

Pelvic ring - Initial management and evaluation



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Mortality in hemodynamically unstable pelvic fractures is still > 30% despite modern resuscitating

- Gustavo P. et al.: The role of associated injuries on outcome of blunt trauma patients sustaining pelvic fractures. *Injury.* **2000**;31:677–682.
- Demetriades D et al.: Pelvic fractures: epidemiology and predictors of associated abdominal injuries and outcomes. *J Am Coll Surg.* **2002**;195:1–10.
- Jang JY et al.: Preperitoneal pelvic packing in patients with hemodynamic instability due to severe pelvic fracture: early experience in a Korean trauma center. *Scand J Trauma Resusc Emerg Med.* **2016**;24:3.
- Heetveld MJ et al.: Hemodynamically unstable pelvic fractures: recent care and new guidelines. *World J Surg.* **2004**;28:904–909.
- Lawson CM et al.: Mortality after angioembolization in pelvic fractures: a ten year review. Boston, MA: 69th Annual Meeting of the American Association for the Surgery of Trauma; **2010**.
- Sathy AK et al.: The effect of pelvic fracture on mortality after trauma: an analysis of 63,000 trauma patients. *J Bone Joint Surg Am.* **2009**;91:2803–2810.
- Smith W et al.: Early predictors of mortality in hemodynamically unstable pelvis fractures. *J Orthop Trauma.* **2007**;21:31–37.
- Starr AJ et al.: Pelvic ring disruptions: prediction of associated injuries, transfusion requirement, pelvic arteriography, complications, and mortality. *J Orthop Trauma.* **2002**;16:553–561.





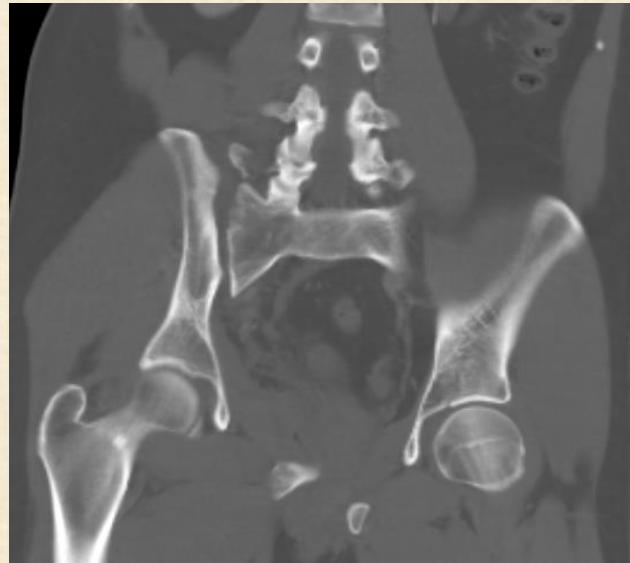
■ REVIEW ARTICLE

An unstable pelvic ring THE KILLING FRACTURE

??

A. B. van Vugt, A. van Kampen JBJS (Br) VOL. 88-B, No. 4, April 2006

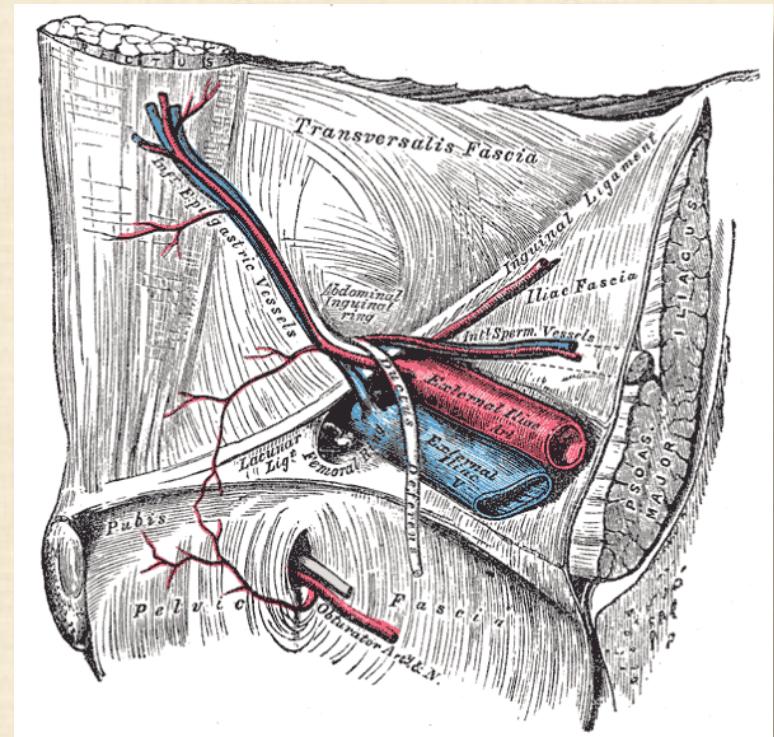
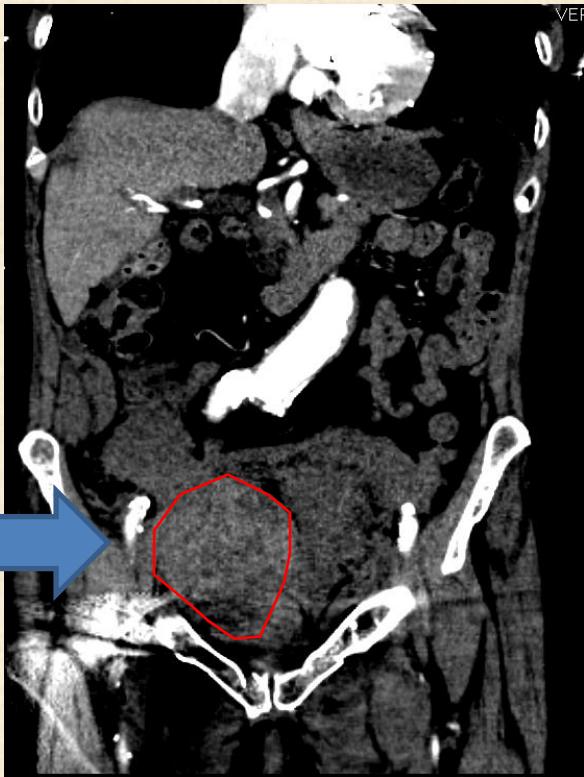
Mechanic instability \neq Hemodynamic instability



Absolute relationship between x-ray look and bleeding?

NO!

Low energy trauma



Absolute relationship between x-ray look and bleeding?

NO!

High energy trauma



Pelvic fracture pattern predicts the need for hemorrhage control intervention—Results of an AAST multi-institutional study

- open book / vertical shear injury
- open pelvic fx
- high age

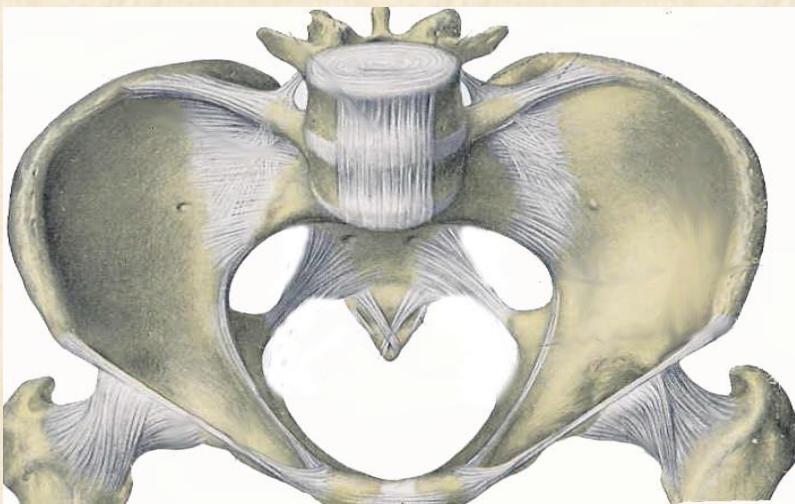


- Prospective, observational multicenter (11) study, 2yrs
- 46716 / 1339 / **163 pts w/ pelvic fracture, BT <90, p> 120**
- **30% mortality**

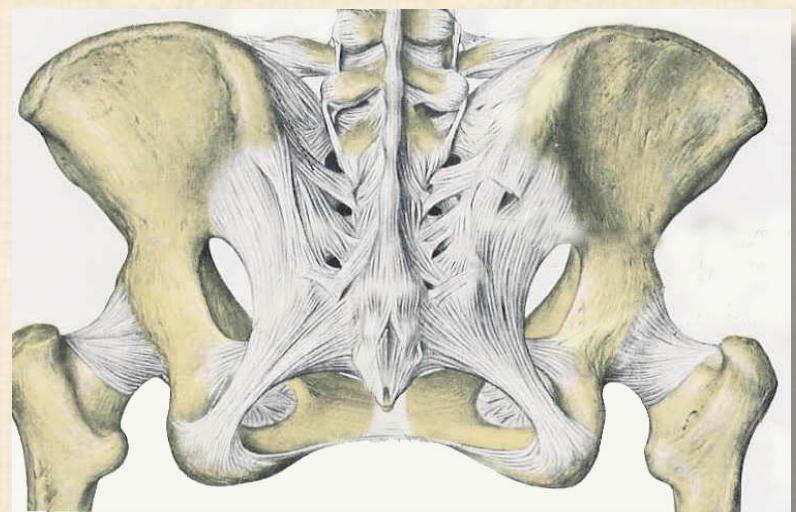


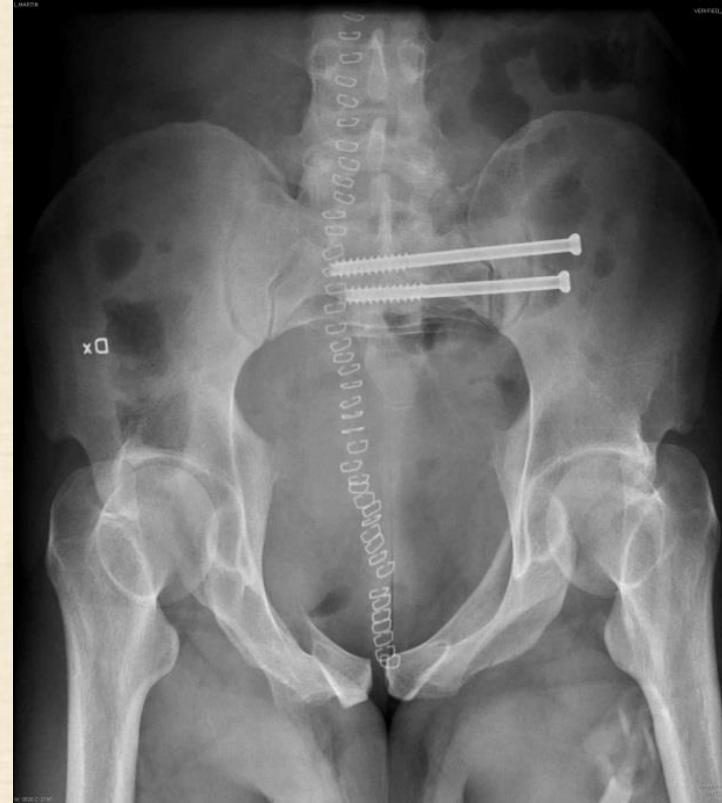
The ring

Anterior ligaments



Posterior ligament complex
(70% of the stability)





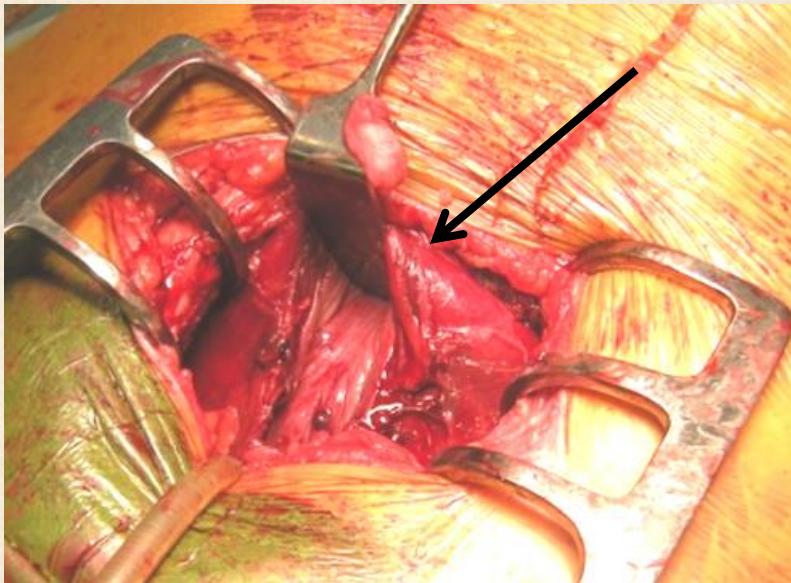
Mechanism of injury

Concomitant injuries



22yo, hit by the tram in Gothenburg





preop. cystoscopy



High risk of bleeding because of the proximity of the blood vessels

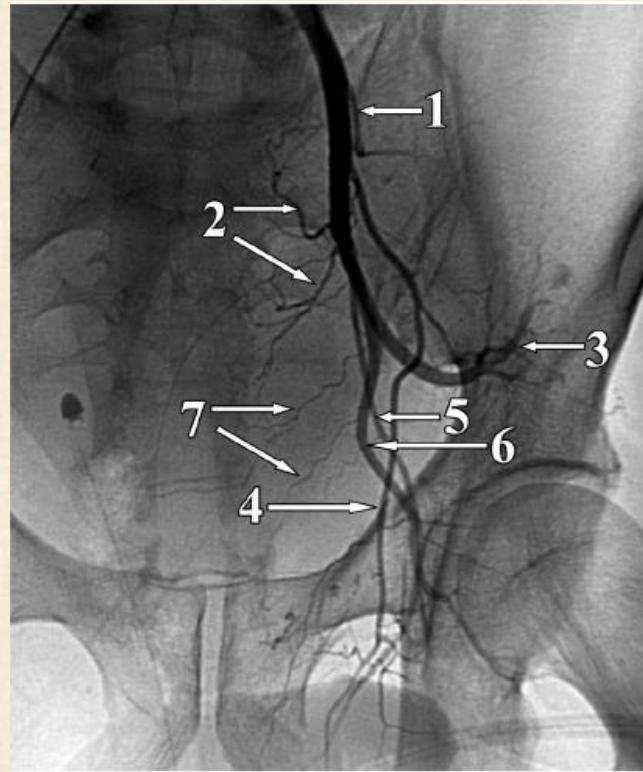


Figure 1. Angiogram shows the internal iliac artery and its branches: the iliolumbar artery (1), lateral sacral arteries (2), superior gluteal artery (3), obturator artery (4), internal pudendal artery (5), inferior gluteal artery (6), and vesical arteries (7).



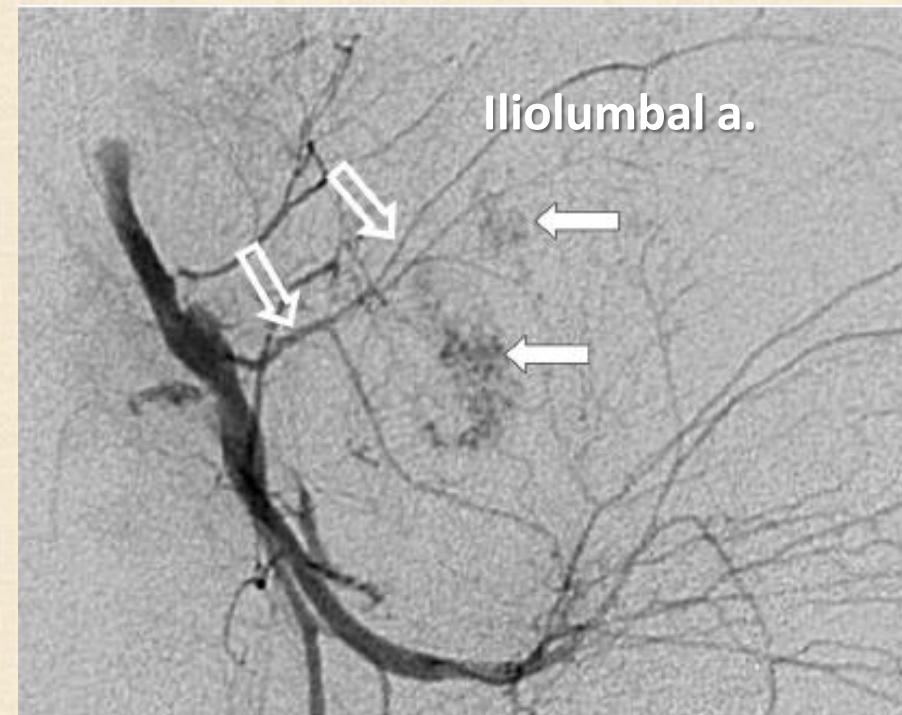
90%

Venous plexuses or
cancellous bone surfaces



10%

Arterial bleeding



ATLS

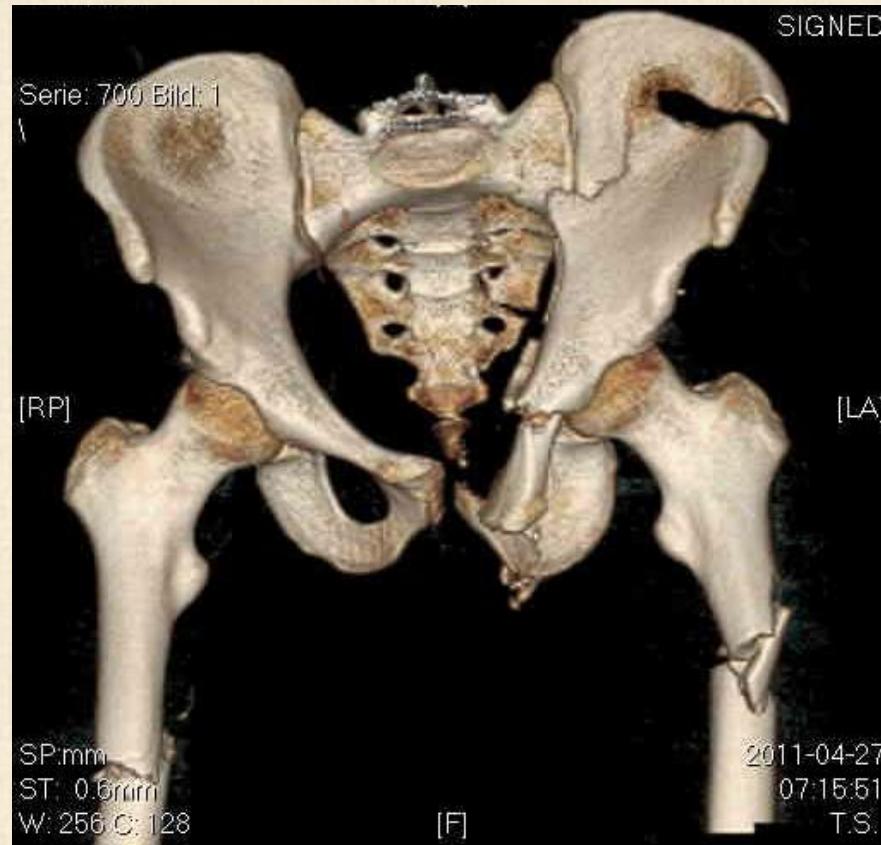


Save the clot!

Don't do stability test
- unreliable
- can provoke bleeding



".....the pelvis is stable"



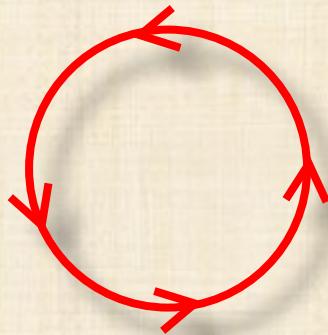
Signs of mechanic instability on the ER pelvic x-ray

- Symphysis pubis diastasis >2,5 cm
- Sacroiliac displacement of 5 mm in any plane
- Avulsion of fifth lumbar transverse process, lateral border of sacrum (sacrotuberous ligament), or ischial spine (sacrospinous ligament)
- Posterior fracture gap (rather than impaction)



Urgent control of bleeding which can prevent “the lethal triad”

- Hypothermia
- Coagulopathy
- Acidosis



SIRS

Systemic Inflammatory Response Syndrome

DIC

Disseminated Intravascular Coagulopathy

MOF

Multiple Organ Failure

ARDS

Acute Respiratory Distress Syndrome

**Exsanguinating related to pelvic injury
“Preventable death”**

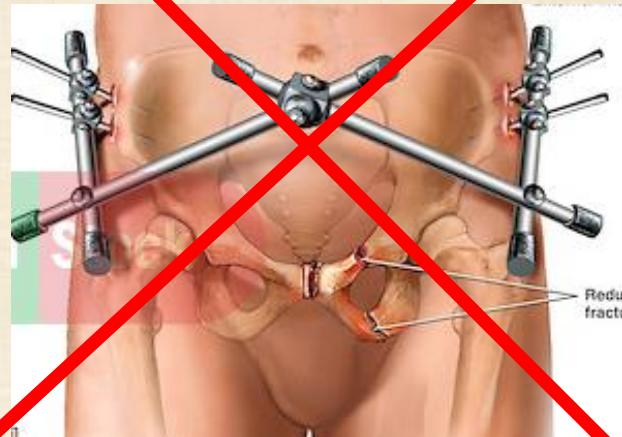


First thing to do

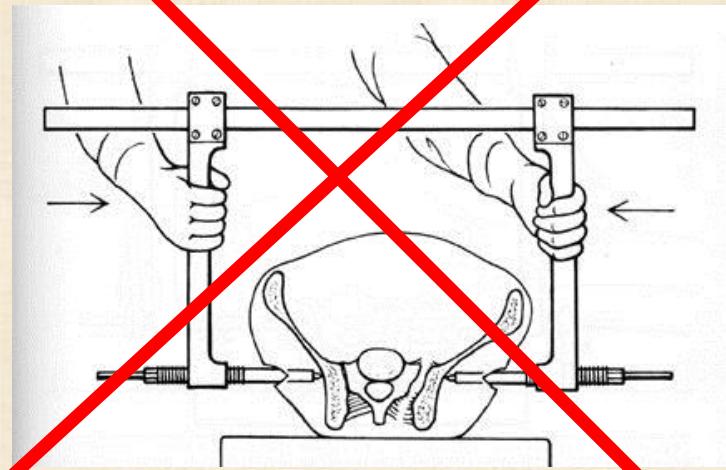
Pelvic binder (T-POD)



External fixator



C-clamp



Pelvic binder

- Ability to reduce pubic diastasis (145-180N pull) and the pelvic volume

DeAngelis NA et al Injury **2008**; Spanjersberg WR et al Injury **2009**; Bottlang M et al JBJS Am **2002**

Tan ECTH. Et al: Effect of a new pelvic stabilizer (T-POD1) on reduction of pelvic volume and haemodynamic stability in unstable pelvic fractures Injury. **2010** Dec;41(12):1239-43

- Pain relief

Krieg JC et al.: JOT **2005**, Krieg et al.: JOT **2005**; Vermeulen et al.; Prehospital report Swiss Surgery **1999**

- Same or better effect than pelvic external fixator on mortality, need for transfusion or hospital stay w/o its complications

Croce MA et al.: Journal of the American College of Surgeons

- No reports on “over-compression” – be cautious

- Soft tissue complication possible at ASIS, TM
 - pressure $\geq 9.3\text{kPa}$
 - ≥ 3 hours
 - open the binder after a few hours
 - keep it under the patient for transports

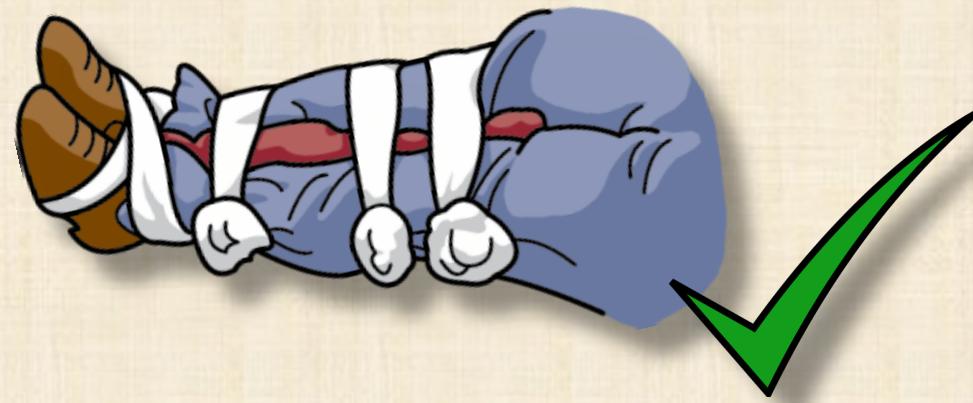
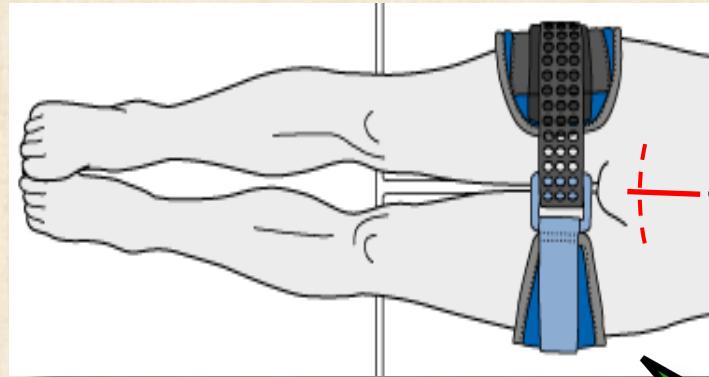
Jowett AJ et al.:Injury 2007



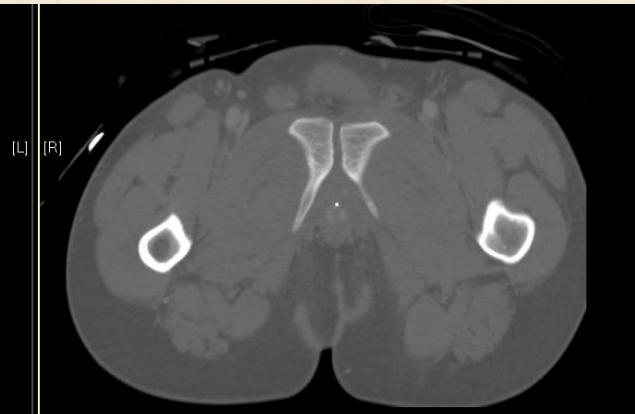
Do it right!



?







After opening the pelvic binder
increasing abdominal tenderness

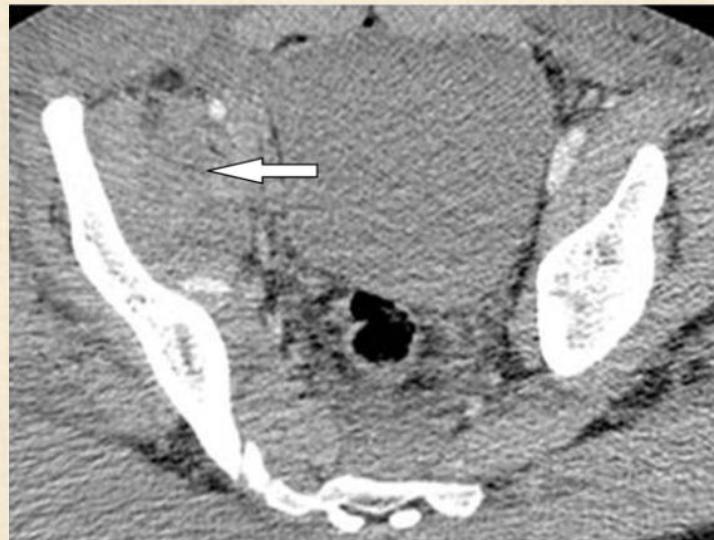


Emergency diagnostic tools in acute hemodynamic instability

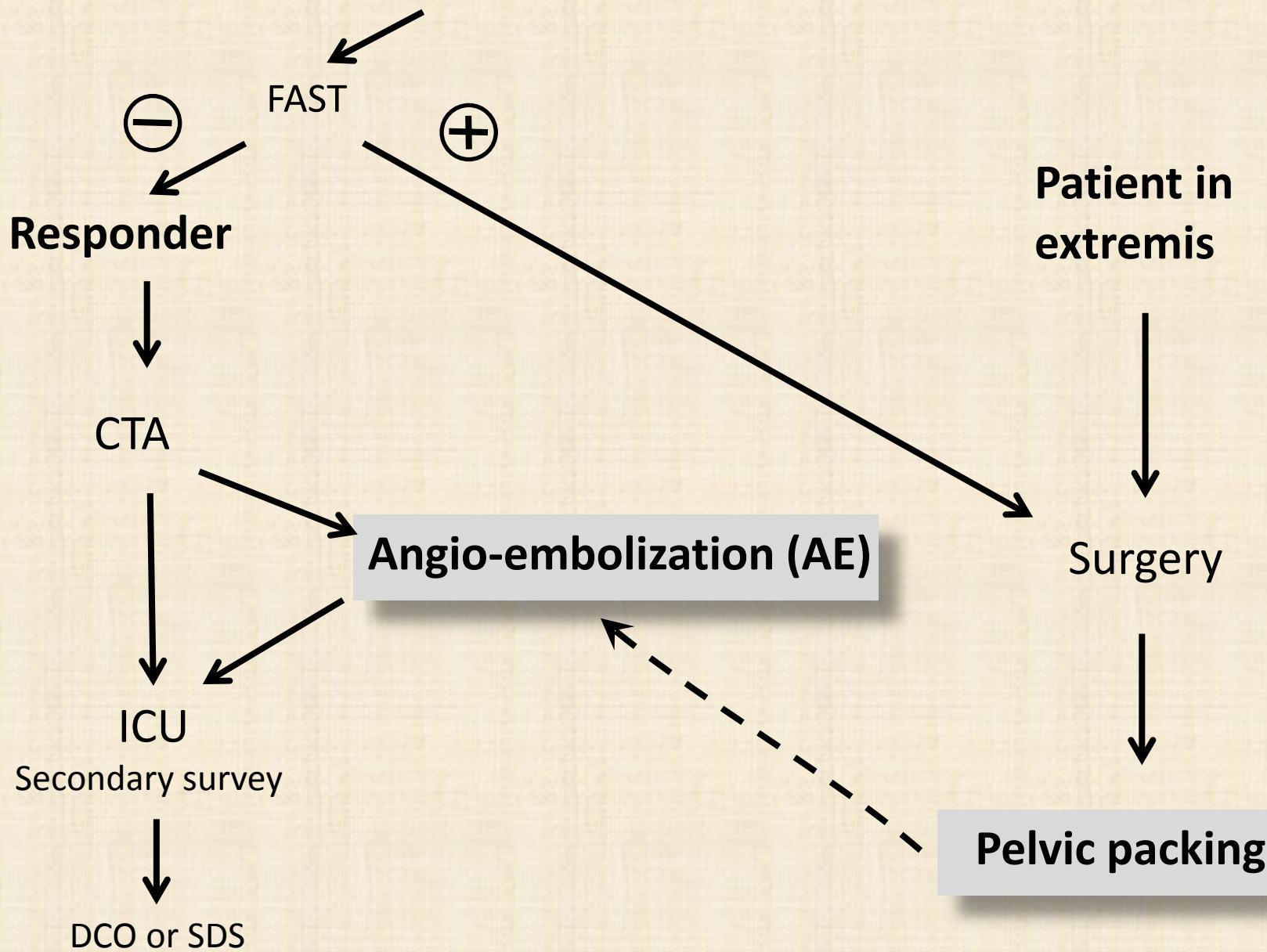
FAST or DPL



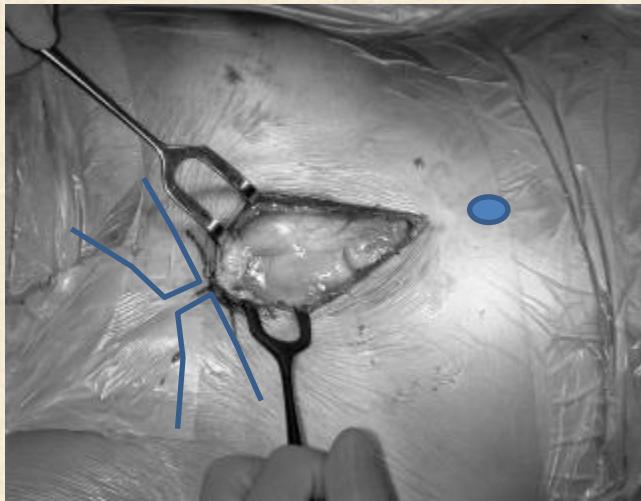
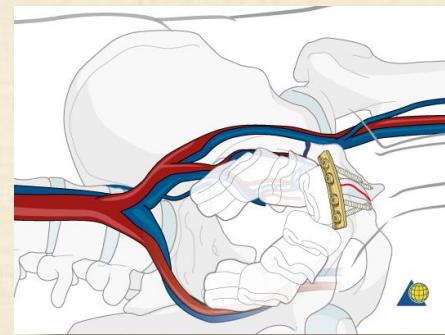
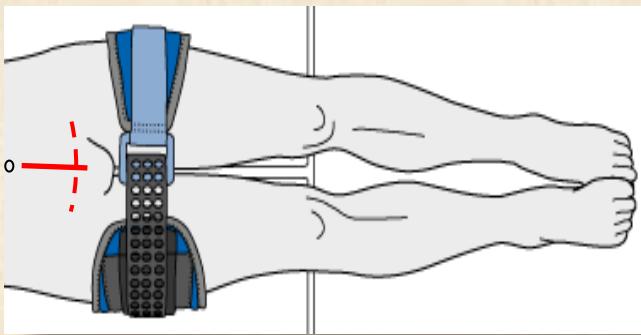
CT w contrast



Hemodynamic instability in the ER



Pelvic packing



If not satisfying effect on the hemodynamics - angioembolization (AE)



Open pelvic fracture

- Mortality up to 70%
- Urgent debridement
- Temporary colostomy
- Vaginal rupture needs urgent repair



Take home message

- Do not test pelvic stability! – **"save the clot"**
- There is no absolute relation between fracture type and bleeding but high risk in **open book, vertical shear, open pelvic fracture, high age**
- Pelvic binder – first to do – do it right!
- Pelvic packing – technically easy and quick – life saving surgery
 - does not always control arterial bleeding
- Angio-embolization: effective but takes time – know your organization
- Definitive fixation of the mechanically unstable fracture require a patient who survive!

Thank you!





Preperitoneal pelvic packing reduces mortality in patients with life-threatening hemorrhage due to unstable pelvic fractures

Denver Health Medical Center and the University of Colorado

- Mean time to AE 5 hours
- 11 years between 2004-2014, 2293 pelvic fractures,
- 128 preperitoneal pelvic packing /16 to AE
- **Mortality 32% => 21%**



What is the best test to exclude intra-abdominal bleeding?

- Negative FAST ≠ negative intraperitoneal bleeding with pelvic fractures (*Level I*)
- Positive FAST → laparotomy (*Level I*)
- DPA is the test of choice in an unstable patient (*Level II*)
- CT is the test of choice in a stable patient (*Level III*)

EAST Trauma Guidelines, 2011

- There is some controversy about whether FAST, Diagnostic peritoneal lavage or aspirate (DPA) should be used.
- Although the specificity of the FAST test is high (around 95%) in patients who have pelvic fractures, it is less reasonable as an initial screening test. While its specificity is 100%, the sensitivity in mechanically unstable Tile B or C pelvic fractures is lower (with reports of around 75% but up to 25% sensitivity).
- Pelvic fractures are a special consideration for DPL because there is a significant possibility that a large retroperitoneal hematoma may dissect into the abdominal wall, but DPL has been shown to have a high rate of false positives in patients with pelvic fractures.
- An aspirate, without the lavage, and a diagnostic peritoneal lavage offer similar sensitivity with a low rate of false negatives.
- Because of the low sensitivity of DPL in patients with pelvic fracture, CTA abdomen/pelvis is recommended in patients who are hemodynamically unstable.

- CT has been a reliable indicator of arterial hemorrhage with Sensitivity of 60-90% and Specificity of 85-98% reported
- Absence of contrast extravasation on CT does not always exclude active hemorrhage as bleeding can be intermittent (Level II – EAST)

Retrograde Urethrograms in Pelvic Trauma

- Pelvic fractures are also associated with urethral and bladder injuries in 7-25% of cases
- Clinical signs such as perineal or scrotal swelling, blood from the urethra or the presence of a high riding prostate may suggest presence of a pelvic fracture
- Retrograde urethrograms should be performed before placement of a foley catheter if there are concerns about urethral injury
- However, if RUG is required, it should be performed after the CTA (Level III-EAST) as there is higher rate of indeterminate or false negative findings

Arterial Embolization

- Selective vs non-selective (bilateral internal iliac artery) embolization can be performed to address arterial bleeding, depending on the stability of the patient
- Small vessel bleeds are embolized with coils, polyvinyl alcohol, or a glue, which are permanent
- If a larger vascular territory is involved, a temporary gelfoam slurry can be used to provide immediate hemostasis, with less chance of long term occlusion

EAST Trauma Guidelines for Angioembolization in Pelvic Trauma:

- Active arterial extravasation on CTA (*Level I*)
- Hemodynamic instability without extra-pelvic blood loss (*Level I*)
- Consideration for stable patient >60 years old with major pelvic disruption (*Level II*)
- Consider repeat angioembolization if there is ongoing bleeding (*Level II*)
- Absence of contrast extravasation does not exclude active hemorrhage (*Level II*)
- Large hematoma >500cm³ (*Level III*)
- Bilateral non-selective is safe (*Level III*)
- Male potency is not affected (*Level III*)

Preperitoneal Packing

- The immediate surgical option for patients is PPP (also called retro-peritoneal packing)
 - PPP is a relatively newer method of packing the retroperitoneum without the need for a laparotomy
 - PPP is useful for hemodynamically unstable patients with hemorrhage in the pelvis
 - Angioembolization can be performed after PPP when the patient is more hemodynamically stable
 - PPP can also be performed after failed embolization as a salvage mechanism
- **The OR is always the safest place for an unstable pelvic trauma patient as preperitoneal packing + exploratory laparotomy can be done simultaneously.**
- Studies have shown that PPP in the OR can be done faster than Angioemolization, and that mortality is worse when patients require operative intervention outside the OR.

REBOA: Resuscitative Endovascular Balloon Occlusion of the Aorta

- REBOA is available in some EDs and is gaining traction as a bridge until definitive hemorrhage control can be obtained in the OR
- The concept of aortic occlusion in the setting of non-compressive thoracic hemorrhage from the abdomen or pelvis is not new, and has been used for decades
- Physiologically, occluding the aorta during hemorrhagic shock results in:
 - Increased cardiac output

able and the FAST is negative, get a CTA to determine whether
(blush)

gioembolization is indicated

but your patient is older than 60 and you have a high suspicion
tion is worth consideration

unstable, assess where your patient is bleeding from (thoracic,
these life threats appropriately

inary exam

l – this is the safest place for an unstable patient as you can
xator if needed, do a laparotomy, and then go to the angio suite

ngioembolization if it can be arranged urgently (30 mins to 1

gray zone with patients who are somewhat responsive to
can but are unstable. Keep in mind that all of the literature and
le patients do not go to the CT scanner, they go to angio or the

ropriate for hemodynamically unstable patients with negative
abilization and hemorrhage control in order to survive transport



Summary: Unstable Pelvis

W_{rap} it
R_ep_{lace} losses
A_{ngioembolization}
P_{reperitoneal}
p_{acking}
E_{xternal} fixation
REBOA... is coming



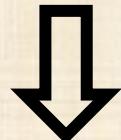
Factors Associated With Pelvic Fracture-Related Arterial Bleeding During Trauma Resuscitation: A Prospective Clinical Study

2006-2008

143 (15pfrab) högenergi polytrauma pts, prospective, single, level I,
bäckengördel, ingen pelvic packing, angio 30-240 min

Mortalitet 46.7% (arterial) vs 2.3% (nonarterial)

- BD < 6 mmol/L,
- BT < 104 mm Hg
- Behov för transfusion på akuten



oberoende prediktorer av bäckenblödning och
behov av angio-embolisering



Mekanisk stabilisering av bäckenet är en del av resuscitationen

Minskar blödning:

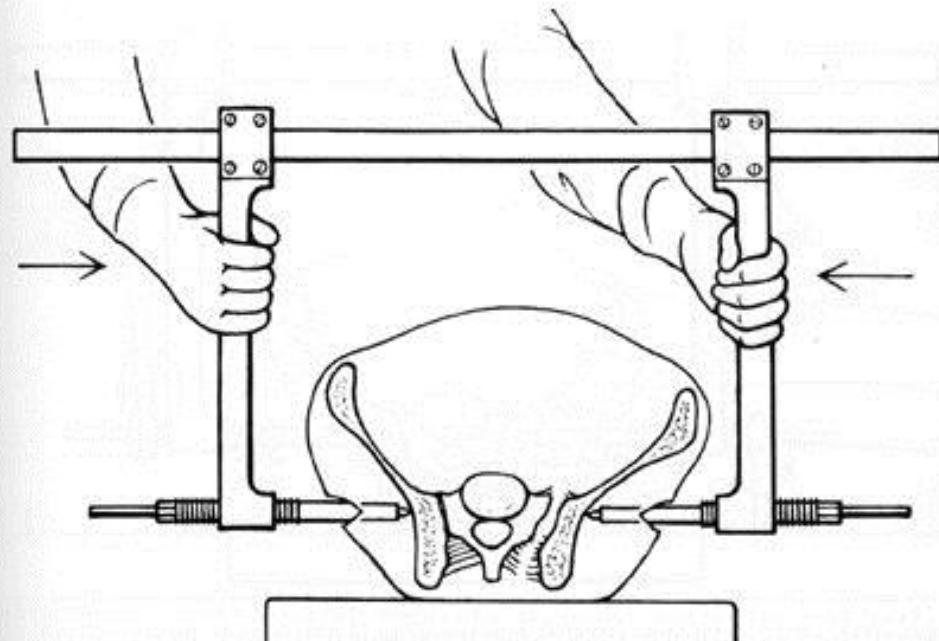
- interfragmentär rörelse 
- bäckenvolym  selftamponad
- smärta/stressreaktion 



Akut stabilisering av bäckenfrakturer med C-clamp

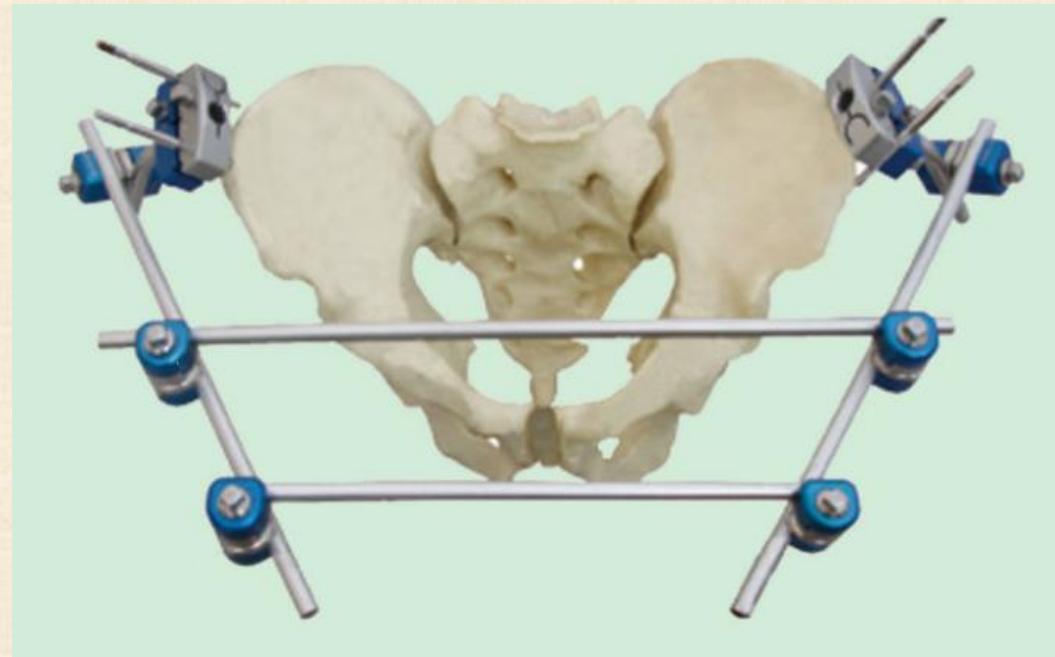
Effektiv men:

- kontraindikationer
- erfarenhet
- genomlysning
- komplikationer
- tid



Extern fixation

Transport från Island, påkörd av buss
magstag, transileosacral bar



Effektiv men:

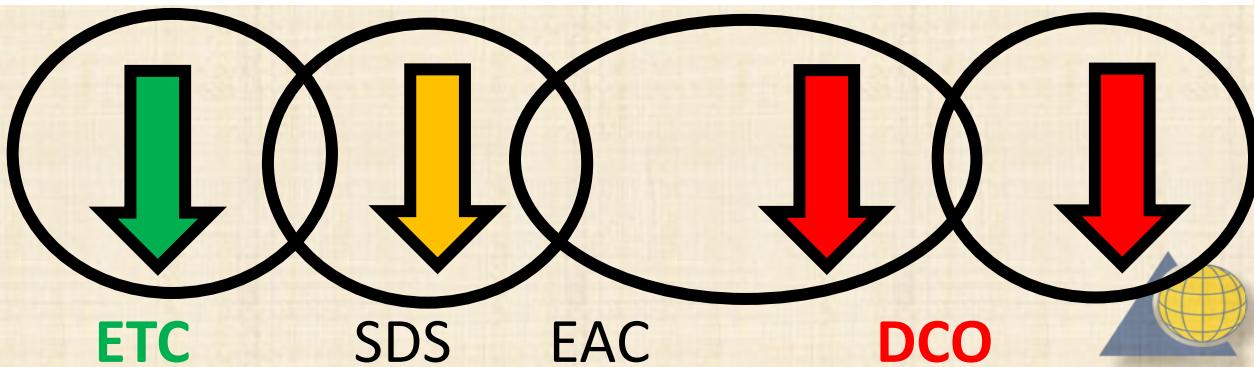
- Tidskrävande
- Inte sällsynt med felplacerade skruvar
- Hög infektionsrisk
- Omvårdnadsproblem
- Patient obehag



Bedömning av cirkulatorisk stabilitet

TABLE 3. Assessment of Four Different Clinical Grades and Ranges of Clinical Parameters Determining These Grades

	Parameter	Stable (Grade I)	Borderline (Grade II)	Unstable (Grade III)	In Extremis (Grade IV)
Shock	Blood pressure (mmHg)	100 or more	80–100	60–90	<50–60
	Blood units (2 h)	0–2	2–8	5–15	>15
	Lactate levels	normal range	approximately 2.5	>2.5	severe acidosis
	Base deficit (mmol/L)	normal range	no data	no data	>6–18
	ATLS classification	I	II–III	III–IV	IV
Coagulation	Urine output (mL/h)	>150	50–150	<100	<50
	Platelet count ($\mu\text{g}/\text{mL}$)	>110,000	90,000–110,000	<70,000–90,000	<70,000
	Factor II and V (%)	90–100	70–80	50–70	<50
	Fibrinogen (g/dl)	>1	approximately 1	<1	DIC
	D-Dimer	normal range	abnormal	abnormal	DIC
Temperature		>34°C	33°C–35°C	30°C–32°C	30°C or less
Soft-tissue injuries	Lung function; $\text{PaO}_2/\text{FiO}_2$	>350	300	200–300	<200
	Chest trauma scores; AIS	AIS I or II	AIS 2 or more	AIS 2 or more	AIS 3 or more
	Thoracic trauma score; TTS	0	I–II	II–III	IV
	Abdominal trauma (Moore)	≤II	≤III	III	III or >III
	Pelvic trauma (AO class.)	A type (AO)	B or C	C	C (crush, rollover abd.)
Surgical strategy	Extremities	AIS I–II	AIS II–III	AIS III–IV	Crush, rollover extrem.
	Damage control (DCO) or		DCO if uncertain		
	Definitive surgery (ETC)	ETC	ETC if stable	DCO	DCO



Pape et al 2005

Identifiera riskpatienter

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	Factor II and V (%)	90–100	70–80	50–70	<50
	Fibrinogen (g/dl)	>1	approximately 1	<1	DIC
Temperature	D-Dimer	normal range	abnormal	abnormal	DIC
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	Damage control (DCO) or		DCO if uncertain		
	Definitive surgery (ETC)	ETC	ETC if stable	DCO	DCO

Pape et al 2005



Effects of Pelvic Volume Changes on Retroperitoneal and Intra-Abdominal Pressure in the Injured Pelvic Ring: A Cadaveric Model

*Daniel Köhler, MD, Richard Martin Sellei, MD, Aaron Sop, DO, Ivan S. Tarkin, MD, Roman Pfeifer, MD,
Robert Leo Garrison, MD, Tim Pohleman, MD, and Hans Christoph Pape, MD*

I fall stor mängd (12L) retroperitoneal blödning och bilateral open book skada reposition av bäcken kan öka risken för IAP och abdominal compartment sy.

*Köhler D et al.: The Journal of TRAUMA®
Injury, Infection, and Critical Care • Volume
71, Number 3, September 2011*



Lethal Triade of Polytrauma

Stor blödning
≥ 6 E blod

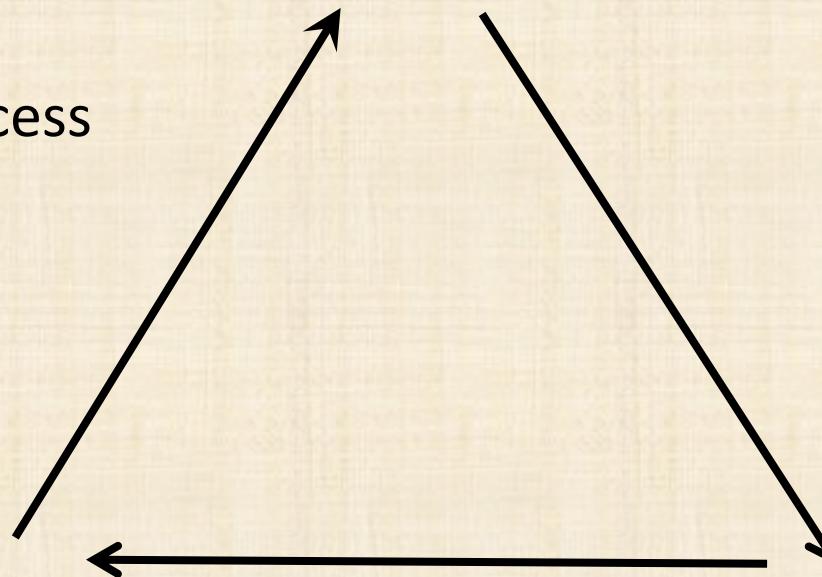
+

inflammationsprocess

SIRS



Koagulopati



Hypotermia

Metabolisk
Acidosis
Laktat ≥ 2,5



MOF





Fig. 3a

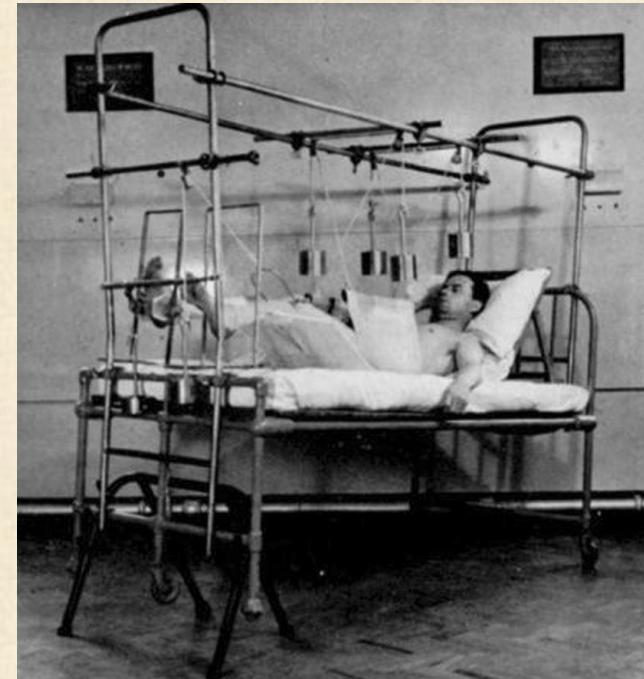
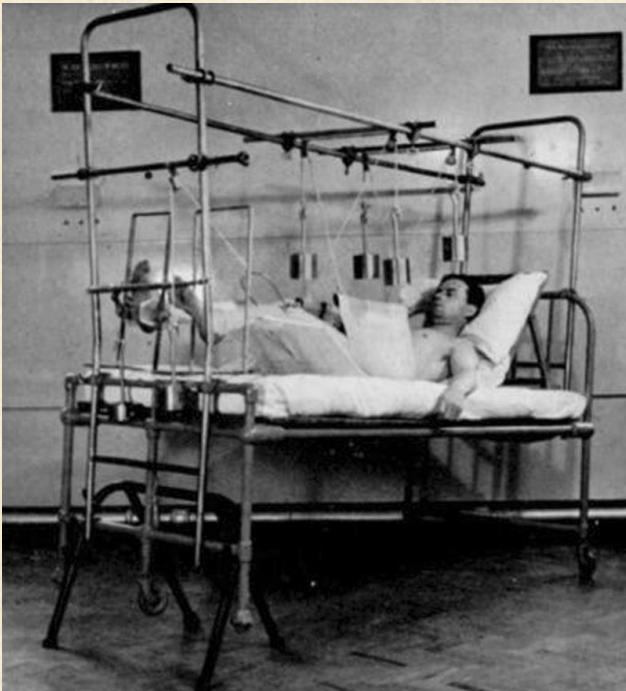


Fig. 3b



Selective angiography and embolisation of active arterial bleeding in a polytrauma patient with a pelvic ring injury and a transient response on volume replacement and a pelvic wrap. a) emergency CT evaluation showing an arterial blush directly ventral to the right sacroiliac joint, b) selective angiography demonstrating active bleeding, and c) after selective embolisation: no further signs of active bleeding are seen.

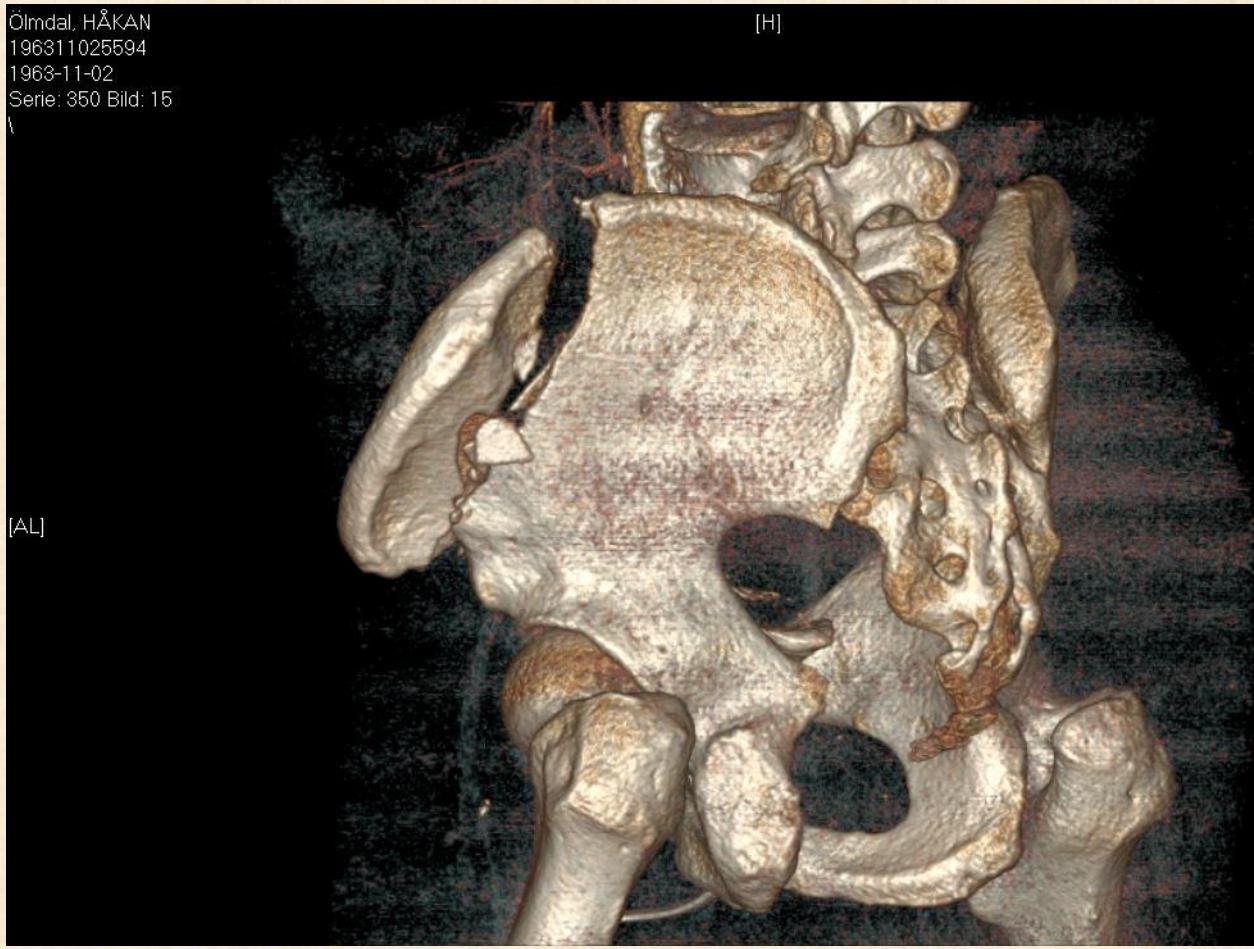
Konservativ behandling av open book skada



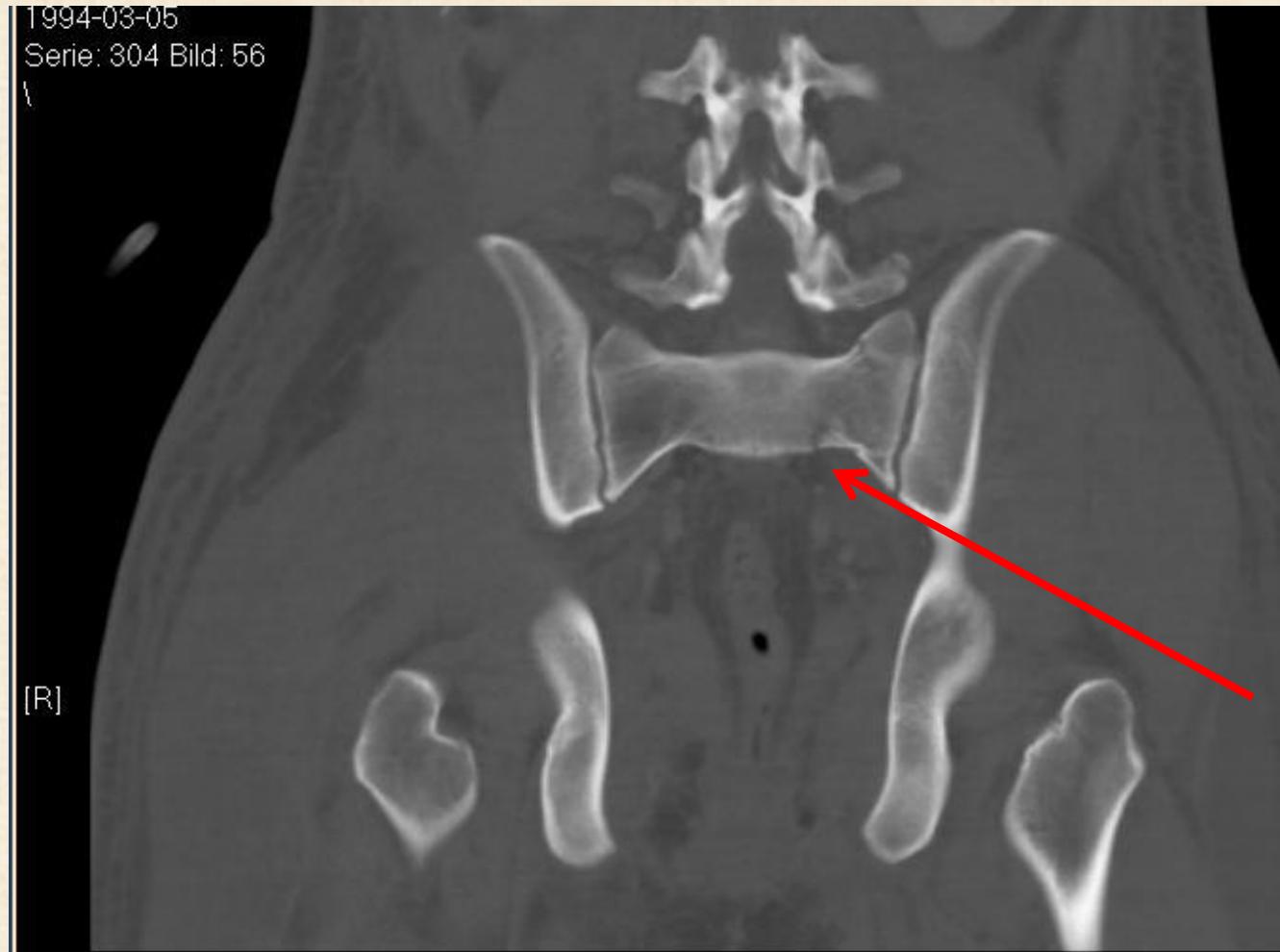
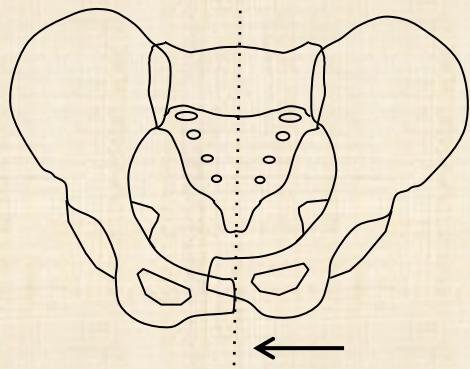
Ad modum Böhler 1935



Typ A frakt. Rel ind. För kirurgi



Definitiv behandling LC I ("closed book", AO B2)

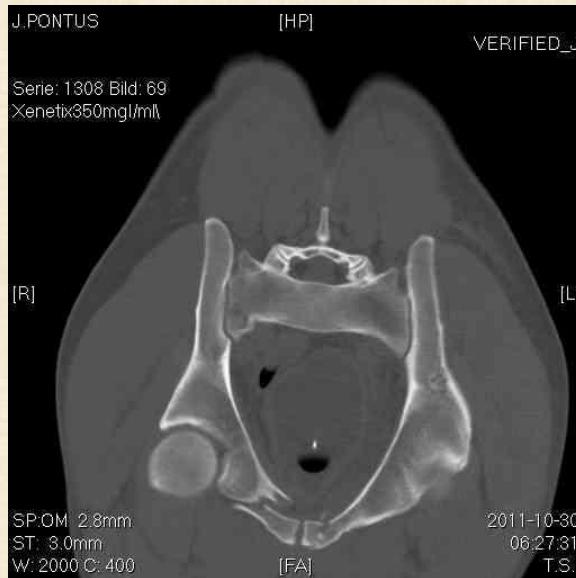


Född 94, påkörd av hjullastare

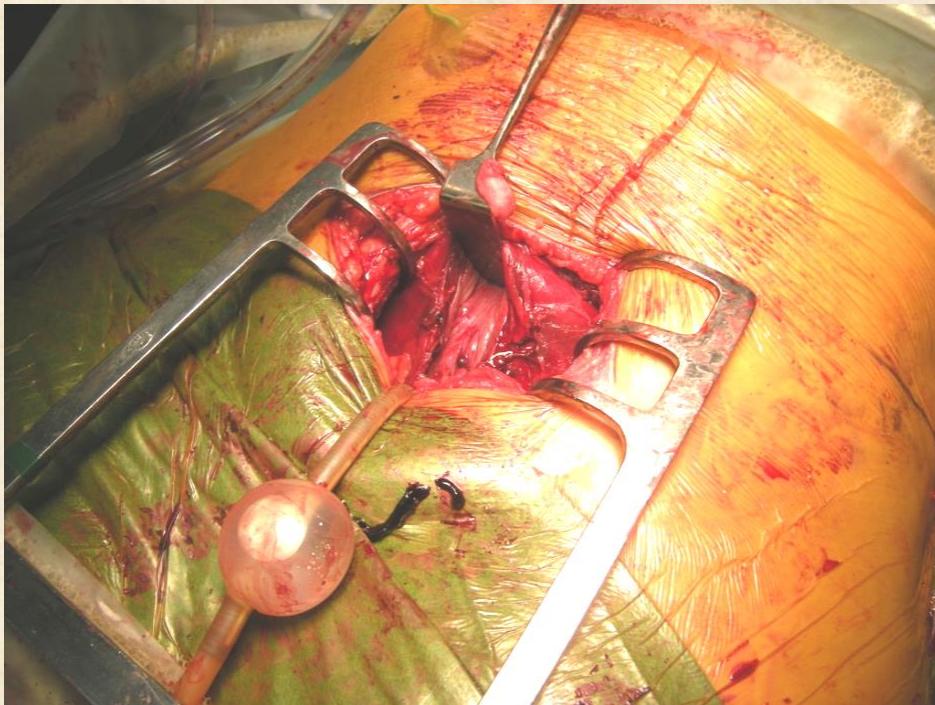


Definitiv behandling LC I ("closed book")

påkörd av spårvagn, 22 år



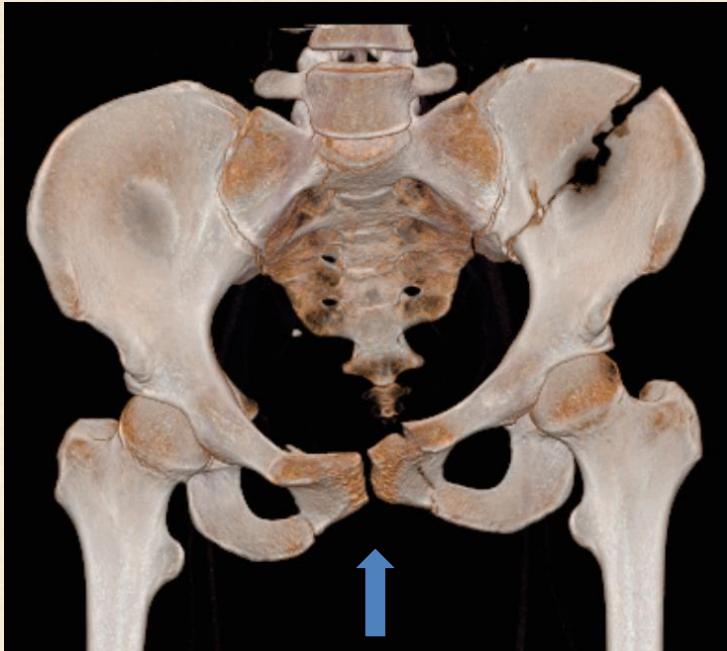
Kompressionsfraktur (closed book) påkörd av spårvagn, 22 år



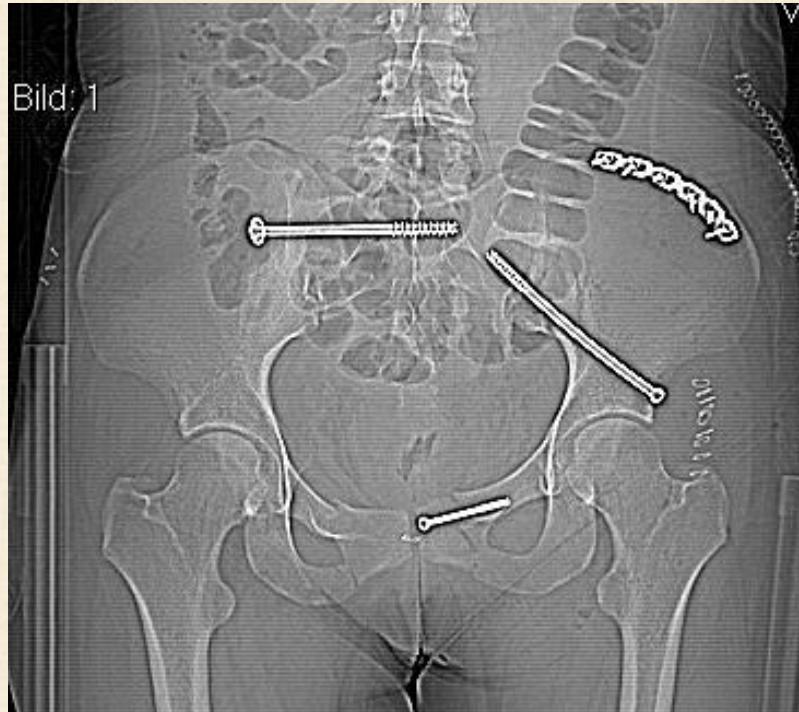
Retrograd ramusskruv
(gängat stag)



Ringskada, LC III instabil



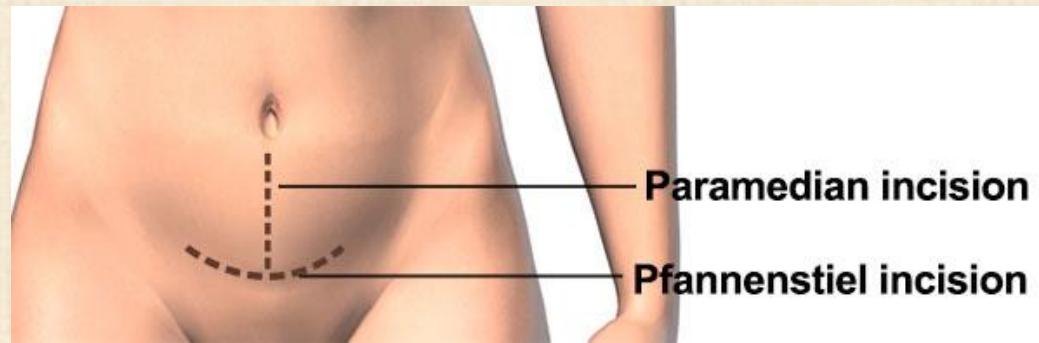
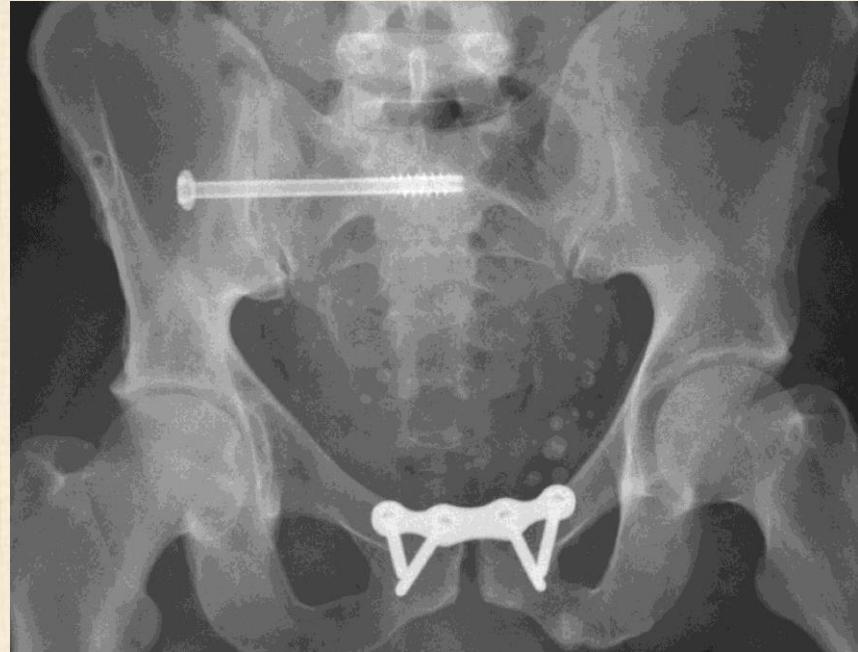
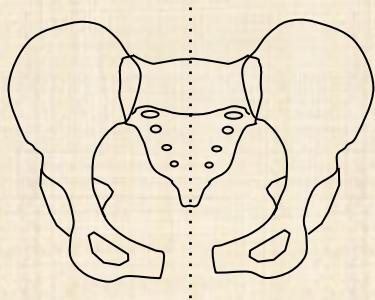
Suicid
hopp från Älvsborgsbron

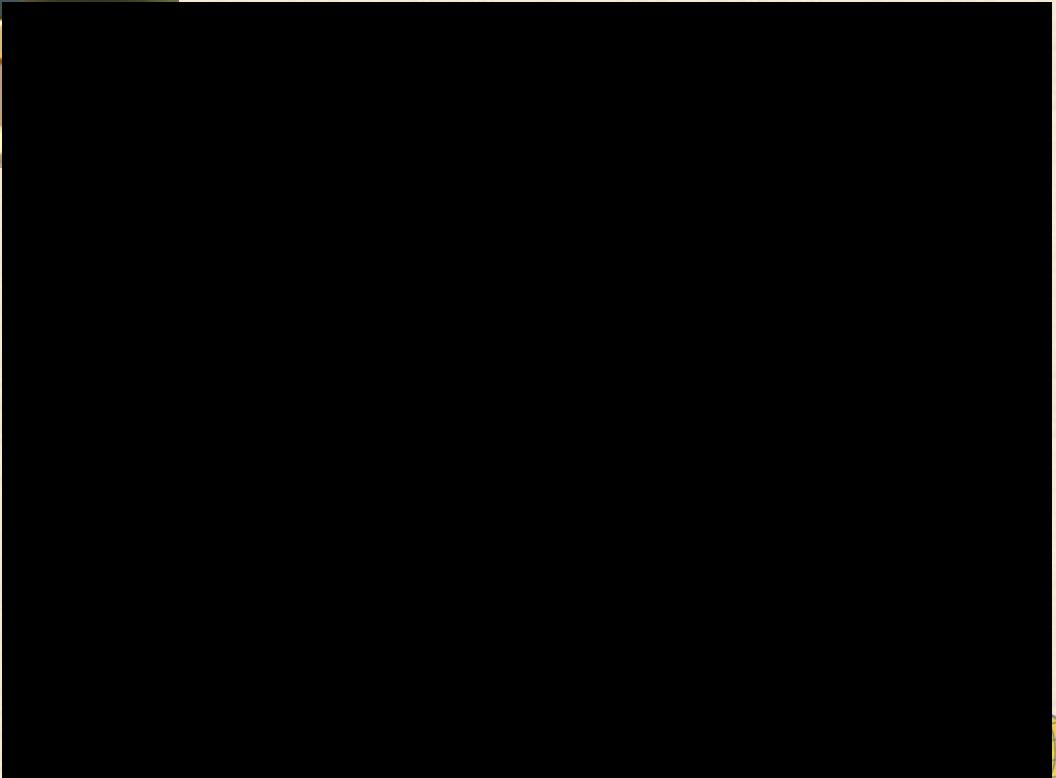


Ryggläge, traumatop, C-båge
7,3mm kannulerad skruv
Rekonstruktionsplatta
4,5mm kannulerad skruv alt.
helgängad Steimann pinne 3,2mm
Bäckentänger

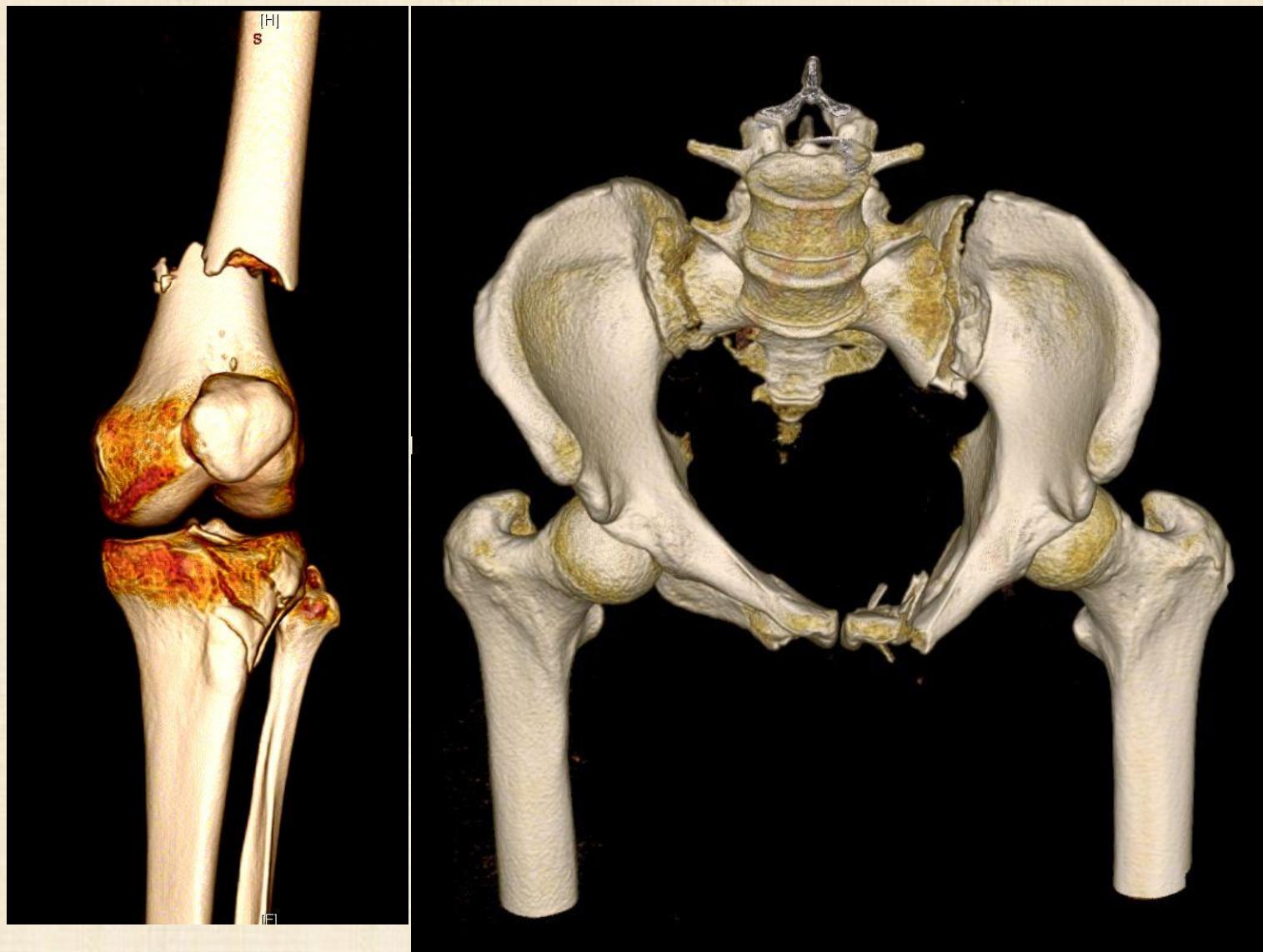


Definitiv behandling – APC ("open book", AO B1,B3)





30 år frisk man, passagerare, klämskada vä ben med kärlskada, bäckenring fraktur
, inga organiskador, ingen skallskada



Inkomst
RR80/50, p130



Dag 3-5



1 år postop



Sammanfattning

- Akut stabilisering (gördel / ex-fix)
- Cirkulatoriskt stabil pat. – ETC (Early Total Care)
- Svarar på resusitation men pågående blödning (responder)
 - Angio/embolisering
- Hemodynamisk alvarligt instabil patient
 - Bäckenpackning
 - Ev senare angio/embolisering
- Definitiv behandling i lugnt skede (4-10 dgr)

Tack! -1



