Emergency embolisation for acute trauma-induced bleeding

- Pelvis
- Kidney
- Spleen
- Liver
- Intercostal/lumbal/epigastric

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Disclosure

Speaker name: Boris Radeleff

I have the following potential conflicts of interest to report:

- [X] Consulting: BSCI, Cook
- [ ] Employment in industry
- [ ] Stockholder of a healthcare company
- [ ] Owner of a healthcare company
- [ ] Other(s)

- [ ] I do not have any potential conflict of interest
Pelvis
Every May ...
Traumatic pelvic fractures

Life-threatening: unstable fracture of the pelvis & haemodynamic instability

Massive pelvic bleeding (5 - 20%)

Blood loss  Shock-related complications (ARDS, MOF's)

Mortality: 18 – 40%

1 Miller PR J Trauma 2003;54:437-443
3 Smith W J Othop Trauma 2007;21:31-37
4 Starr AJ J Orthop Trauma 2002;1:553-561
Traumatic pelvic fractures

Life-threatening: unstable fracture of the pelvis & haemodynamic instability

Massive pelvic bleeding (5 - 20%)

Early hemostasis, because „bleeding to death“ is the most important treatable cause of death

Hemodynamically unstable pelvic fractures. Injury. 2009
Indications: our problems

No correlation between arterial bleeding and fracture-morphology and/or –classification \textsuperscript{1,2}

Fractures of the posterior column, ISG, sacrum: associated with arterial bleedings \textsuperscript{3,4,5}

\textsuperscript{1} Sarin EL J Trauma 2005;58:973-977
\textsuperscript{2} Starr AJ J Orthop Trauma 2002;16:553-561
\textsuperscript{3} Burgess A J Trauma 1990;30:848-856
\textsuperscript{4} Hamill J Aust NZ J Surg 2000;70:338-343
\textsuperscript{5} Young J AJR 1990;155:1169-1175
Indications: it seems easy ...

- Instable pelvic fractures \(^2,3\) &
- Haemodynamic instable patients \(^1,3,4\) &
- Arterial bleeding in the MDCT \(^2,3,5\)

- …, but treatment of venous bleedings (**more common**) first
- In case of persistent haemodynamic instability, arterial embolisation

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2. Westhoff J Unfallchirurg 2008;111:821-828
4. Tötterman A Acta Othop 2006;77:462-468
5. Slater S Eur J Radiol 2010;74:16-23

Local strategies: pelvic circumferential compression & fixation devices
Technique

Source of bleeding

- Superior & Inferior Gluteal
- Iliolumbar
- Lateral Sacral

- Obturator
- Inferior Gluteal

- Internal Pudendal
- Obturator

Pelvic Fracture Classification

Lateral Compression
- LC-I
- LC-II
- LC-III

Anterior-Posterior Compression
- AP-I
- AP-II
- AP-III

Vertical Shear
- VS
Technique of Pelvic Emergency Embolisation

**MDCT:** incl. CT-angiography is obligatory pre-interventional

**Anaesthesia:** do you need ITN or not (standby is obligatory!)

⇒ haemodynamic stable (vs. instable?)

- Transfemoral **contralateral** approach (ultrasound-guided & MPC)
- Short 4F Schleuse; 4 F Cobra C2 (4F Sidewinder Typ 1)
- Overview angiography (?? role vs. MDCT-Angio)
- Selective angiography: A. iliaca interna (obligatory); (AIE, if not AII)
- „**Bloody trias**“: active bleeding, PSA, cut-off’s, (spasm & diss.)

⇒ superselective recanalisation of the bleeding vessel (microcatheter)
⇒ but time runs ... (haemodyn. instability?): embol. AII, uni- or bilateral
Results of Pelvic Emergency Embolisation

- Detection of bleeding (trias) 58.1 – 100%\(^1-6\)
- Technical success 90 – 95.8% \(^1,6\) (100%\(^7\))
- Clinical failure (re-bleeding) 0 – 29% \(^1,2,4\)

⇒ If pat. embolized < 3h: signif. better survival rate\(^7\)

⇒ Most important predictive factor: transfusion volume before embolisation

⇒ Mortality rate is very variable (due to additional injuries)

\(^1\) Verbeek D World J Surg 2008;32:1874-1882
\(^2\) Fang JF Langenbecks Arch Surg 2011;396:243-250
\(^3\) Constantini T Am J Surg 2010;200:752-758
\(^4\) Tanizaki S Am J Em Med 2012 Feb;30(2):342-6
\(^5\) Fu CY Am J Em Med 2013 Oct;31(10):1432-6
\(^6\) Westhoff J Unfallchirurg 2008;111:821-828
\(^7\) Agolini SFJ Trauma 1997;43:395-399
Basic Embolisation Technique

1. Frontdoor only

2. Frontdoor & Backdoor
Basic Embolisation Technique

1. Frontdoor only

2. Frontdoor & Backdoor
Case 1: car accident, 24 years, male

- instable pelvic ring fracture & transverse process of the right 5th lumbar vertebrae
- haematoma around the symphysis & testes / penis base, perivesical, periprostatic
Case 1: car accident, 24 years, male

- Bleeding branches from the A. pudenda interna; superselective recanalisation
Case 1: car accident, 24 years, male

- Embolisation: 9 x pushable microcoils // **Cave:** A. dorsalis penis was preserved
Case 2: traffic accident 84 years, female

- instable pelvic ring fracture bilateral! Additional bladder rupture
- Left pubis: active arterial bleeding
Case 2: traffic accident 84 years, female

- active arterial bleeding little side branch left AII
- No stasis after coiling ➔ glue bolus

2 x 2/10 & 2 x 4/4 Microcoils / 0,2 ml Histoacryl/Lipiodol 1:1
Case 4: fall from the 5th floor, 72 years, female

- active arterial bleeding: multiple spots, Hb <4,5
What would I do – in which situation?

Scenario 1:
Haemodynamic stable; normal coagulation; only **one or few** spots
⇒ superselective positions; microcoils (pushable & detachable)

Scenario 2:
Haemodynamic stable; **impaired coagulation**; multiple spots
⇒ superselective position; coils & if necc. Histoacryl/Lipiodol

Scenario 3:
Haemodynamic **instable; no coagulation**; multiple spots
⇒ AllI main branch; start with 900μm particles, than 1:3 mixture & Histoacryl/Lipiodol
Kidney
Indications of Renal Emergency Embolisation

- Arterial bleeding in the MDCT $^{3,4}$
- Haemodynamical *stable* patients $^1,2$
- Discontinuity of the Gerota fascia + perirenal haematoma associated with need embolization$^3$

2. Pfitzenmaier J Unfallchirurg 2009;112:317-326
Technique of Renal Emergency Embolisation

• Overview (4F Cobrakatheter C2 / 4F Sidewinder 1)

• Obligatory superselective angiography of all 3 renal branches (only selective ➔ possible missed bleeding)

• Search for the „Bloody trias“

• Embolic materials:

  Coils, (combination of Coils & Histoacryl), particles
Results of Renal Emergency Embolisation

- Technical success
  80 - 100% \(^1,2\)
- Clinical success rate
  70 - 100% \(^1,2,3\)
- Loss of tissue
  ca. 10% \(^4\)
- Complications
  0-19% \(^1,6\)
- Embol. grade 4 renal trauma without impairment of GFR
  100% \(^5\)

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1 Brewler ME J Urol 2009;181:1737-1741
2 Schmidlin F Urologe 2005;44:863-869
3 Menaker J World J Surg 2011;35:520-527
4 Santucci RA BJU 2004;93:937-954
5 Morita S Scand J Trauma 2010;18:1
Case 6: bicycle vs. car, 74 years, male
Case 6: bicycle vs. car, 74 years, male

- Embolisation: glue/lipiodol-mixture (1:1) (0,2 ml) / Amplatzer Typ 4
Case 6: bicycle vs. car, 74 years, male

Delayed phase: no urinoma
Spleen
Indications of splenic Emergency Embolisation

- Haemodyn. stability $^1,^2$ / instability $^3$
- Detection active bleeding or PSA im MDC in:
  Sensitivity 100%, specificity 88%$^2,^4$
- Spleen injury grades III-V $^5,^7$

1 Cooney R J Trauma 2005;59:926-932
2 Shanmuganathan K Radiology 2000;217:75-82
3 Hagiwara A Radiology 2005;235:57-64
4 Thompson BE J Trauma 2006;60:1083-1086
5 Haan J J Trauma 2003;55:317-321
6 Rajani RR Surgery 2006;140:6525-632
7 Dent D J Trauma 2004;56:1063-1067
Technique of splenic Emergency Embolisation

**Proximal** embolisation distal of the A. pancreatica dorsalis (multiple spots from different branches)

- Coils
- Amplatzer Vascular Plug

**Advantage**: haemostasis by reduction of the arterial pressure due to preserved collaterales

**Disadvantage**: higher risk of recurrent bleeding
Technique of splenic Emergency Embolisation

**Distal** embolisation (single bleeding / precise localisation):

- Mikrocoils (pushable & deteachable)
- Mikropartikel 300-500μm
- Histoacryl/Lipiodol

**Advantage:** low risk of recurrent bleeding

**Disadvantage:** higher risk for spleen infarct

1 Bessoud B Eur J Radiol 2004;14:1718-1719
Results of splenic Emergency Embolisation

- Technical success 73 - 100% \(^1-^4\)

- Partial splenic infarction
  prox. embolisation: 63% \(^4\)
  dist. embolisation: 100% \(^4\)

- Splenectomy (due to re-bleeding, abscess)
  prox. embolisation: 22% \(^5\)
  dist. embolisation: 33% \(^5\)

1 Haan J J Trauma 2004;56:542-547
3 Cooney R J Trauma 2005;59:926-932
4 Killeen KL JVIR 2001:12:209-214
5 Raikhlin A J Can Chir 2008;51:464-472
Results of splenic Emergency Embolisation

- Multi-center study: 140 pat.
- Preservation of the spleen: 87%
- Grade IV + V splenic injury: spleen preservation in >80%
- No signif. differences between prox. & dist. embolisation
- Complications: re-bleeding in 11%
  spleen abscess in 4%

Haan J J Trauma 2004;56:542-547
Milzembolisation
Liver
Technique of Liver Emergency Embolisation

- Coelico- & mesentzericography (4F Cobrakatheter C2 / 4F Sidewinder 1)
- Obligatory superselective angiography of the common liver artery, than semental or subsegmental
- Search for the „Bloody trias“
- Embolic materials: Coils, Histoacryl, (particles – biodegradable?)
Results of Liver Emergency Embolisation

• Technical success rate 85-100% 1-4
• Re-bleeding ➔ laparotomy /re-intervention 10% 1
• Angiographical- / or Embolization associated complications are rare (ischemia induced choleystitis)2

1 Monnie V CVIR 2008;31:875-882
2 Mohr A J Trauma 2003;55:1077-1082
3 Wahl WL J Trauma 2002;52:1097-1101
4 Asensio JA J Trauma 2003;54:647-653
Case 8: bicycle vs. tram, 77 years, female
Case 8: bicycle vs. tram, 77 years, female

- Embolisation: glue/lipiodol-mixture (1:4) (2 x 0.1 ml)
51/612 patients (8%) with grade III-V
• Technical success: 100 (18/18) with grade III
• Technical success: 84% (11/13) with grade IV
• 1 pat. grade V immed. laparotomy after TAE
• Negative predictive factors: grade IV & V, transfusion volume > 2000 ml/h

The Efficacy and Limitations of Transarterial Embolization for Severe Hepatic Injury
Akiyoshi Hagiwara, MD, Atsuo Murata, MD, Taketo Matsuda, MD, Hiroharu Matsuda, MD, and Shuji Shimazaki, MD

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