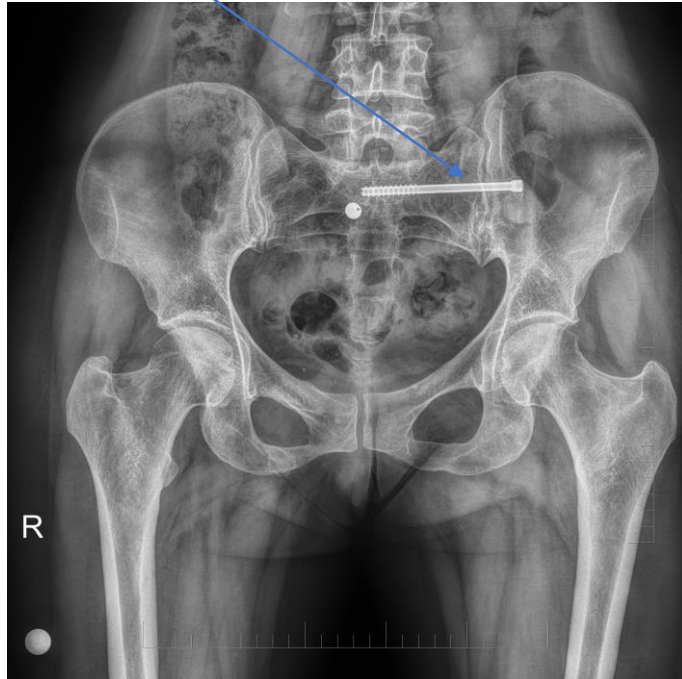
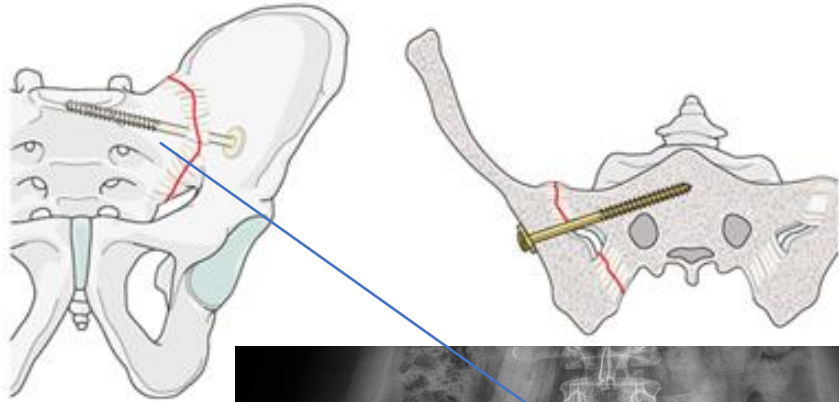
- division- fr. without pelvic ring instability
 - **fr. with pelvic ring instability**
 - part of acetabular fractures
- Treatment for an unstable pelvic ring:
 - plating or combination with intramedullary screws



Iliac fractures

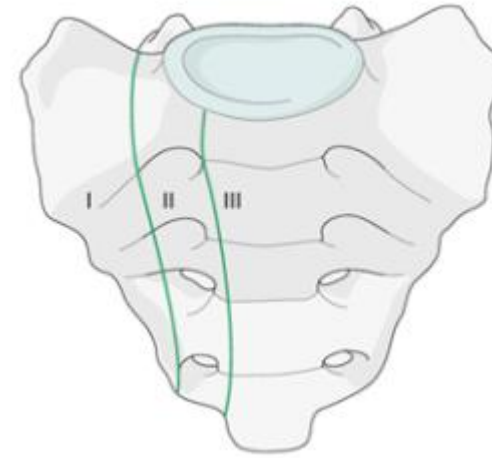


Dislocation and fracture- dislocation SI joint



Sacral fractures

- classification: DENIS (vertical fractures)
 - Denis I- lateral fracture line
 - Denis II- fr. transforaminal
 - Denis III- medial fracture line

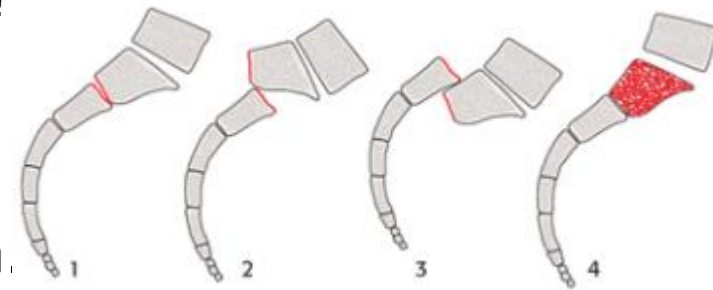


ROY-CAMILLE (transversal fractures)

!!! Sy cauda equina, neurologic lesions!!!



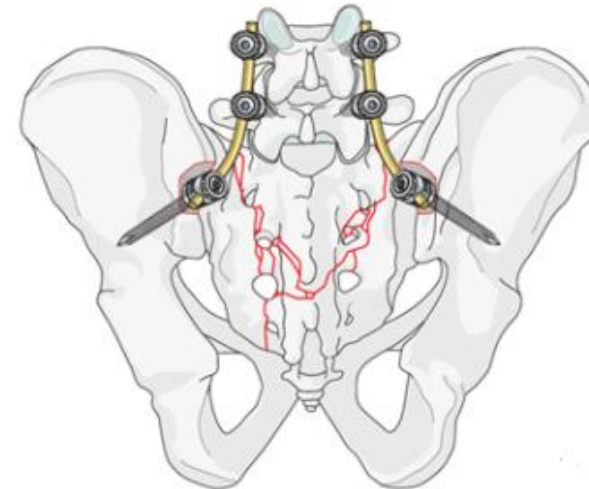
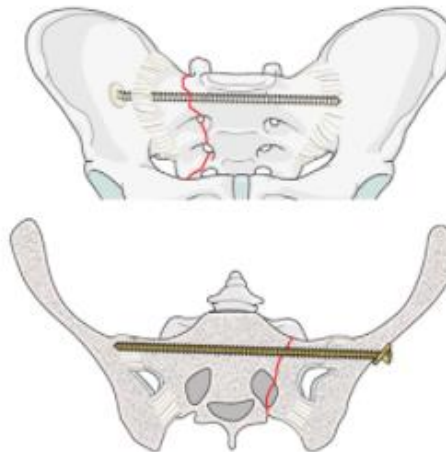
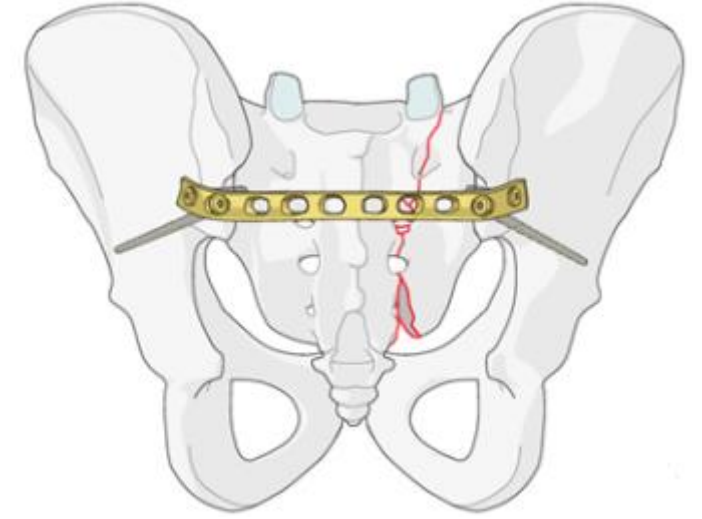
- Combination of both- H type, U type, Lambda.



Sacral fractures



- treatment:
 - ExFix- temporary fixation
 - insufficient by itself to fix the posterior segment
 - plating- ilioiliac plate
 - screws- iliosacral
 - spinopelvic fixation



Compartment syndrome



„ Syndrome of soft tissue compression in a closed osteofascial space, in which muscle ischemia and subsequent necrosis of contractile fibres and fibrotization occur. Oppression also threatens and devitalized nervous tissues. Overlooking the syndrome leads to permanent and functional consequences and, in extreme cases, to amputation of the limb.“

Volkman, 1881- the first description as an ischemic contracture of a supracondylar fracture in a child..



Compartment syndrome



- Occurrence: lower leg, thigh, forearm, shoulder (high energy injuries)
- Reasons:
 1. ↑ Compartment volume- hematoma, trauma swelling, postischemic swelling
 2. ↓ Compartment volume- bandage, plaster, backfilling, fascial closure
- Symptoms:
 1. pain- excessive (nerve ischemia)
 2. Swelling- progressing, disappearance of the skin fold, blisters
 3. Sensitivity disorder- paraesthesia, hypesthesia, anaesthesia (after 30 min.)
 4. Motoric disorder- late symptom
 5. Weakening of pulsation (unreliable symptom)



Compartment syndrome



„Dermatofasciotomy- urgent surgical procedure consisting in decompression of closed osteofascial spaces by sufficiently extensive dissection of skin and fascia.“

- Compartment release is important!
- Fracture stabilisation (ExFix or internal fixation)
- We do not suture the fascia!
- Defect coverage (V.A.C.)- risk of ischemic muscle infection



Compartment syndrome



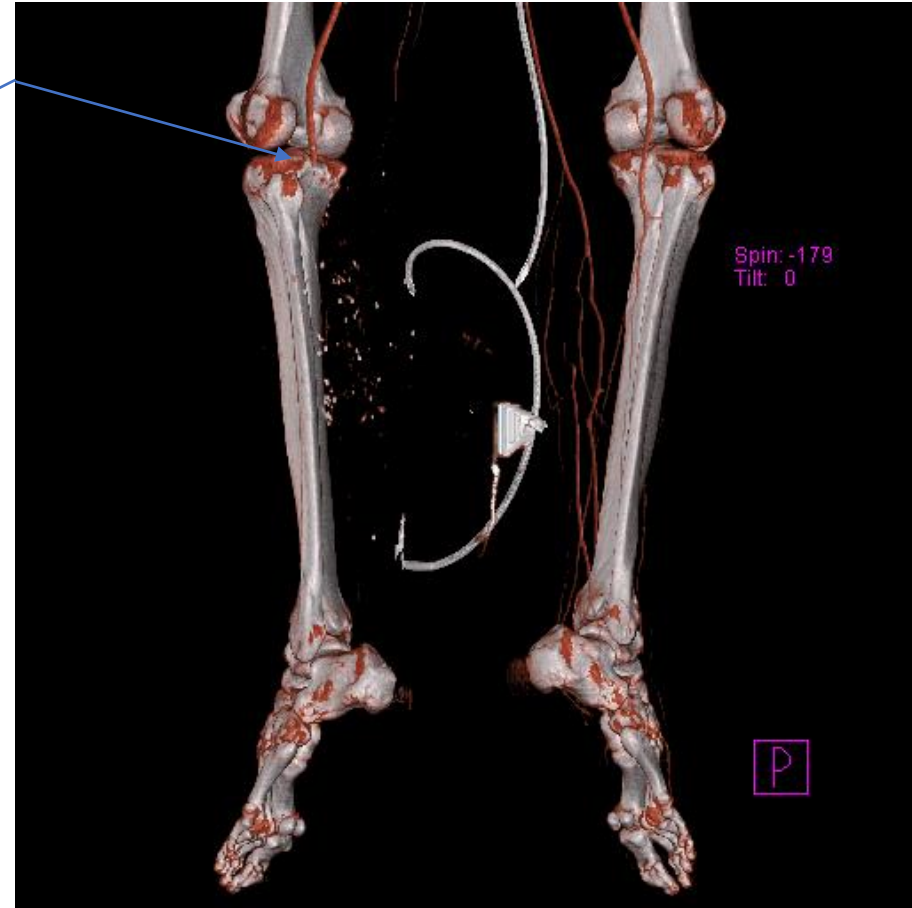
Vascular injuries- extremities



- Serious injuries but rarer
 1. Endangering the patients life (source of bleeding)
 2. Endangering of the limb (ischemia, compartment syndrome)
- Within DCS procedures in polytrauma, they are among the priorities
- Devision: penetrating and non-penetrating injuries
injuries with/without fractures
- diagnostics: CT AG (gold standard)
DSA, MRI (examination availability)



Vascular injuries- extremities



Vascular injuries- extremities



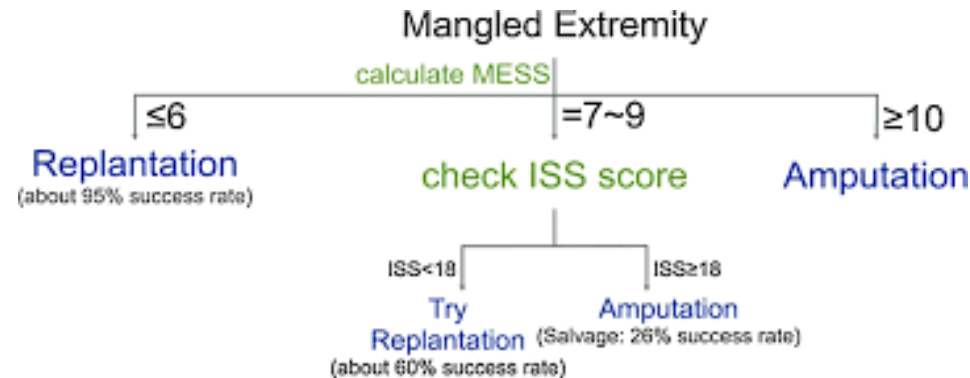
- Treatment: surgical- interdisciplinary cooperation !!!
 1. Primary suture, resection and replacement, bypass
 2. Radio interventional treatment- limited (dissections?)
 3. The role of an orthopaedist/traumatologist
 - a. Bone repositioning and stabilisation
 - b. Irrigation and Debridement
 - c. Defects coverage



Vascular injuries- extremities



„MESS /Mangled Extremity Severioty Score/ is a scoring system used in the devastation of limbs, which prompts the dicision to save the limb (replantation) or the need for its amputation.“



MESS

Skeletal / soft-tissue injury	score
Low energy (stab; simple fracture; pistol gunshot wound)	1
Medium energy (open or multiple fractures, dislocation)	2
High energy (high speed MVA or rifle GSW)	3
Very high energy (high speed trauma + gross contamination)	4
Limb ischemia	
Pulse reduced or absent but perfusion normal	1*
Pulseless; paresthesias, diminished capillary refill	2*
Cool, paralyzed, insensate, numb:	3*
Shock	
Systolic BP always > 90 mm Hg	0
Hypotensive transiently	1
Persistent hypotension	2
Age (years)	
< 30	0
30-50	1
> 50	2
* Double the score in cases of ischemia >6 hours	

MESS score: A score above 7 increases the chance of amputation.



Hand-foot (polytrauma)

- Mechanism of the injury is typical
- „overlooked injuries“ (45%)...
- Quality of life and prognosis











Avascular necrosis (polytrauma)

- Intraarticular injuries with dislocations:
 - Femoral and humeral heads
 - Radial capitellar fractures
 - Carpal bones (scaphoid, lunatum)
 - Talus, navicular fractures



Avascular necrosis (polytrauma)

- Risk factors
 - Energy of the injury
 - Size of dislocation
- Operative treatment
 - Individual for location of the injury and patients condition.
 - Fragments reduction and temporary or definitive fixation



