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

NORDTER
Trauma radiology course 2012
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## Overview

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

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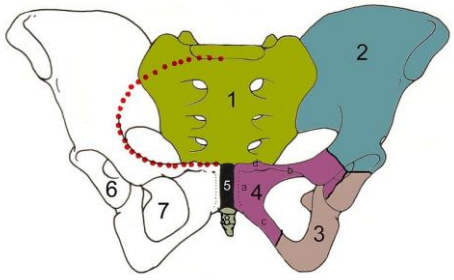


- Sacrum, coccyx, three innominate bones: Ilium, ischium and pubis

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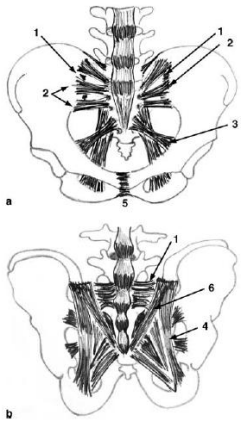
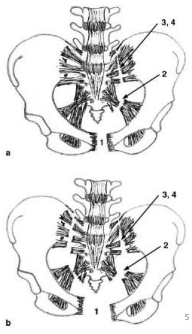



Theumann, 2002

## Injury mechanisms

- Anterior-posterior compression:
  - Force applied to the pubis or the posterior pelvis.
    - →Iliac external rotation
    - →Symphyseal separation
    - →Sacroiliacal dislocation

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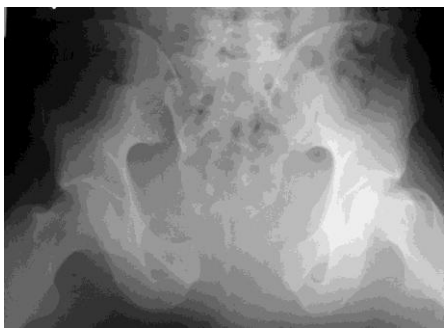

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- Lateral compression
  - Lateral blow to the pelvis
  - →Iliac internal rotation
  - →Anterior overriding of the fragment
  - →Posterior impacted fragments

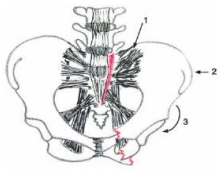


Fig. 3 Lateral compression. 1 Impacted fractures of the sacrum; 2 horizontal overlapping ring fracture; 3 internal rotation of the left hemi-pelvis

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


Pelvic vertical shear injury

Vertical shear injury with left sacral fracture, rami fractures, and associated left transverse acetabulum fracture.
Courtesy of Jim Fleckl, MD.

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## Tile /AO classification

- Type A:
  - Stable
  - Isolated wing fx
  - scarococcyx fx
  - Avulsion fx
  - Minimal anterior disruption

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Theumann 2002

## Type B (partial stable)

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


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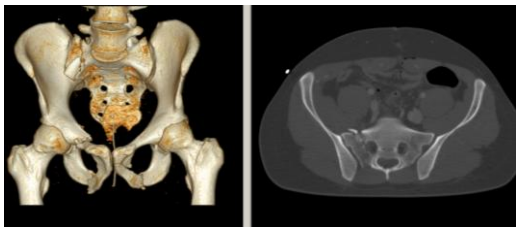
## Subtypes of type B fractures



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## 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


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## But: No one is perfect, don't become desperate!

**Classification of Pelvic Ring Injuries Using the Tile Classification System[a]**

| | n, % | | |
|---|---|---|---|
| Observer | A | B | C |
| 1 | 7 (7.87) | 61 (68.53) | 21 (23.60) |
| 2 | 27 (30.34) | 38 (42.69) | 24 (26.97) |
| 3 | 41 (46.07) | 29 (32.58) | 19 (21.35) |
| 4 | 8 (8.99) | 77 (86.52) | 4 (4.49) |
| 5 | 40 (44.94) | 35 (39.33) | 14 (15.73) |
| Total | 123 (27.64) | 240 (53.93) | 82 (18.43) |

*[a]Interobserver variability kappa value equal to 0.47 (95% CI 0.42, 0.5*

**Intraobserver Agreement Results for Young-Burgess and Tile Classification Systems**

| | Kappa Value (95% CI) | | |
|---|---|---|---|
| Observer | Young-Burgess With Subclasses | Young-Burgess No Subclasses | Tile |
| 1 | 0.64 (0.59, 0.69) | 0.72 (0.66, 0.78) | 0.55 (0.47, 0.63) |
| 2 | 0.52 (0.46, 0.58) | 0.64 (0.57, 0.71) | 0.56 (0.49, 0.63) |
| 3 | 0.60 (0.54, 0.66) | 0.73 (0.67, 0.80) | 0.55 (0.48, 0.62) |
| 4 | 0.60 (0.54, 0.66) | 0.76 (0.69, 0.83) | 0.25 (0.12, 0.38) |
| 5 | 0.69 (0.65, 0.74) | 0.76 (0.70, 0.82) | 0.45 (0.38, 0.52) |
| Mean | 0.61 (0.53, 0.69) | 0.72 (0.66, 0.78) | 0.47 (0.31, 0.64) |

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- Furey, Orthopedics, 2009

## 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.
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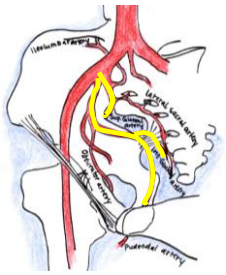
## Basic anatomy of pelvic branches of the internal iliac artery



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

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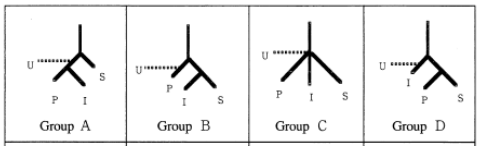
Original Article

Kurume Medical Journal, 45, 333-340, 1998

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

KOH-ICHI YAMAKI, TSUYOSHI SAGA, YOSHIAKI DOI*, KATSUMARO AIDA AND MITSUAKI YOSHIZUKA

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




| Frequency | | | |
|---|---|---|---|
| 80% | 15% | 5% | < 1% |

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Surg Radiol Anat (2011) 33:151–159
DOI 10.1007/s00276-010-0716-3

ANATOMIC BASES OF MEDICAL, RADIOLOGICAL AND SURGICAL TECHNIQU

**Branching patterns of the male internal iliac artery: imaging findings**

Tiago Bilhim · Diogo Casal · Andrea Furtado · Diogo Pais · João Erse Goyri O'Neill · João Martins Pisco

- Using angio MR, angio CT and digital angiography
- 42pelvic halves in 21 male patients
- Compared findings to the Yamari classification

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| | Group A | Group B | Group C | Group D |
|---|---|---|---|---|
| **Autopsy, Yamari 1998 (n=645)** | **80%** | **15%** | **5%** | **< 1%** |
| **Imaging, Bilhim 2010 (n=42)** | **62%** | **31%** | **7%** | **0%** |

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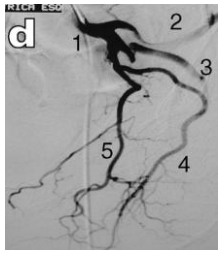
## Other interesting findings

- Difficult to differ between inferior gluteal a. and internal pundenda 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 epigastic artery in 33%.

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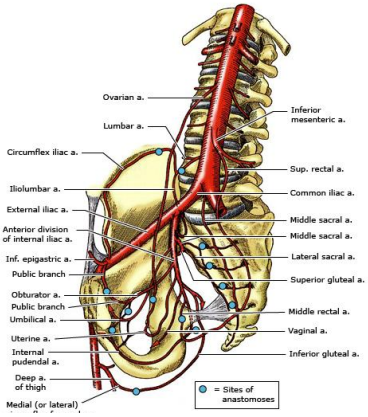


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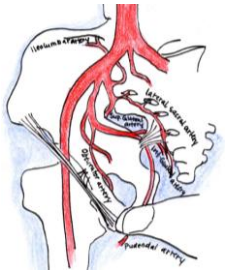

- Three main branches:
  - Sup. gluteal a. (post.)
  - Internal pudenda a. (ant.)
  - Inf. gluteal a. (ant.)
- Other arteries
  - Lateral sacral artery (post.)
  - Ileolumbar art. (post.)
  - Obturator art. (ant.)
  - Main truncus of IIA (post.)

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## Which arteries are injured

| Injured artery | Angiographic findings | | | | |
|---|---|---|---|---|---|
| | Extravasation | Occlusion | Intima tear | Spasm | Sum |
| Main trunk of the internal iliac artery | 1 | 6 | 0 | 0 | 7 |
| Posterior trunk | 1 | 0 | 0 | 0 | 1 |
| Superior gluteal artery | 26 | 7 | 2 | 1 | 36 |
| Iliolumbar artery | 10 | 4 | 2 | 0 | 16 |
| Lateral sacral artery | 8 | 1 | 0 | 1 | 10 |
| Anterior trunk | 3 | 3 | 1 | 0 | 7 |
| Pudendal artery | 22 | 2 | 0 | 0 | 24 |
| Obturator artery | 17 | 3 | 1 | 2 | 23 |
| Umbilical artery | 3 | 1 | 0 | 1 | 5 |
| Inferior gluteal artery | 2 | 0 | 0 | 0 | 2 |
| Inferior rectal artery | 1 | 0 | 0 | 0 | 1 |
| Sum | 92 | 27 | 6 | 5 | 132 |

Dormagen, Acta Radiol 2010

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## Relationship between pelvic arteries and bony structures

| Artery | Segment | Fracture site |
|---|---|---|
| Sup. Gluteal art. | Post. | Greater sciatic foramen, ischial spine or tuberosity. Piriformis fascia. |
| Lateral sacral art. | Post. | Sacral foramina or posterior trans-sacral fracture |
| Ileolumbar art. | Post | Posterior fracture involving ilium or anterior SIJ's |
| Obturator art. | Ant. | Superior obturator foramen, superior pubic ramus, pubic acetabulum |
| Internal pudenda art. | Ant. | AP compression fracture involving lesser sciatic foramen, inferior pubic ramus |

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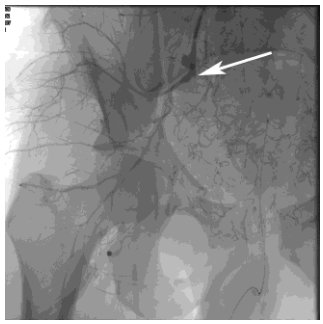

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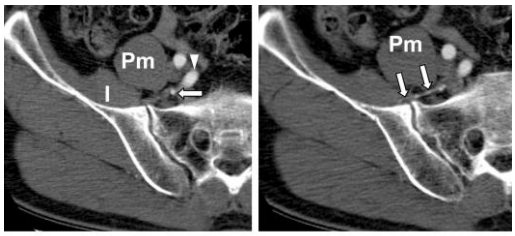


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Woong,
Radiographics 2004

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## MDCT in pelvic trauma
## Basic principles

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

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## 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 <u>20 ml i.v. contrast</u>

Then:


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## 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

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## 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

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## Vascular imaging findings

- **Arterial active bleeding**
- Occlusion
- Venous bleeding
- PSA
- Stenosis/Spasm

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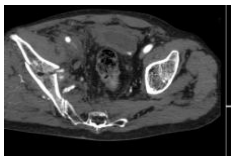
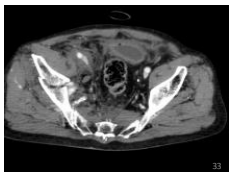
## Arterial extravasation

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





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## 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

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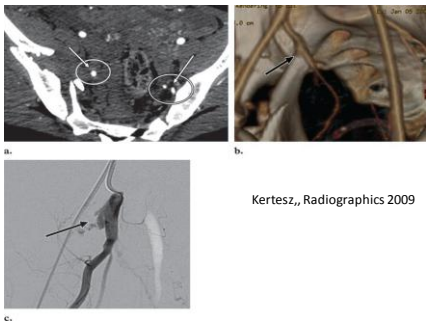

Kertesz,, Radiographics 2009

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## Venous bleeding

- Extravascular hyperattenuation not seen on arterial phase
- No corresponding abnormalities on arterial phase
- → Most probably venous origin

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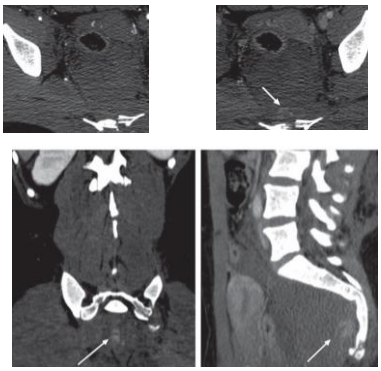
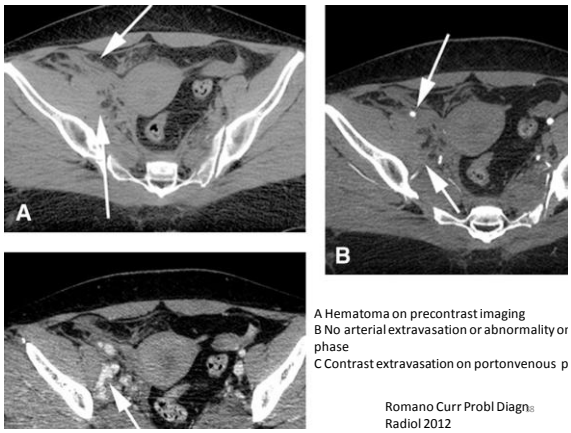


Kertesz, Radiographics 2009






A Hematoma on precontrast imaging
B No arterial extravasation or abnormality or phase
C Contrast extravasation on portonvenous p

Romano Curr Probl Diagn Radiol 2012



## Other features

- PSA
  - Secondary to disrupture 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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## Other features

- Stenosis /Spasm
  - Irregular narrowing of the arterial lumen
  - Difficult to differ from focal spasm
  - Other differential diagnosis:
    - Intramural hematoma
    - Partial thrombosis

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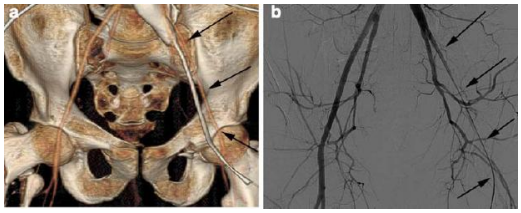


- Diffuse narrowing of the left external iliac artery.
- Uyeda Emer Radiol, 2010

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## 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

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