MEDIZINISCHE UNIVERSITÄT
INNSBRUCK

INNOVATION | EDUCATION | INTERVENTION

Lisbon, Portugal
September 26-30
CIRSE 2015

FC 1701 - Basic principles of transcatheter embolisation in the trauma patient:

Treatment of pelvic haemorrhage

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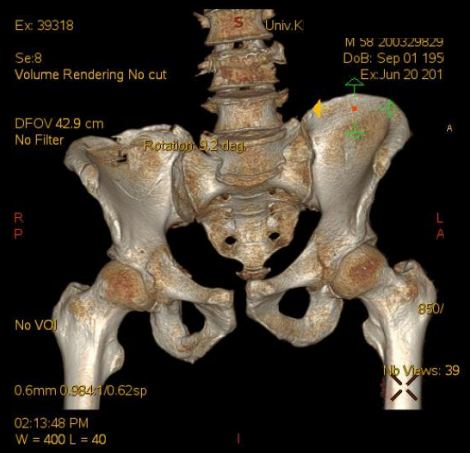
Learning objectives

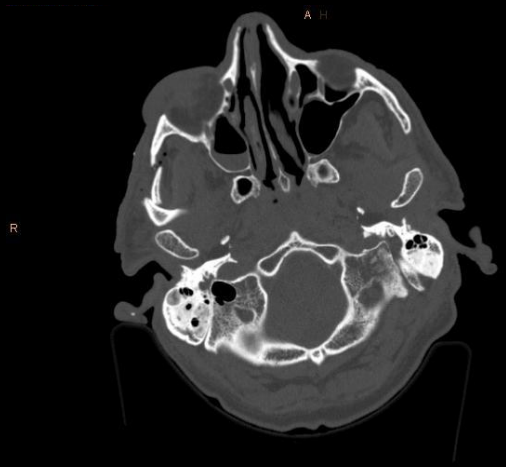
- 1. To discuss suitable candidates
- 2. To understand the relevant anatomy and examine embolisation techniques
- 3. To review potential failure and complications of embolisation

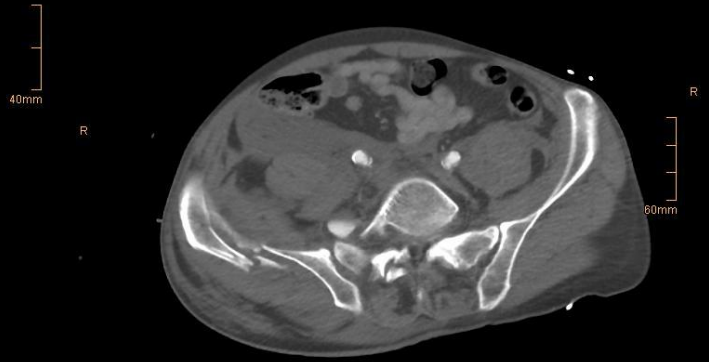
Illustrative case report

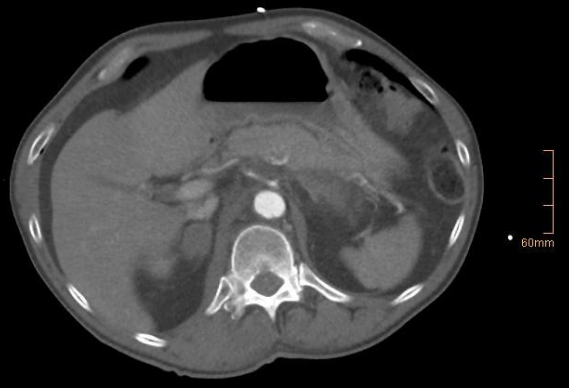
- 56 year old male
- Operator of an earthmoving machine
- Hit by a 200 kg stone at construction site
- Admitted at 1:15 pm to the emergency room in unstable condition
- RR not measurable,
  - hemoglobin 6.2, pH 7.19, O2-saturation 19.8%, aPTT 63 sec, clotting time 81 sec
- CT performed at 2:15 pm;
- Interdisciplinary discussion: pessimistic prognosis regarding survival, embolization first choice to control multiple bleeding sites
- IR service informed at 2:30 pm
- Arrival of patient in angio room at 3:15 pm (IR team ready!)
- Catheterization at 3:30pm
- Embolization of first bleeding vessel 15 min later

Most important injuries: unstable pelvic fracture, unstable fracture of lumbar vertebral body 3, multiple rib fractures on the left, retroperitoneal and pelvic hemotomas with multiple sites of CM extravasation, rupture of the left diaphragm, blunt trauma of the left upper abdomen, multiple fractures of facial bones

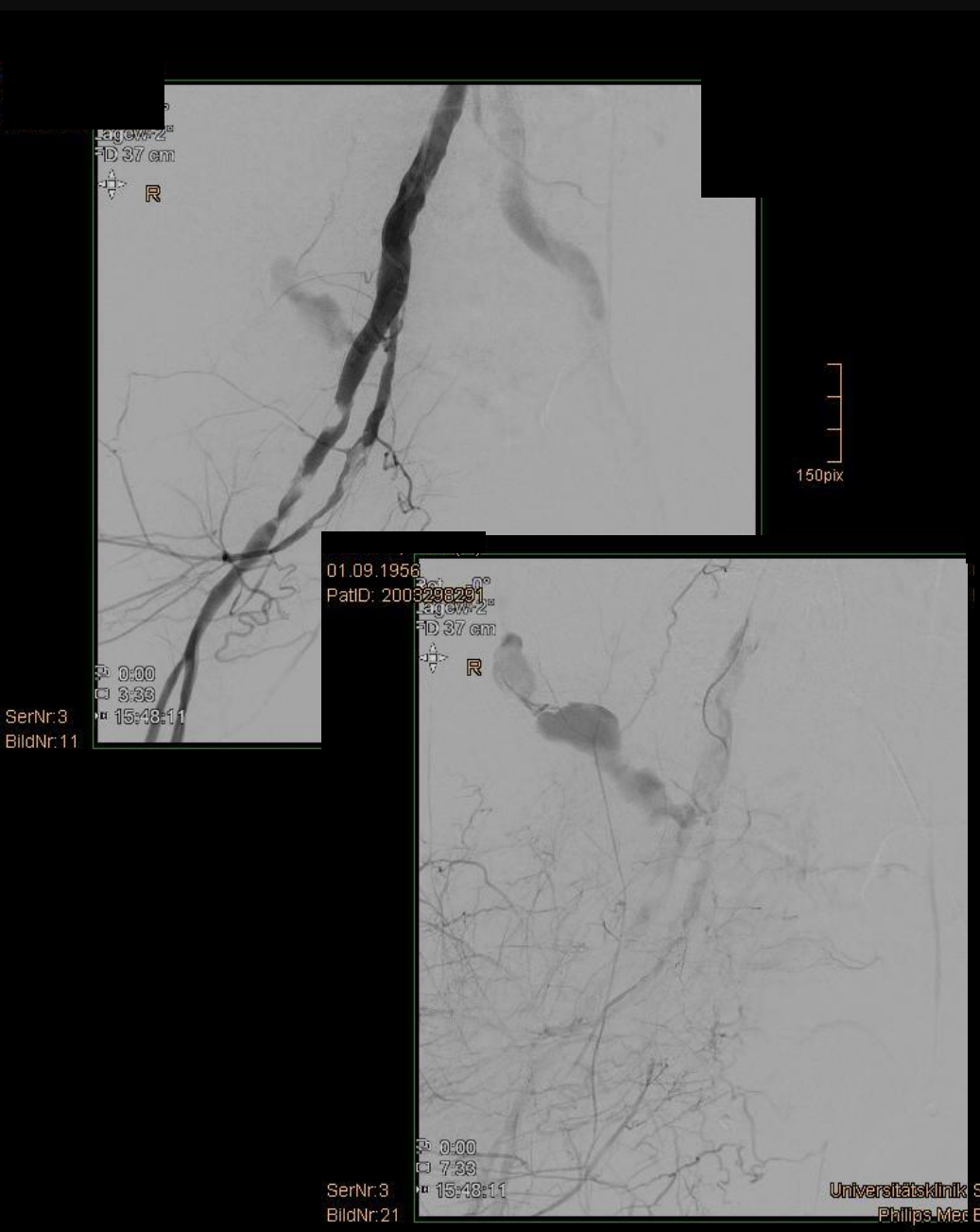


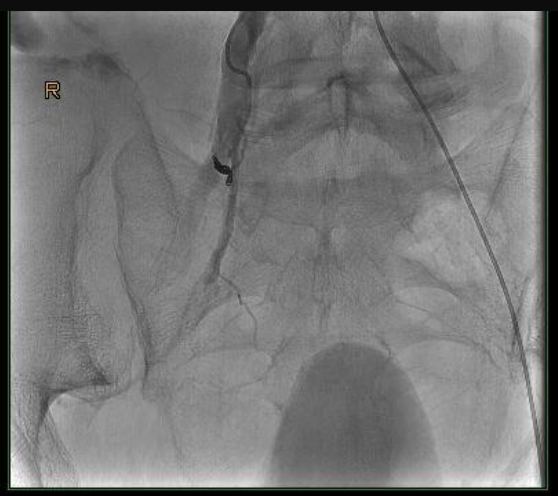


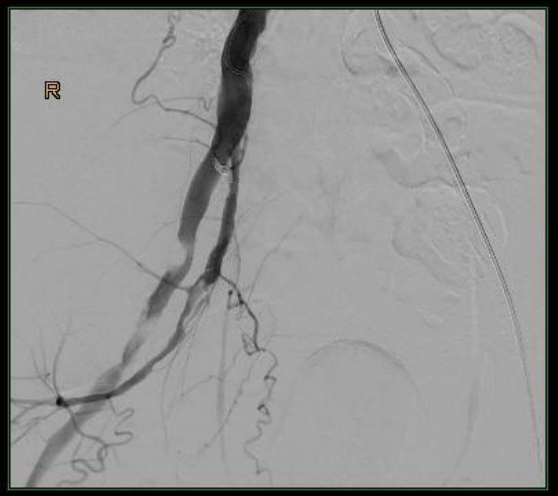




Massive bleeding from ruptured iliolumbar artery,
Intimal tears in right external&internal iliac artery







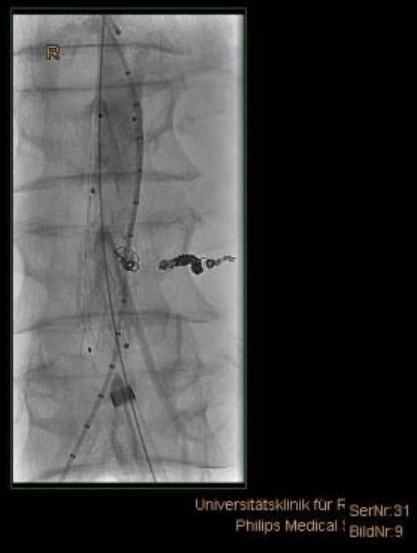
Universitätsklinik für Radiologie Innsbruck
Philips Medical Systems AlluraXper

Intimal tears in the infrarenal abdominal aorta, bleeding from 3 lumbar arteries and avulsion of 3rd left lumbar artery

Coiling of lumbar arteries.
5:30 pm: indication for stent grafting of infrarenal aorta because of avulsion of 3.left lumbar artery.
Cut down left groin 6:15 pm.

Stentgrafting of infrarenal aorta. Placement of 18F sheath from a cut down of the left groin.
Device: Endurant left iliac extension (8,2 cm covered length).
Finished: 8:22 pm. Total time for complex procedure: 5h. **Hemorrhage was controlled**.

Angiographie
FRONTAL



Surgical repair of diaphragmatic hernia and lumbar spine fracture. Pelvic stabilization. Patient survived.

Blunt pelvic trauma

- What are the most common sources of bleeding?
- What are the indicators for life threatening hemorrhage?
- What are the therapeutic options?
- Who should be embolized?
- Which technique of embolization should be used?
- Results

Bleeding sites in patients with pelvic fractures

1. Rupture of veins and/or venous plexus
2. Bleeding from bone marrow
3. Rupture of arteries (rare)
4. Simultaneous bleeding from 1- 3

Massive bleeding following blunt pelvic trauma

- Self limiting bleeding from venous sources common: ca. 90%.
- Massive bleeding occurs in approx. 7-11% of patients. Most common source: arterial injury
- Indicators for massive arterial bleeding:
  1. unstable pelvic fracture,
  2. Poor response to volume replacement therapy,
  3. Large pelvic hematomas,
  4. CM-extravasation at MS-CT.

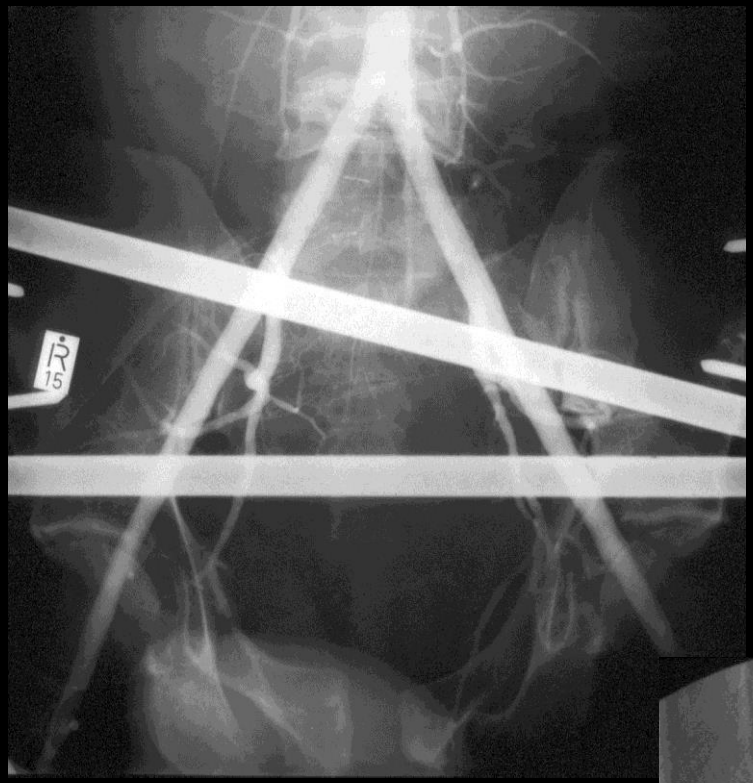
Therapeutic options in patients with massive bleeding after pelvic trauma

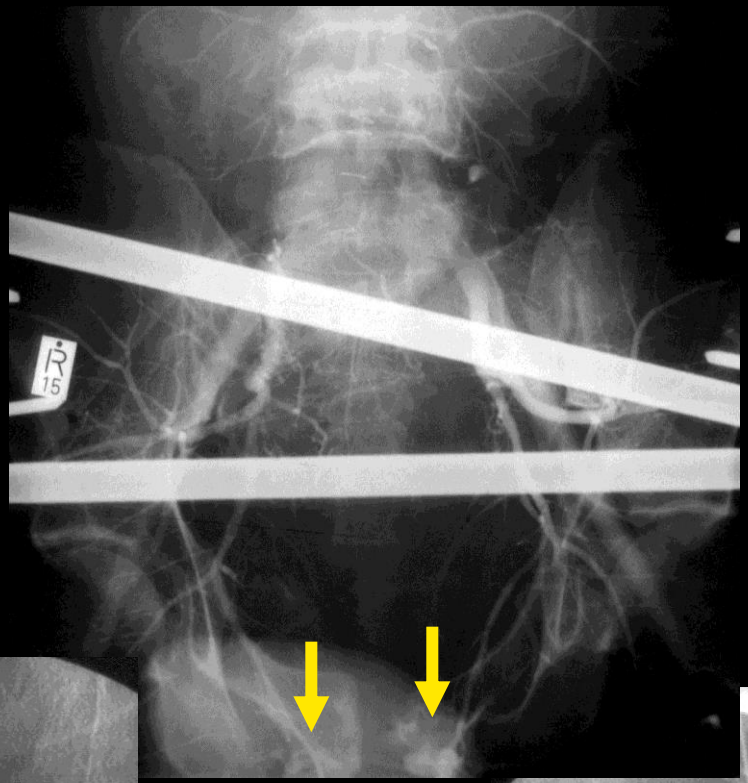
- Transfusion of fluids and blood
- External fixation
- TransArterial Embolisation (TAE)
- Internal fixation
- Laparotomy, tamponade and pelvic stabilization

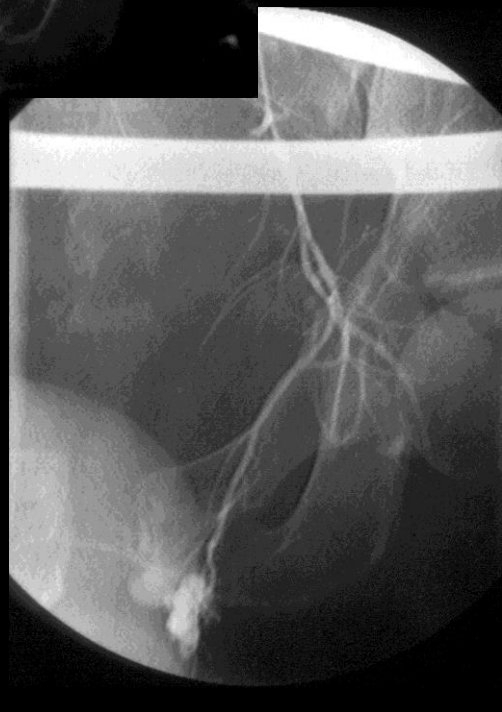
Facts.

- Venous bleeding and bleeding from fractured bones respond very well to external stabilization (pelvic volume reduction) and/or conservative therapy (volume replacement).
- Massive bleeding causing hemodynamic instability or shock is most often caused by arterial bleeding.
- Arterial bleeding cannot be efficiently controlled by external or internal stabilization.

Langenbecks Arch Surg (2011) 396:243–250; Injury, Int. J. Care Injured 40 (2009) 1023–1030; EJR2011: Papakostidis et a.; The American Journal of Surgery (2010) 200, 752–758; *J Trauma. 2010;68: 415–420;* American Journal of Emergency Medicine (2011): Tanizaki et al.







Arterial bleeding cannot be controlled by external fixation!

Arch Orthop Trauma Surg (2005) 125: 443–447
DOI 10.1007/s00402-005-0821-7

ORIGINAL ARTICLE

Hassan Sadri · Thai Nguyen-Tang · Richard Stern
Pierre Hoffmeyer · Robin Peter

Control of severe hemorrhage using C-clamp and arterial embolization in hemodynamically unstable patients with pelvic ring disruption

Table 2 Details of blood units administered before and after C-clamp application

Patient	Number of blood units before C-clamp application	Number of blood units after C-clamp application
1	4	10
2	8	9
3	3	2
4	5	10
5	14	14
6	3	2
7	9	8
8	4	6
9	7	10
10	10	7
11	4	3
12	7	11
13	7	43
14	15	9

Conclusions Although the C-clamp is effective in controlling hemorrhage, one must be aware of the need for arterial embolization to restore hemodynamic stability in a select subgroup of patients.

Approx. 30% of patients treated by pelvic C-clamp had to be embolized to control bleeding!

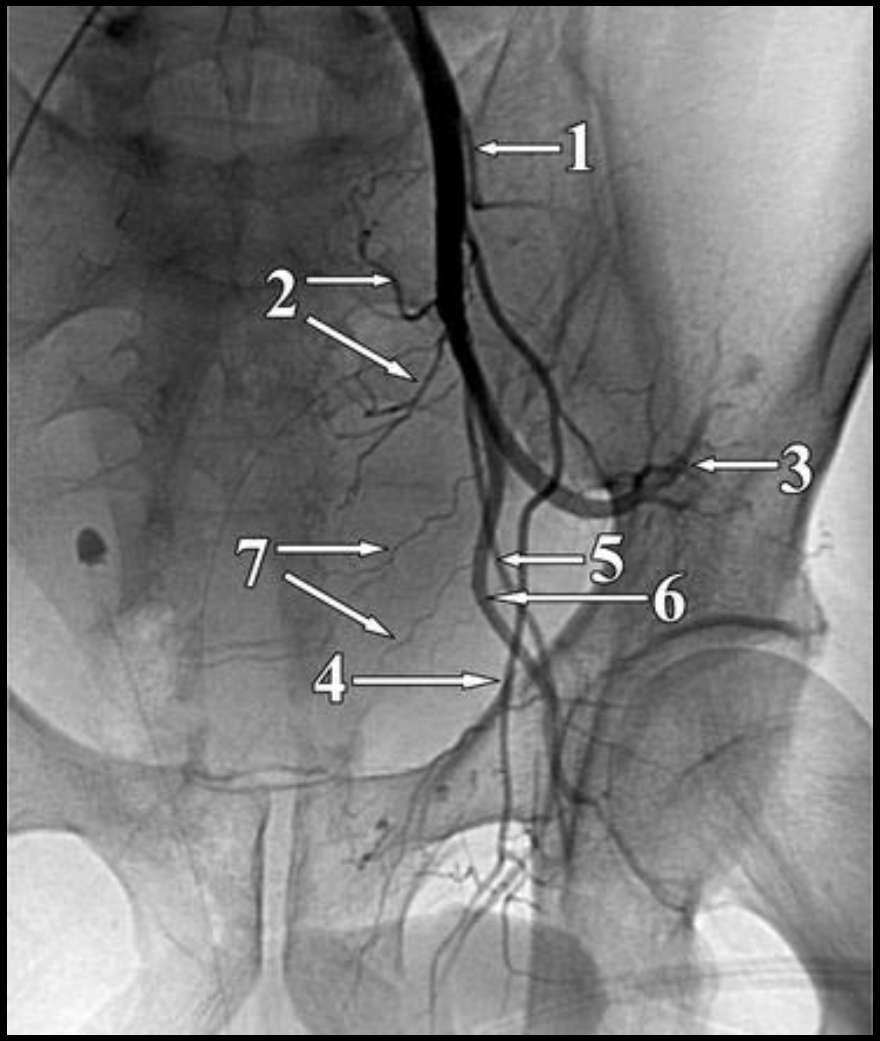
Table 3 Details of patients requiring arterial embolization for hemodynamic instability

Patient number	Time to embolization (h)	Number of units transfused before embolization	Number of units transfused after embolization	Arteries embolized	Reason for angiography	Death (time)
1	18	14	0	Obturator	Hemorrhagic shock	-
4	12	15	0	Lateral sacral	Hemorrhagic shock	-
8	1	9	1	Superior gluteal	Severe shock	-
12	2	16	2	Small branch of external iliac	Severe shock	-
13[b]	3	10	40	Superior gluteal; bilateral lumbar L3	Hemorrhagic shock	< 12 h

[b]Deceased

Which are the most common sites of arterial injuries caused by pelvic fractures?

Arterial anatomy of the pelvis



Arteria
1=iliolumbalis,
2=sacralis, 3=glutea superior, 4=Obturatoria,
5= pudenda interna,
6= glutea inferior,
7= vesicalis sup. + inf.

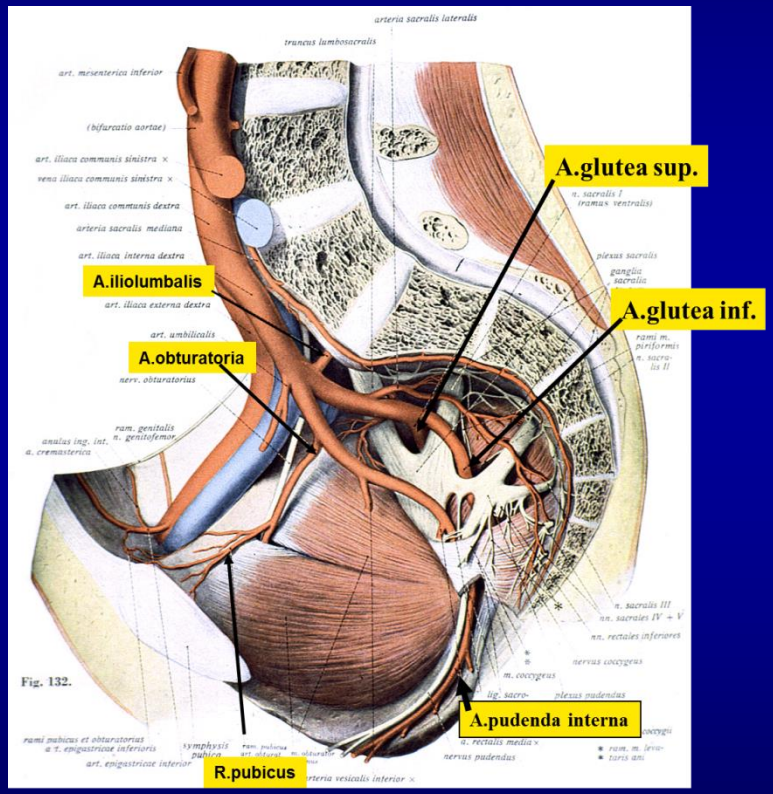
Important!!:

Pubic branches arise also from A.epigastrica inferior

Pelvic arteries form an arterial network (extensive collaterals!)

„Hot spots“ you have to look for when dealing with arterial bleeding caused by pelvic fractures

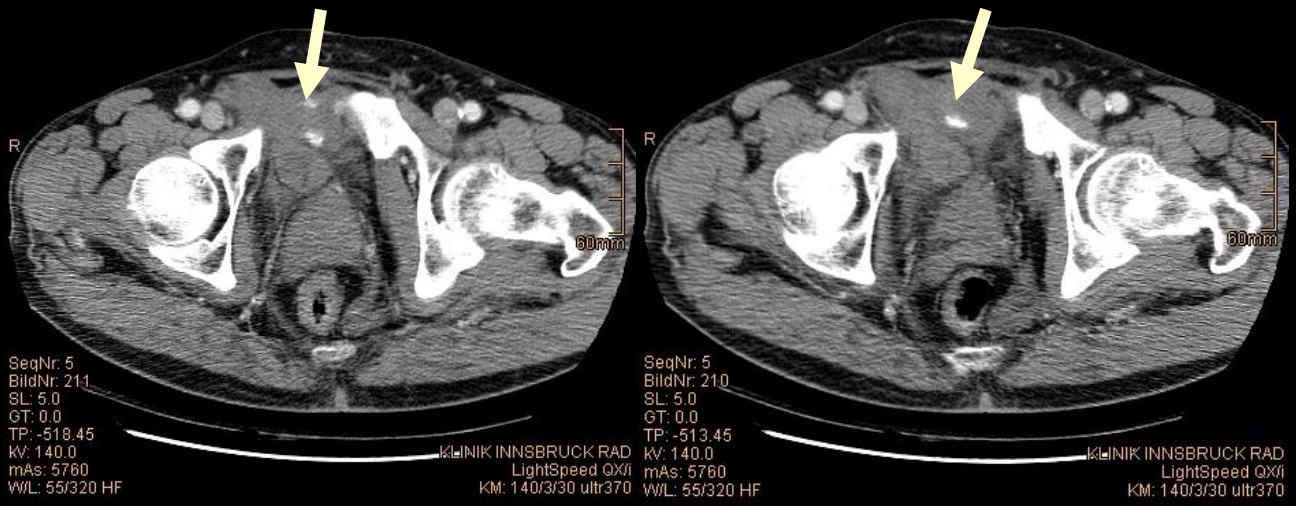
- Close relationship between bone and artery (internal iliac, lateral sacral, obturator, pudendal arteries)
- Exit points (supra-/infra piriforme foramen, obturator canal, urogenital diaphragm) of side branches of internal iliac (gluteal, obturator and pudendal arteries)



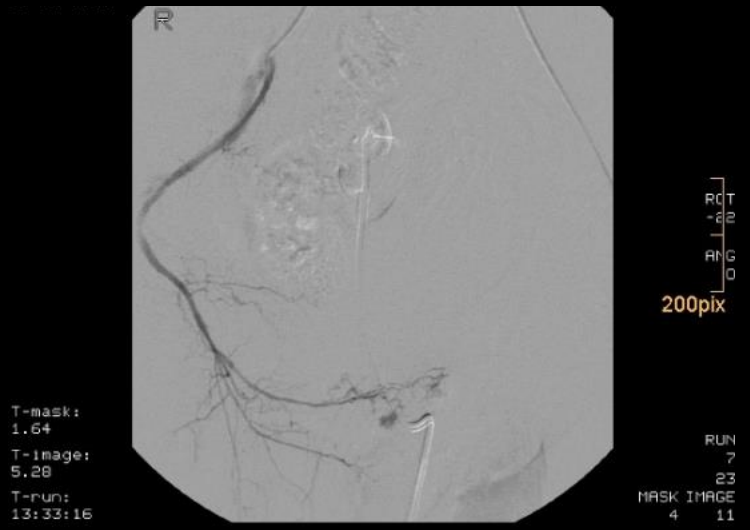
Sabotta Anatomie des Menschen
Urban&Fischer ELSEVIER; 22.Auflage, 2007

Laceration of A. pudenda interna, caused by fracture of Os pubis

Arterial bleeding caused by fracture of Ramus superior ossis pubis

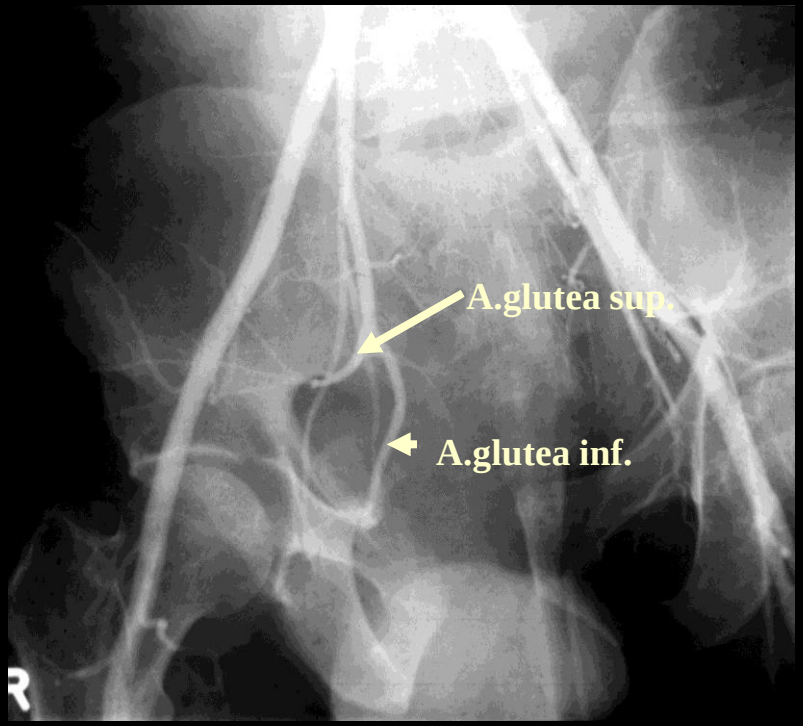


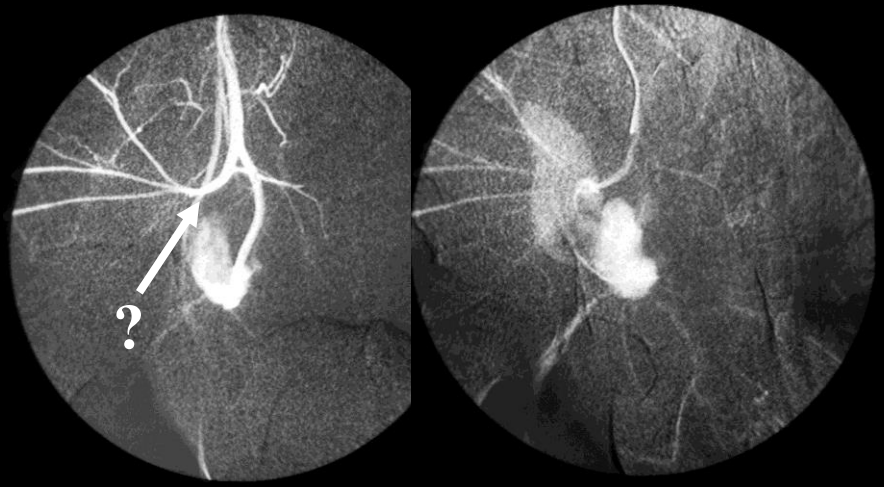
Rupture of a side branch of
A. obturatoria (pubic branch)!



Pubic branch may also arise from inferior epigastric artery!

Laceration of Arteria glutea superior und inferior at the exit points!





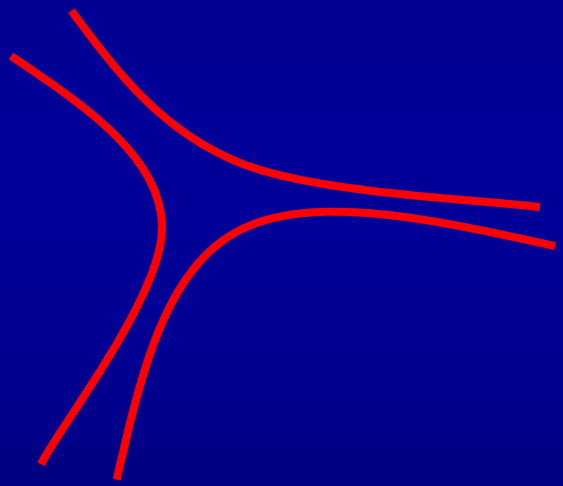
Rupture of A. glutea inferior in Foramen infrapiriforme!

Technique of embolization

- important characteristics of pelvic vasculature
- embolization materials

Collaterals

Iliaca interna

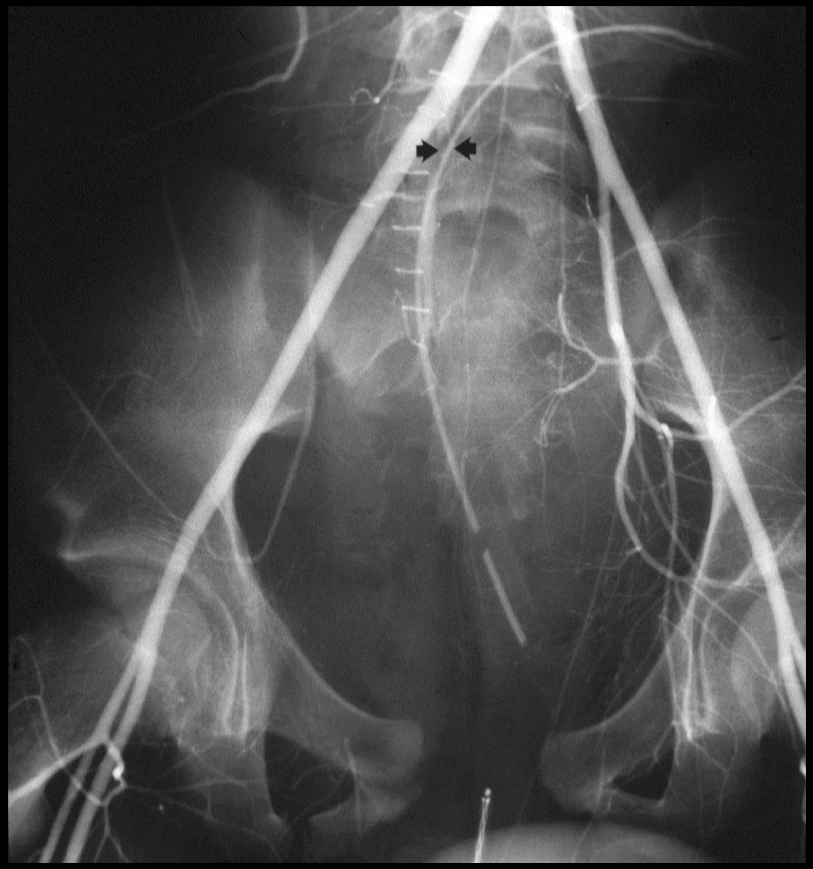


Posterior branch
- Lumbalis
- Iliolumbalis
- Sacralis medialis
- Femoralis profunda
- contralateral iliaca interna

anterior branch
- mesenterica inferior
- Femoralis profunda
- epigastrica
- contralateral iliaca interna

Patient with open book fracture and persistent bleeding following ligation of right internal iliac interna

Note: filling of ligated internal iliac via collaterals from the contralateral internal iliac (presacral, pubic, rectal anastomoses)



Guidelines for TAE

- **Embolize as close to the vascular injury as possible!**
- Coils (micro & macro) = first choice (radioopaque,precise positioning, easy to handle, require dense packing for control of bleeding)
- PVA, Beads = second choice (use larger diameters: > 350 µ, good for ill defined bleeding sites and multiple small bleeding sites)
- Avoid fluids and small particles < 150 µ (higher risk of tisssue necrosis and damage to nervous tissue)
- Thrombus, Gelfoam: controlled delivery difficult; early recanalization possible

Green light:

- Microcoils, Macrocoils & Amplatzer plug
- PVA , Beads >350 µ

Red light:

- Beads (<150 µ)
- Alcohol
- Histoacryl
- Thrombus
- Gelfoam

Who should be embolized?

Patient with pelvic fracture, hemodynamically unstable despite volume replacement:

unstable pelvic fracture, retroperitoneal/intrapelvic hematoma **=> Embolisation!**

Patient with pelvic fracture, drop of Hb, hemodynamically stable with volume replacement:

MSCT-> pelvic/ retroperitoneal hematoma, CM-extravasation **=> Embolisation!**

Rationale

Mortality of patients with pelvic fractures and shock ranges between 36,4 – 54%.

Patients with arterial bleeding can reliably be identified by MSCT.

- ↘ CM enhanced MSCT demonstrates active bleeding, blood test indicate significant blood loss; ppv CM-extravasation at CT – arterial injuries at angiography 93% [Hagiwara et al. (2003) J Trauma]

There is enough evidence that patients with massive hemorrhage caused by pelvic fractures benefit from embolization.

- **Mortality may be lowered,**
- **Complications by massive transfusions and space occupying hematomas can be avoided**
- **Clinical outcome may be improved!**

Langenbecks Arch Surg (2011) 396:243–250; Injury, Int. J. Care Injured 40 (2009) 1023–1030; EJR2011: Papakostidis et a.; The American Journal of Surgery (2010) 200, 752–758; *J Trauma. 2010;68: 415–420;* American Journal of Emergency Medicine (2011): Tanizaki et al.

Results Innsbruck n=45

- **1476 pelvic fractures during study period, 45 patients (<5%) hemodynamically unstable due to arterial bleeding (CT!)**

- **Laparotomy in 2 patients because of intraperitoneal hemorrhage including pelvic packing**
- **1 pat. died im ER**
- **TAE in 42 patients (24 without, 18 with Emergency-CT)**

- **Control of pelvic bleeding in all patients who underwent TAE!**
- **RBC: 3.7±3.5 vs. 0.1±0.1 PRBC/h; p<0.001**
- **Control of bleeding within 163±83 Min.**
- **No difference between survivors and non-survivors (158±82 vs.177±91 minutes; n.s.)**

J Trauma. 2010;68: 415–420

Innsbruck Algorithm pelvic fractures & hemorrhage

Hemodynamically unstable patient with bleeding from pelvic fractures

Patient with pelvic fracture and bleeding
Localization of bleeding using CE-MS-CT
CT used for triage if other severe injuries are present

Angio + Emb.

Avoid pelvic packing!

The End