Pelvic trauma
Anatomical considerations
(What the radiologist needs to know!)

Imaging

NORDTER
Trauma radiology course 2012
Helsinki, Finland
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Overview

• Bones and ligaments
• Fracture classification
• Pelvic arteries
• Pelvic CT
  – How to detect hemorrhage?
  – Arterial versus venous bleeding

• Sacrum, coccyx, three innominate bones: ilium, ischium and pubis
Injury mechanisms

- Anterior-posterior compression:
  - Force applied to the pubis or the posterior pelvis.
    - Iliac external rotation
    - Symphyseal separation
    - Sacroiliacal dislocation
• Lateral compression
  – Lateral blow to the pelvis
  ➔ Iliac internal rotation
  ➔ Anterior overriding of the fragment
  ➔ Posterior impacted fragments

• Vertical shear
  – After vertical axial fall
  – Superior, usually asymmetric displacement of involved hemi-pelvis
  – Anterior and posterior ligament disruption

Tile /AO classification

• Type A:
  – Stable
  – Isolated wing fx
  – Scarococcyx fx
  – Avulsion fx
  – Minimal anterior disruption
Type B (partial stable)

Disruption or fracture of the symphysis, associated with unilateral or bilateral anterior sacroiliac joint rupture

Subtypes of type B fractures

- B1: Unilateral open book
- B2: Lateral compression
- B3: Bilateral rotational injuries

Type C

- Unstable with complete disruption of the posterior arch caused by vertical shearing forces
- C1: Unilateral
- C2: Bilateral (one side partially stable)
- C3: Bilateral unstable
But: No one is perfect, don’t become desperate!

Accuracy of pelvic plain film: Their 2005, Eur Rad

- Low sensitivity for fractures, 55%, esp. in the posterior ring.
- Significant discrepancies between plain film and MDCT for Tile classification, 31% for A, B, C and 86% for subtype classification.
- In 40% MDCT unstable fractures were classified as stable on plain film.
Basic anatomy of pelvic branches of the internal iliac artery

- Three main branches:
  - Sup. gluteal a. (post.)
  - Internal pudenda a. (ant.)
  - Inf. gluteal a. (ant.)

- Other arteries

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A Statistical Study of the Branching of the Human Internal Iliac Artery

645 pelvic halves of Japanese cadavers. Simplified the Adachi classification for medical purpose.

<table>
<thead>
<tr>
<th>Group</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>80%</td>
</tr>
<tr>
<td>B</td>
<td>15%</td>
</tr>
<tr>
<td>C</td>
<td>5%</td>
</tr>
<tr>
<td>D</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>

Branching patterns of the male internal iliac artery: Imaging findings

- Using angio MR, angio CT and digital angiography
- 42 pelvic halves in 21 male patients
- Compared findings to the Yamari classification
<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>Group D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autopsy, Yamari 1998 (n=645)</td>
<td>80%</td>
<td>15%</td>
<td>5%</td>
</tr>
<tr>
<td>Imaging, Bilhim 2010 (n=42)</td>
<td>62%</td>
<td>31%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Other interesting findings

- Difficult to differ between inferior gluteal a. and internal pudenda a. in group A (common trunc)
- Various origin of the obturator artery from the anterior trunc (50%), the posterior trunc, the internal pudendal artery, the inferior gluteal art. and superior gluteal artery in 11% each.
- The obturator artery had its origin from the inferior epigastric artery in 33%.
• Three main branches:
  – Sup. gluteal a. (post.)
  – Internal pudenda a. (ant.)
  – Inf. gluteal a. (ant.)

• Other arteries
  – Lateral sacral artery (post.)
  – Ileolumbar art. (post.)
  – Obturator art. (ant.)
  – Main truncus of IIA (post.)

Which arteries are injured

<table>
<thead>
<tr>
<th>Artery</th>
<th>Segment</th>
<th>Fracture site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sup. Gluteal art.</td>
<td>Post.</td>
<td>Greater sciatic foramen, ischial spine or tuberosity, Piriformis fascia.</td>
</tr>
<tr>
<td>Lateral sacral art.</td>
<td>Post.</td>
<td>Sacral foramina or posterior trans-sacral fracture</td>
</tr>
<tr>
<td>Ileolumbar art.</td>
<td>Post.</td>
<td>Posterior fracture involving ilium or anterior SIJs</td>
</tr>
<tr>
<td>Obturator art.</td>
<td>Ant.</td>
<td>Superior obturator foramen, superior pubic ramus, pubic acetabulum</td>
</tr>
<tr>
<td>Internal pudenda art.</td>
<td>Ant.</td>
<td>AP compression fracture involving lesser sciatic foramen, inferior pubic ramus</td>
</tr>
</tbody>
</table>

Dormagen, Acta Radiol 2010
MDCT in pelvic trauma
Basic principles

- Technique
- Findings
  - Hemorrhage
  - Ongoing bleeding
  - Arterial vs venous bleeding?
  - Other vessel injuries

How we do it in Oslo
Standard whole body CT with 3-phasic contrast injection
Shortly after non-contrast imaging of the brain, face and cervical spine inject 20 ml i.v. contrast
Then:

Technical parameter with a 64 slice CT and 3 phasic contrast injection
- Rotation speed 0.74 sec/rotation
- Pitch: 0.515-0.8-1.1 (depending on the body habitus)
- Scan time (thorax-greater trochanter): ca. 55-60 sec
Patients with higher risk of pelvic bleeding:
- Positive FAST
- Pelvic fracture with dislocation
- Hemodynamically minimally unstable
- High-energy MOI with clinically or radiographically suspected aortic injury

Arterial scanning first, followed by portovenous scanning

Vascular imaging findings
- **Arterial active bleeding**
  - Occlusion
  - Venous bleeding
  - PSA
  - Stenosis/Spasm

Arterial extravasation
- Small foci of high attenuation
- Enlarging in portovenous phase
- Irregular margins
Occlusion

• Typically after intima disruption with subsequent thrombosis
• Less frequently embolus or spasm
• Abrupt interruption in the flow
• Important: Even with no extravasation on CT, significant hemorrhage can develop

Venous bleeding

• Extravascular hyperattenuation not seen on arterial phase
• No corresponding abnormalities on arterial phase
• → Most probably venous origin
A Hematoma on precontrast imaging
B No arterial extravasation or abnormality on arterial phase
C Contrast extravasation on portovenous phase

Other features

• PSA
  – Secondary to disruption of inner layers or entire vessel wall
  – Blood is contained by adventitia or surrounding soft tissue
  – Roundish high attenuating area with same attenuation as adjacent arteries
Other features

- Stenosis /Spasm
  - Irregular narrowing of the arterial lumen
  - Difficult to differ from focal spasm
  - Other differential diagnosis:
    - Intramural hematoma
    - Partial thrombosis
• Diffuse narrowing of the left external iliac artery.
• Uyeda Emer Radiol, 2010

Conclusions

• Try to differ on plain film and CT between stable, partial stable and completely (vertically) unstable
• Three main branches to identify on angio
  – Injuries of vessels close to bony structures
  – Corona mortis
• CT angio only in subgroup of patients
• Differ between arterial and venous bleeding