

1500-1520

Evaluating soft tissues in Pelvic Trauma

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TRAUMA RADIOLOGY

12TH NORDIC COURSE

**JUNE 10TH – 13TH, 2024
STOCKHOLM, SWEDEN**

All patients anonymised and pseudoanonymised
Thank you to Mr Angus Lewis, Dr Erika Kashef, Mr Chris Jordan, Mr Mark Chamberlain, Dr Marcela de la Hoz Polo

Nordter, Stockholm, SE, June 2024

Disclosures



1.GC Global Healthcare/RANZCR:

Speaker sponsorship for RANZCR Brisbane 2023

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2.Everlight Radiology: honorarium (2023) donated to Crisis Rescue Foundation and Meningitis Now

Learning Objectives

- Develop a checklist for soft tissue injuries in pelvic trauma
- Be able to alert the trauma team to critical findings
- Understand how radiological findings can predict increased risk of morbidity and mortality



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Background – Pelvic Fractures in Major Trauma

- High Morbidity
- High Mortality
 - Improving
- Instability



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Checklist

1. Binder
2. Bleeding
 - Haematoma volume
 - Active bleeding
3. Anterior abdominal wall
4. Bladder and urethra
5. Perineum (vagina)
6. Anorectum
7. Nerves (lumbosacral plexus, sciatic nerve, obturator nerve)
8. External muscles and soft tissues



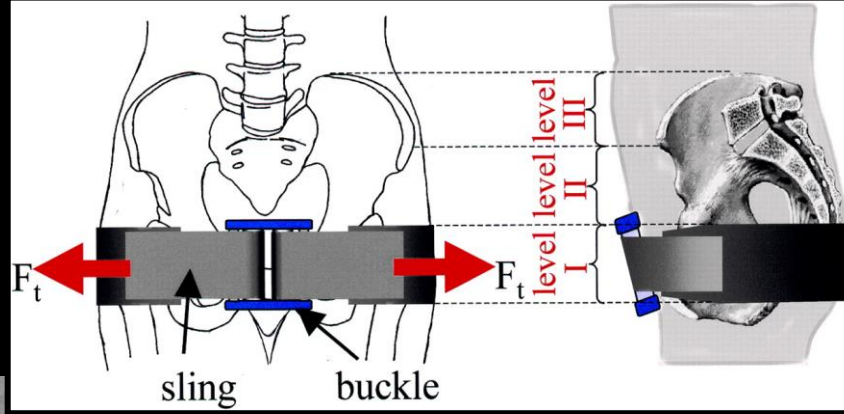
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Checklist

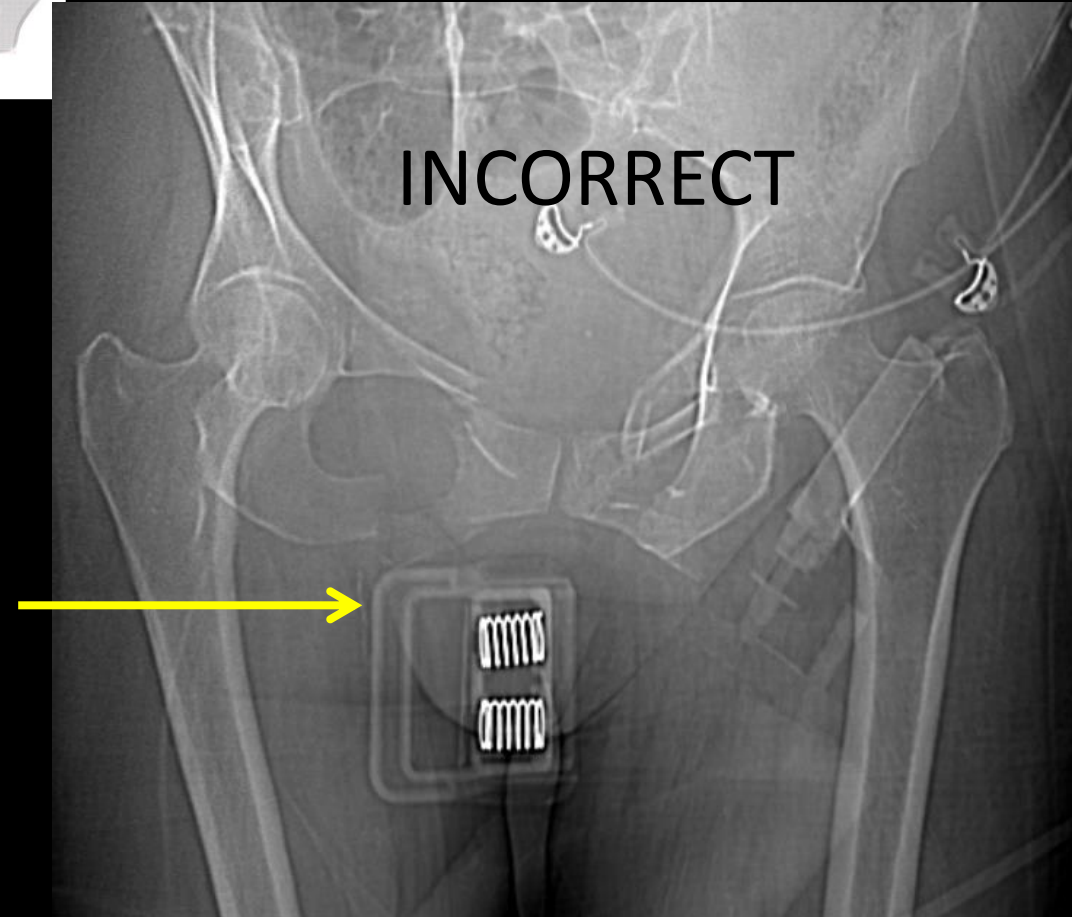
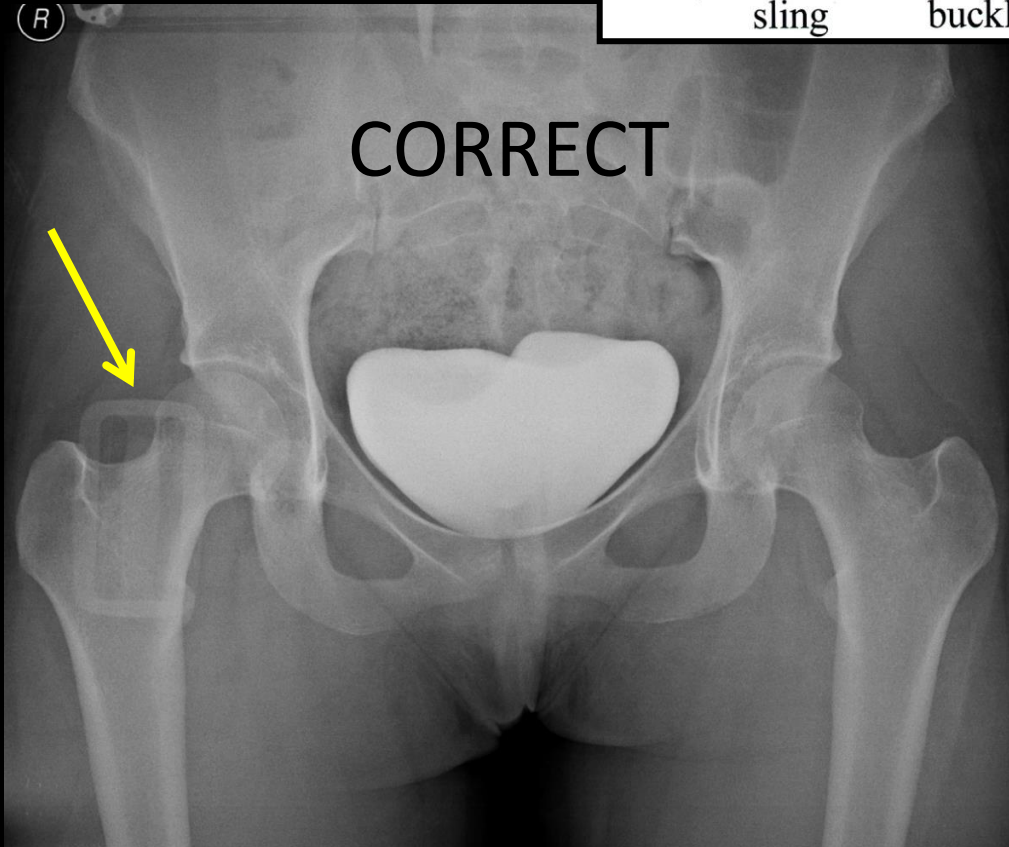
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Pelvic Binder – at the level of the greater trochanters

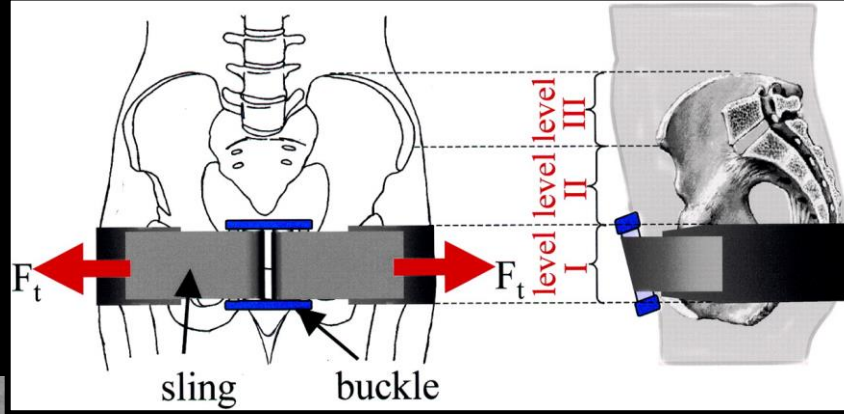


CASE 1

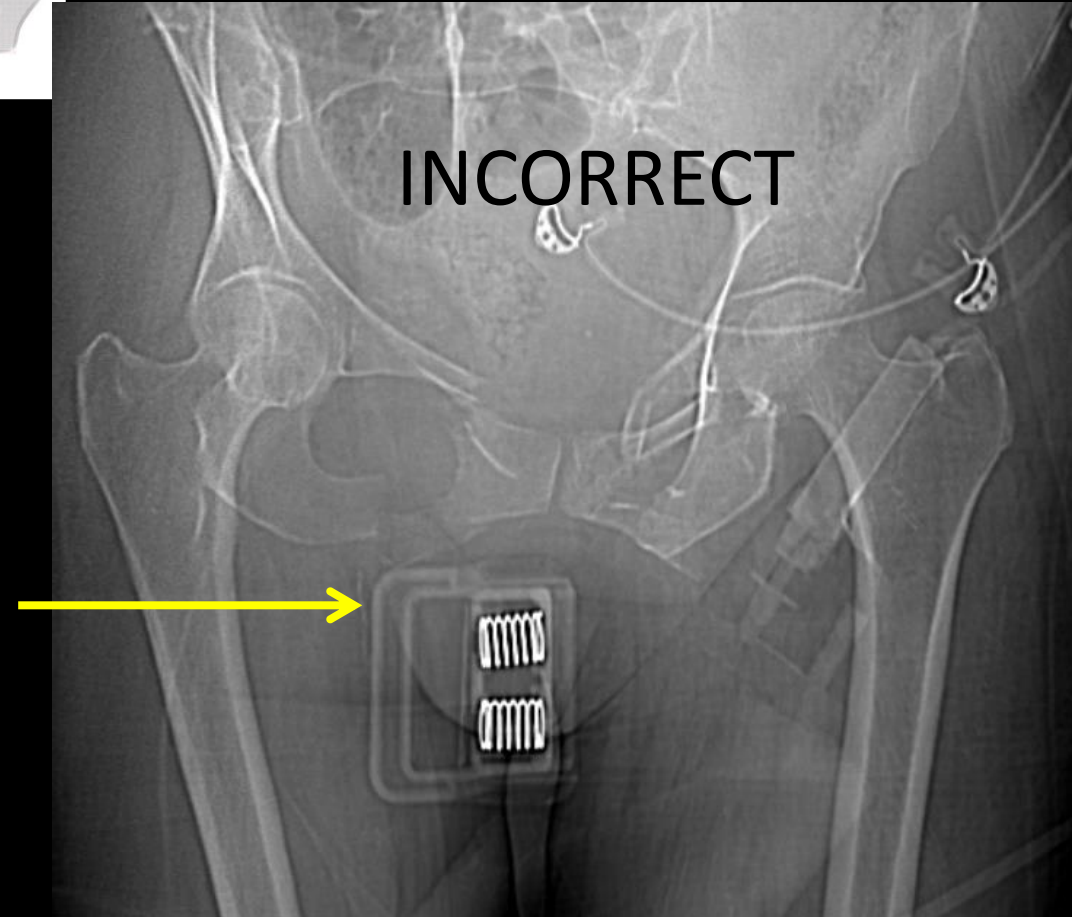
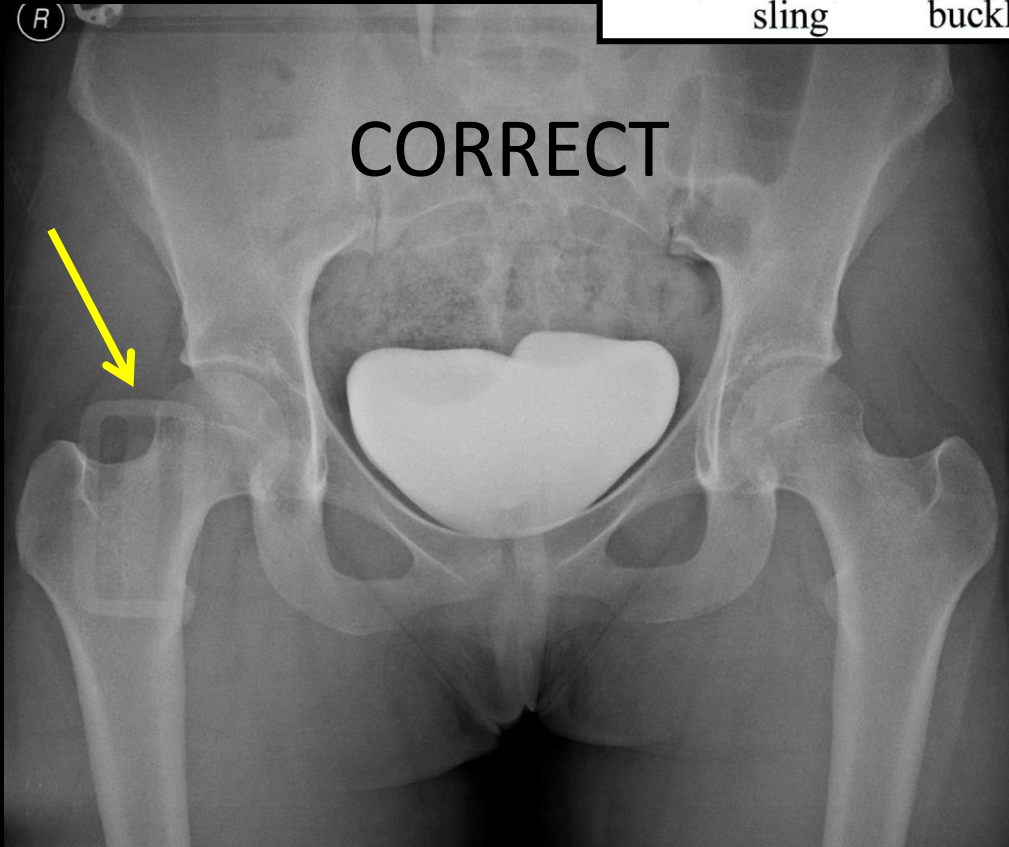


Thanks to Dr Marcela de la Hoz Polo

Pelvic Binder – at the level of the greater trochanters



CASE 1

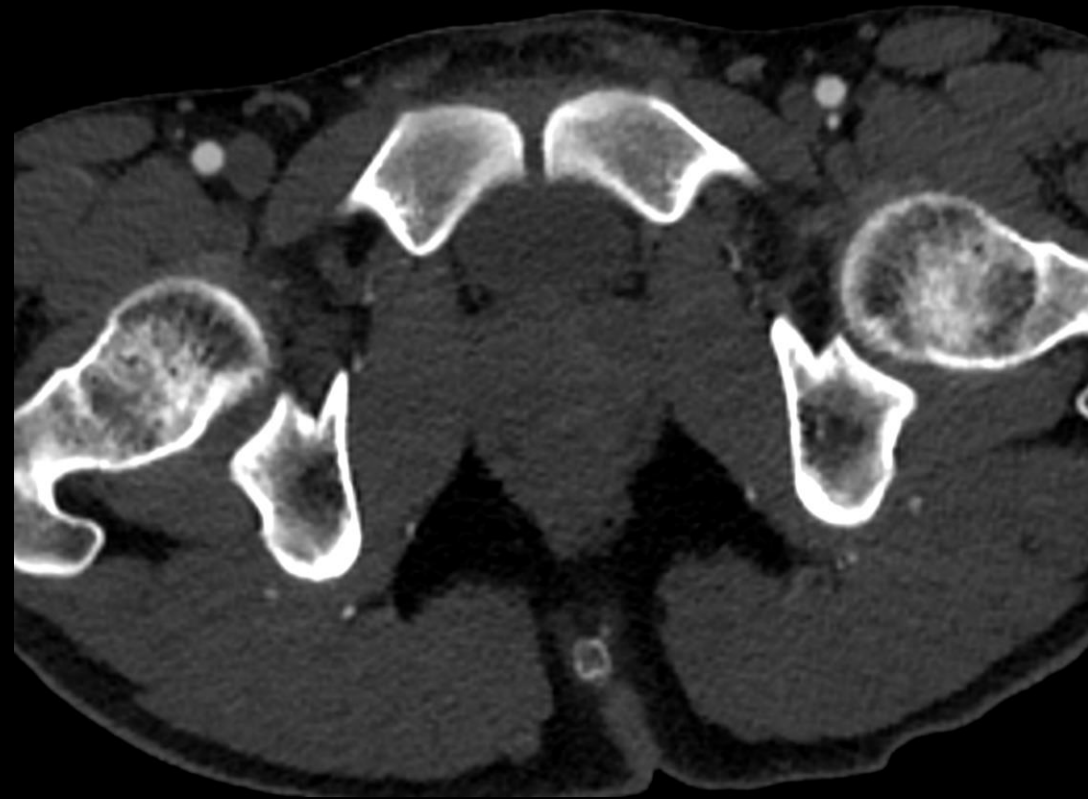


Thanks to Dr Marcela de la Hoz Polo

Blunt trauma

BINDER IN SITU

CASE 1



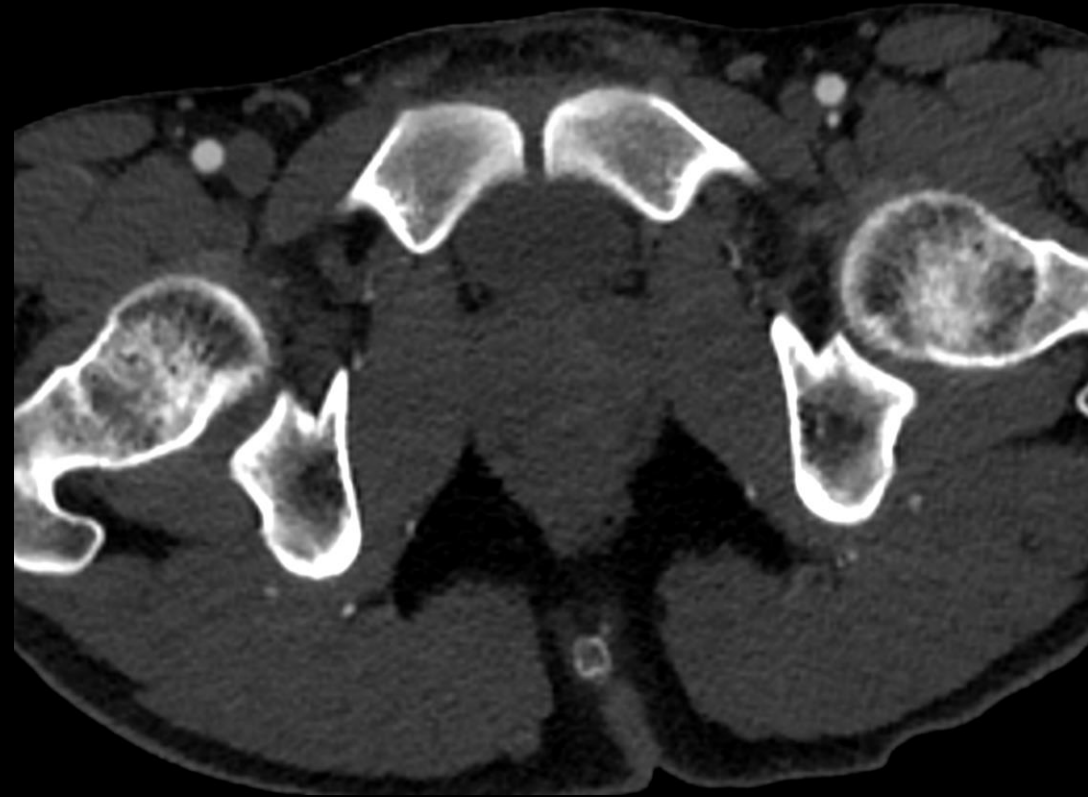
Report: Binder in Situ. Pubic Symphysis aligned

Blunt trauma

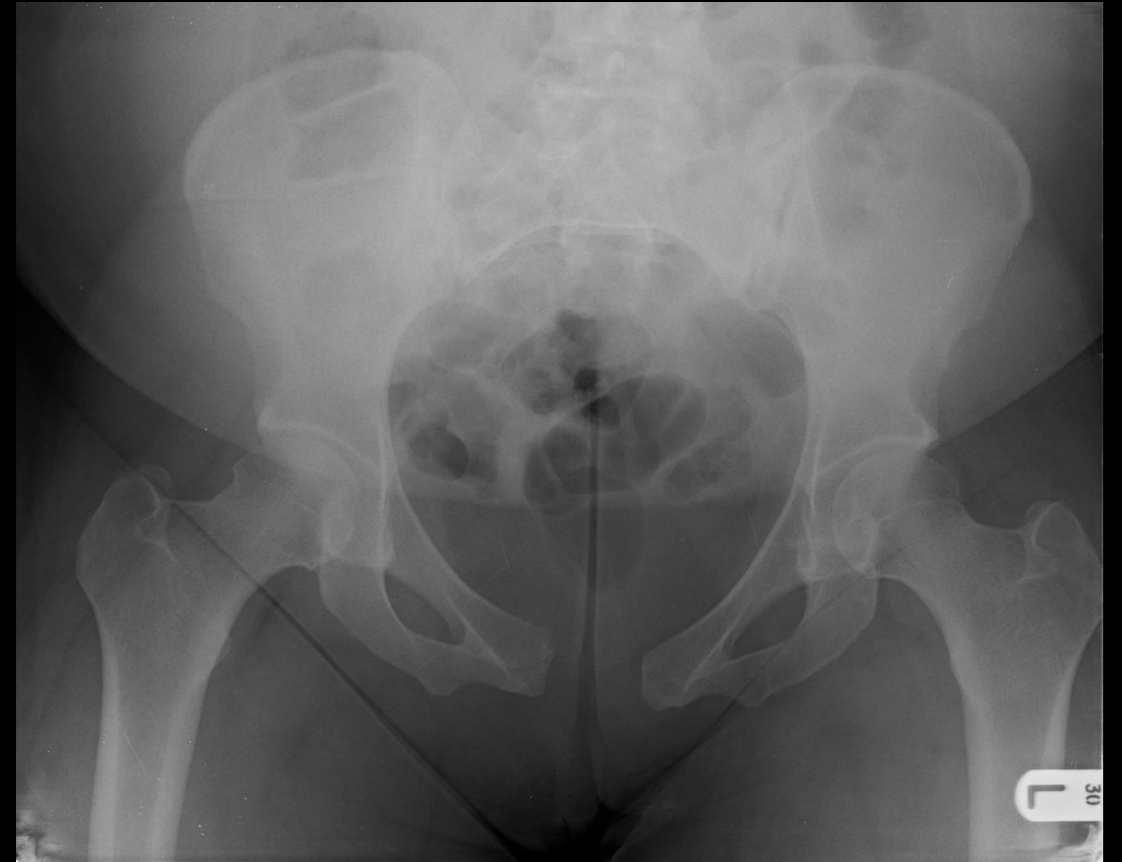
BINDER IN SITU

BINDER TAKEN OFF

CASE 1



Report: Binder in Situ. Pubic Symphysis aligned



Pubic Symphysis Diastasis

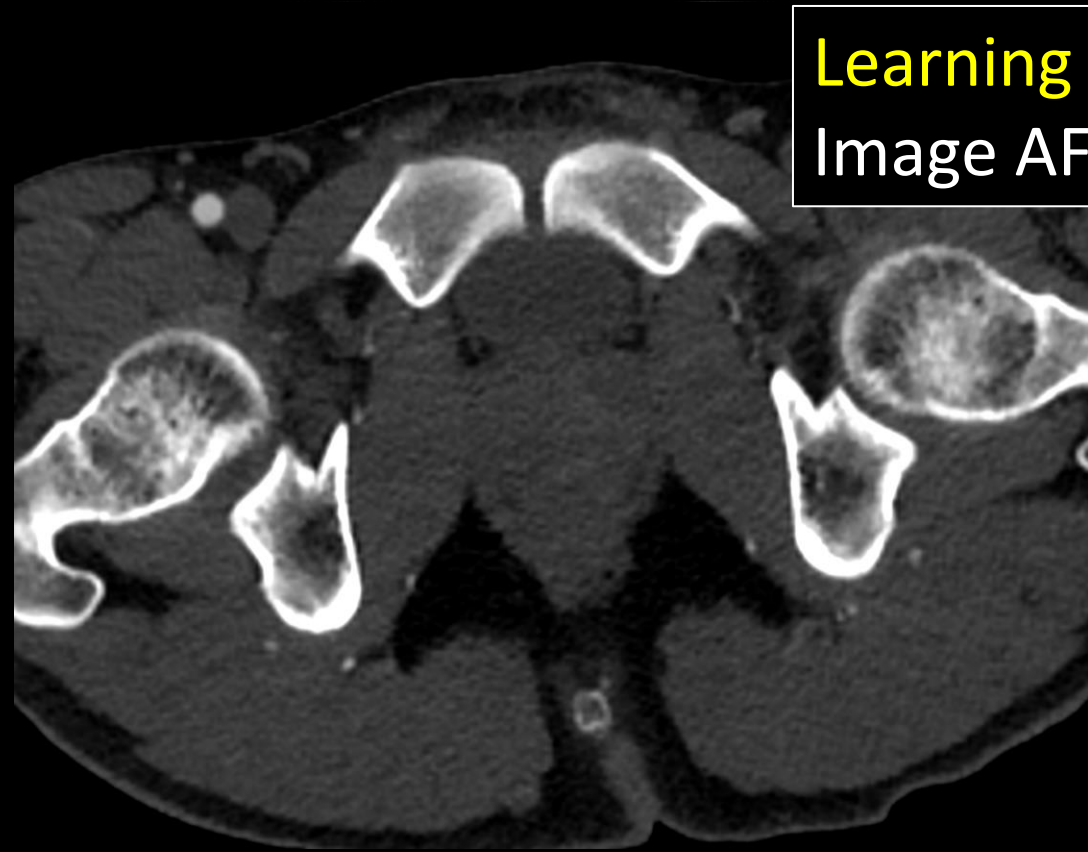
Blunt trauma

BINDER IN SITU

BINDER TAKEN OFF

CASE 1

Learning Points: Always mention if binder in situ
Image AFTER binder removed to confirm pelvic stability



Report: Binder in Situ. Pubic Symphysis aligned



Pubic Symphysis Diastasis

Checklist

1. Binder
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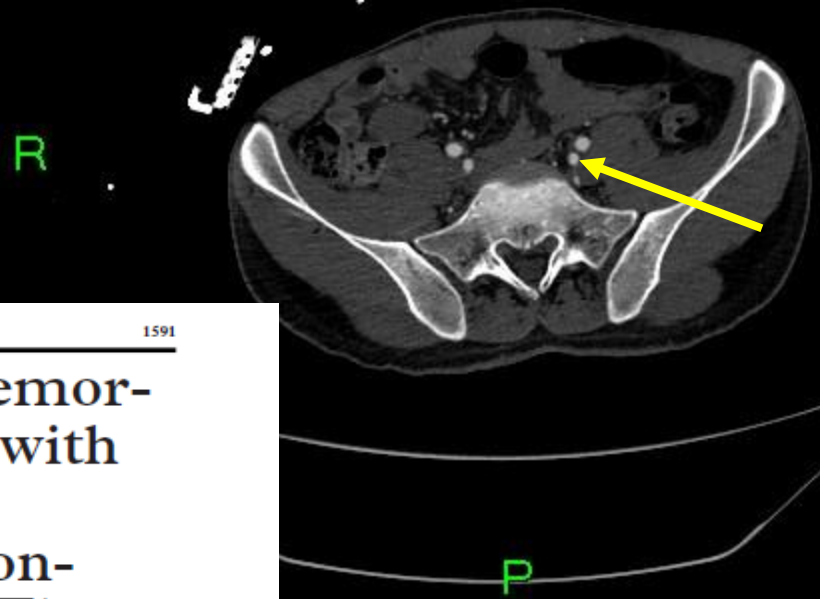
Learning Point

- Even without active bleeding or large visible haematoma, fractures cause large volume blood loss (>1.5litres)
- Bleeding sources:
 - Artery (interventional radiology, surgical packing)
 - Venous plexus (more common)
 - Bones
- Unstable fracture ↑↑ risk of bleeding

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NORMAL ANATOMY



Internal iliac artery

EDUCATION EXHIBIT 1591

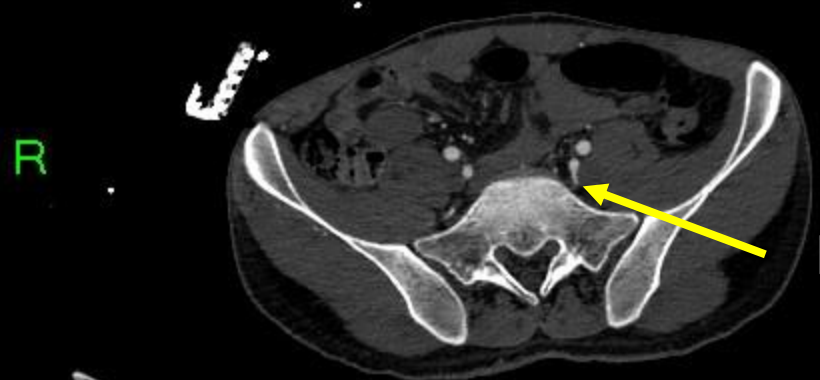
Radio Graphics

Pelvic Arterial Hemorrhage in Patients with Pelvic Fractures: Detection with Contrast-enhanced CT¹

Woong Yoon, MD • Jae Kyu Kim, MD • Yong Yeon Jeong, MD • Jeong Jin Seo, MD • Jin Gyoon Park, MD • Heoung Keun Kang, MD

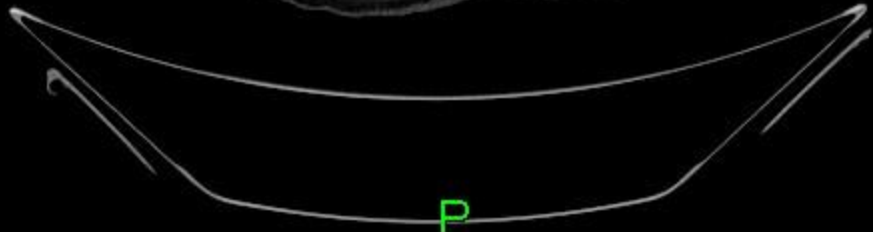
ONLINE-ONLY CME

See www.rsna.org

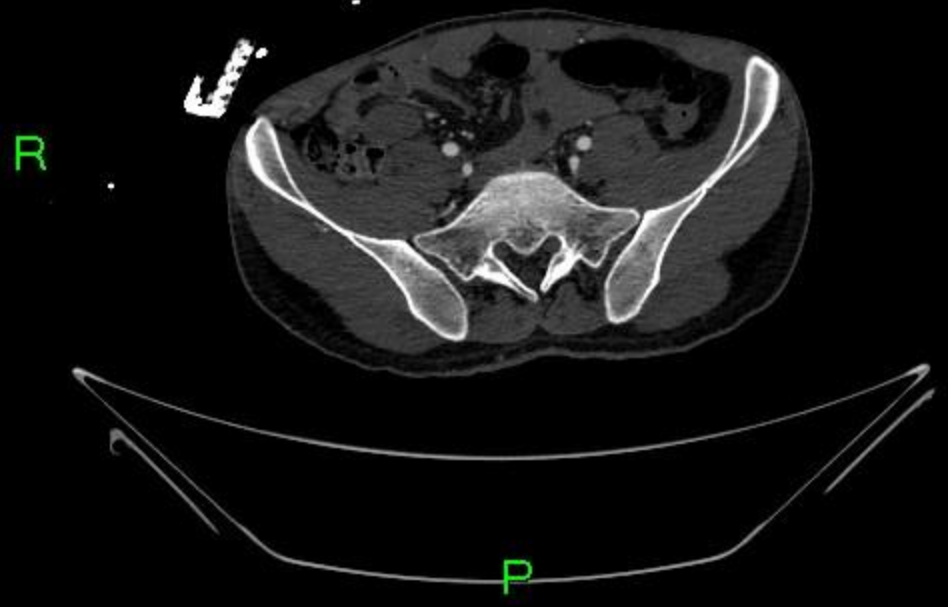


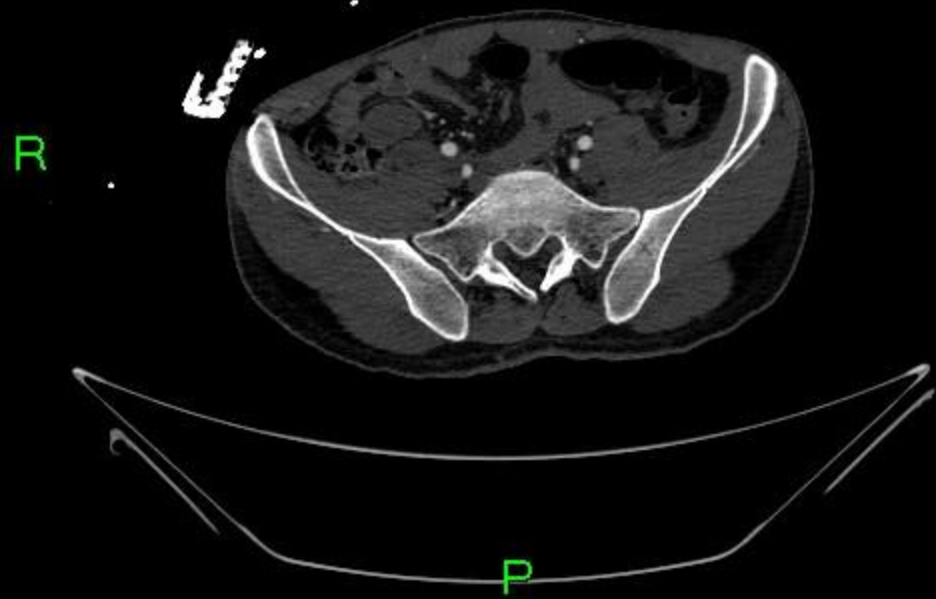
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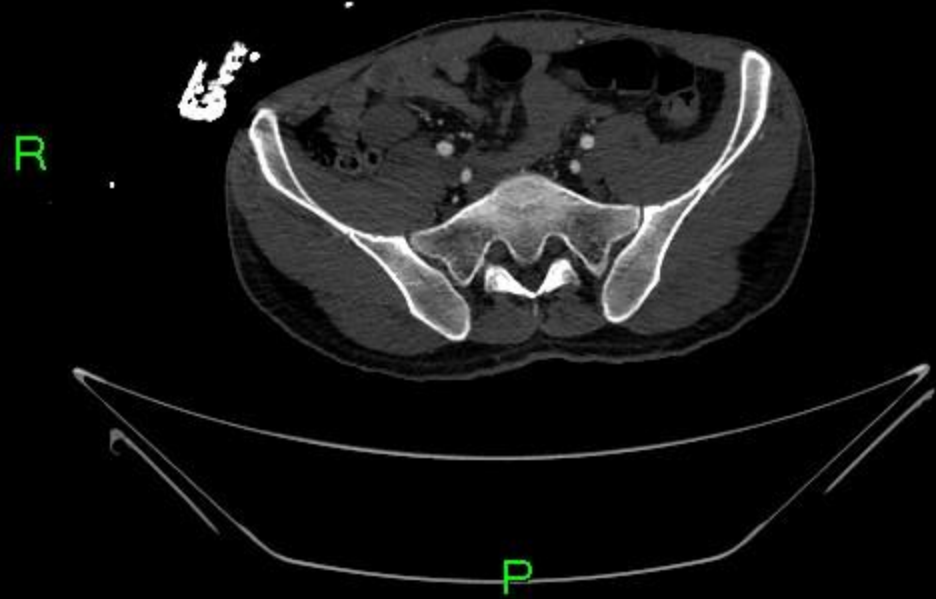
Lateral sacral artery



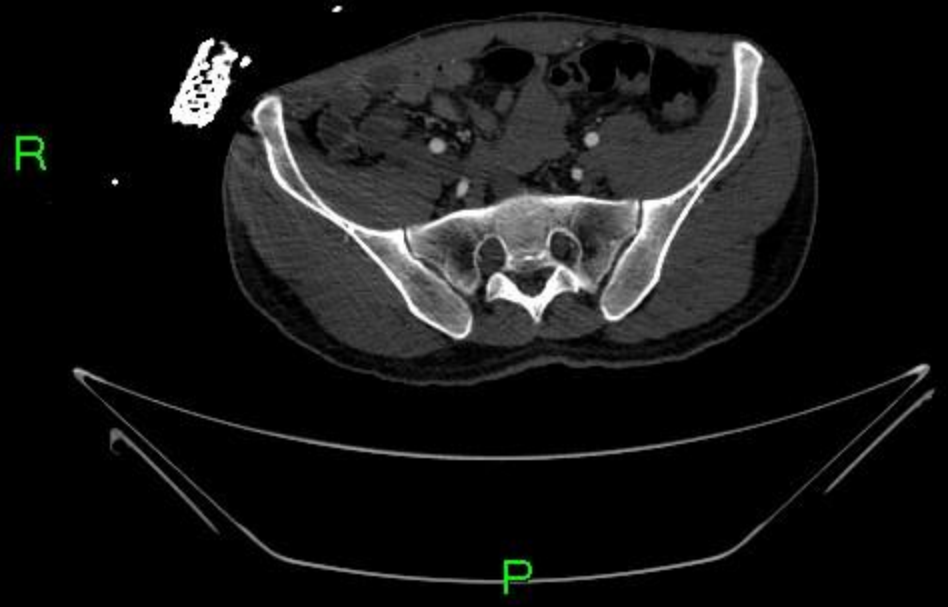
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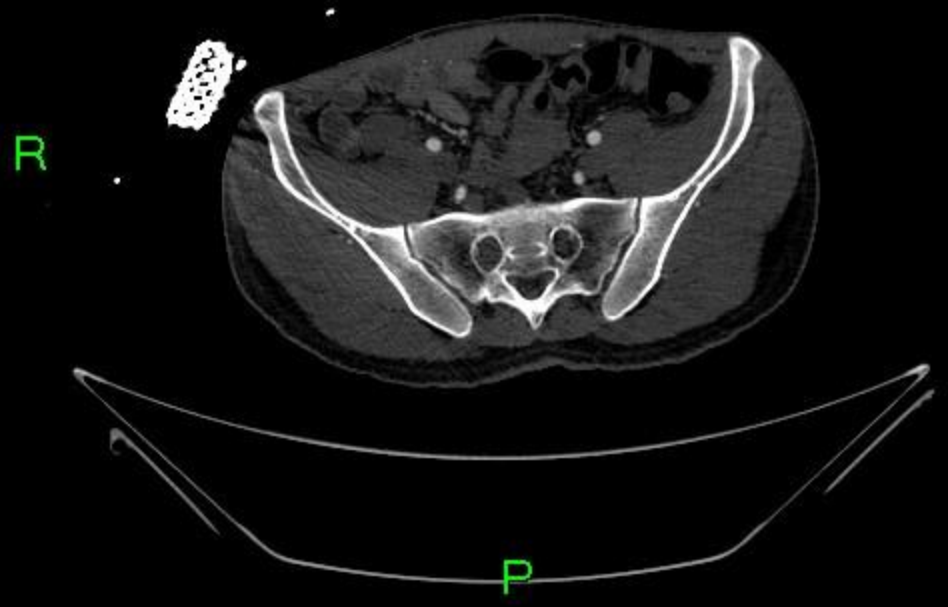


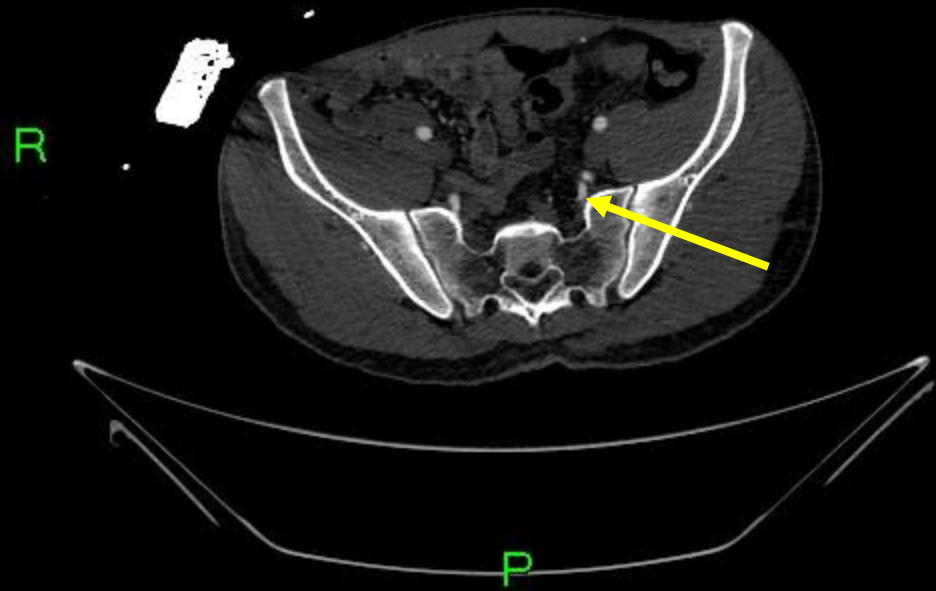




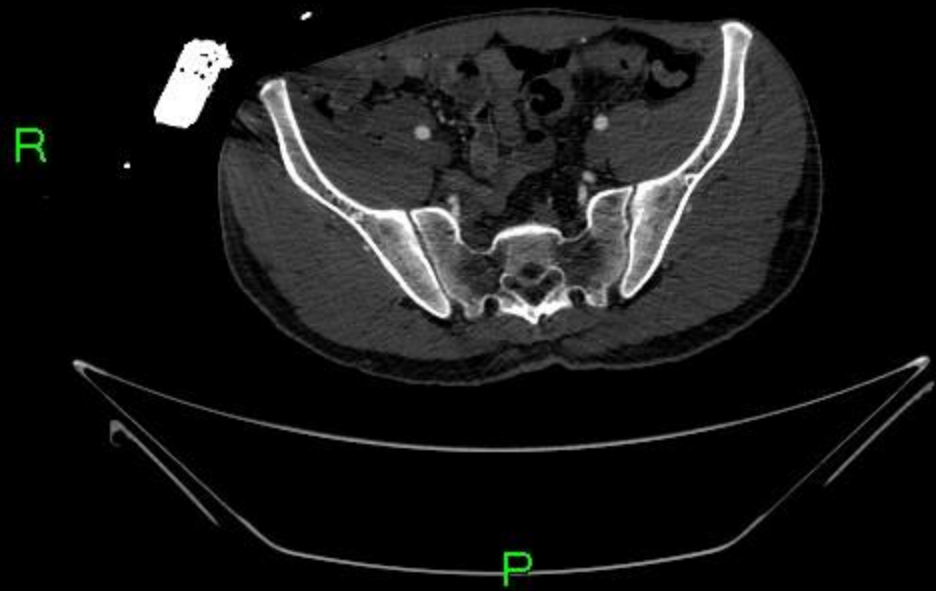


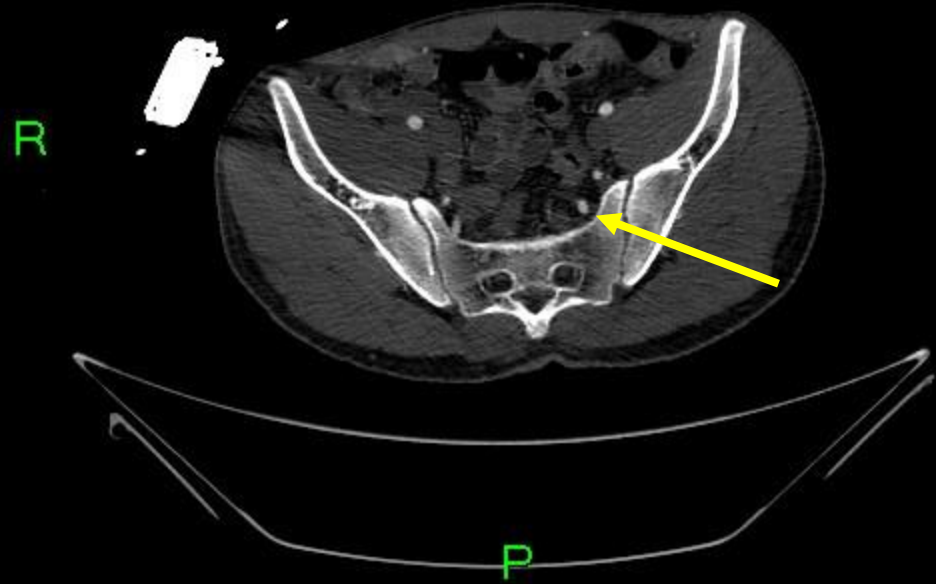




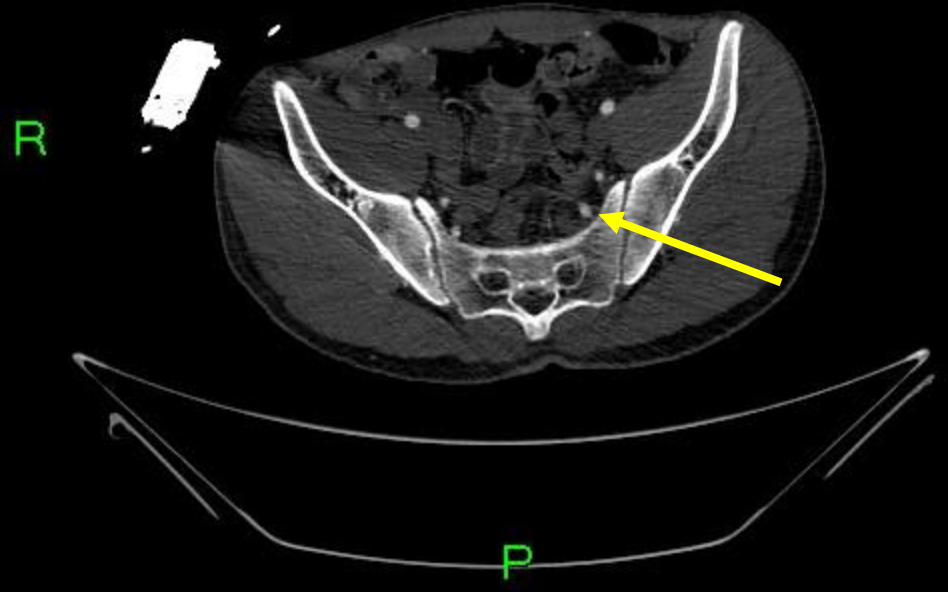


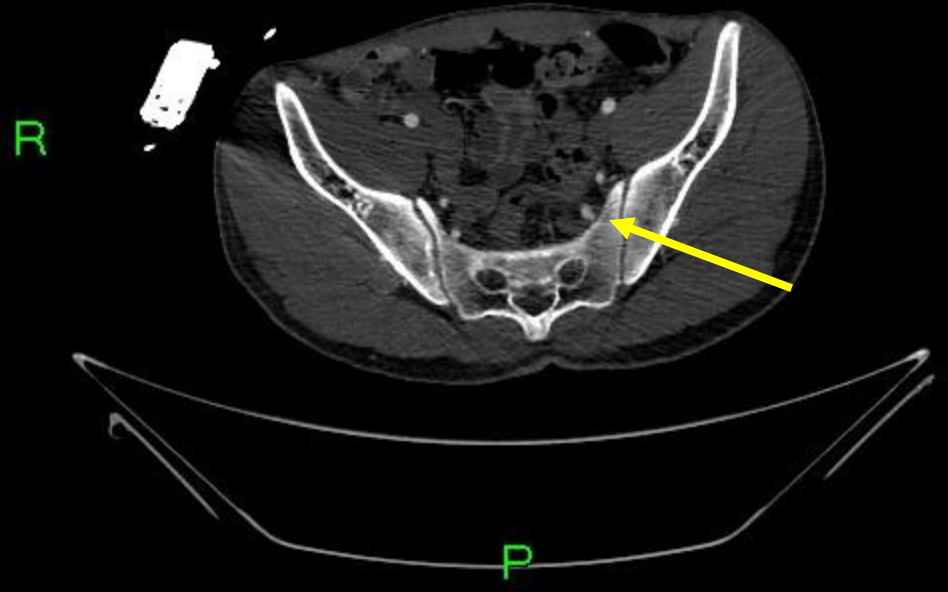
Superior gluteal artery

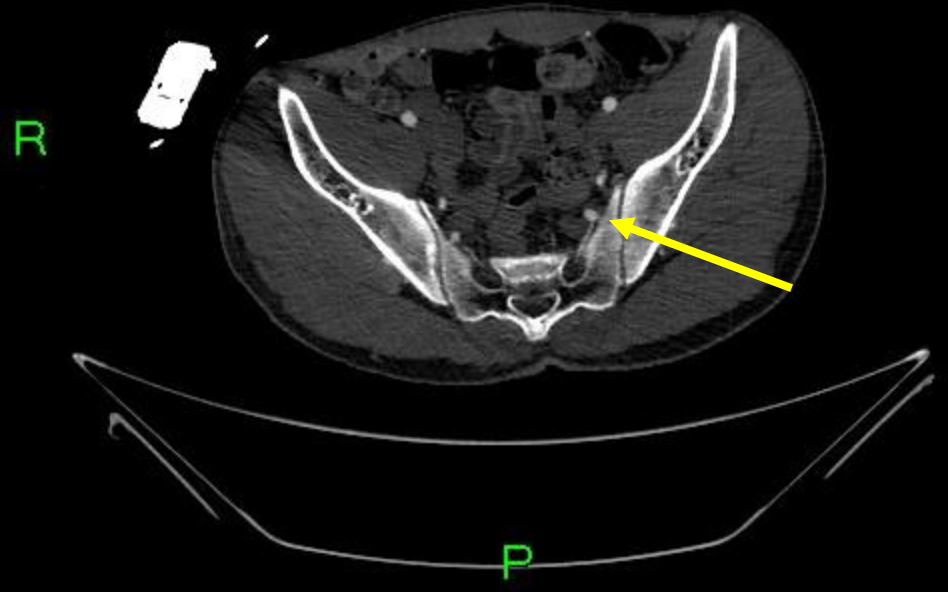


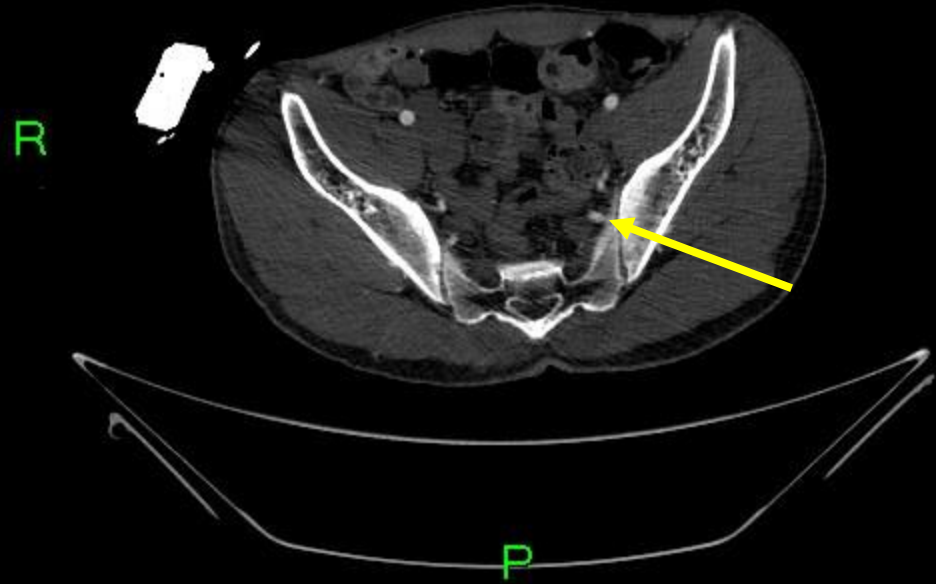


Superior gluteal artery

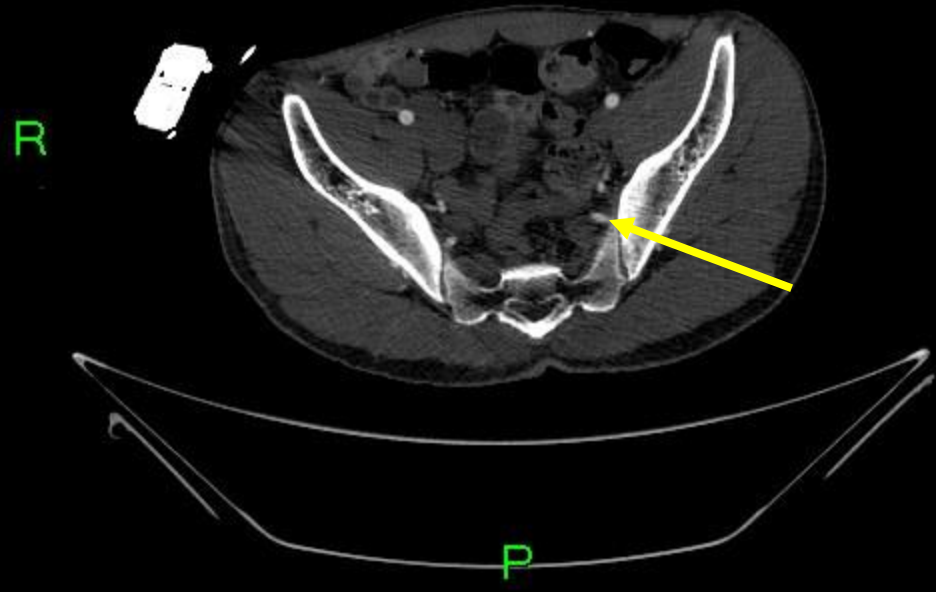


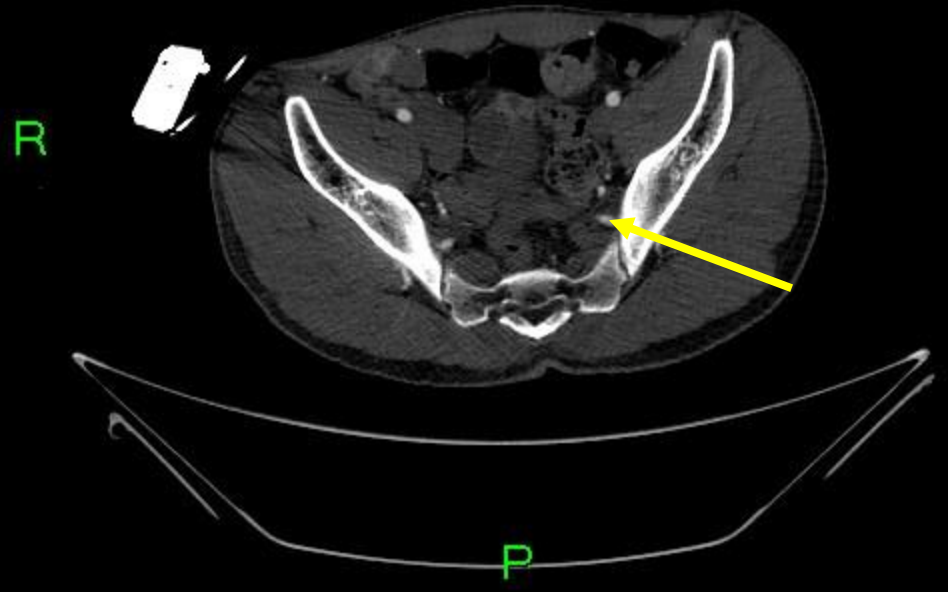


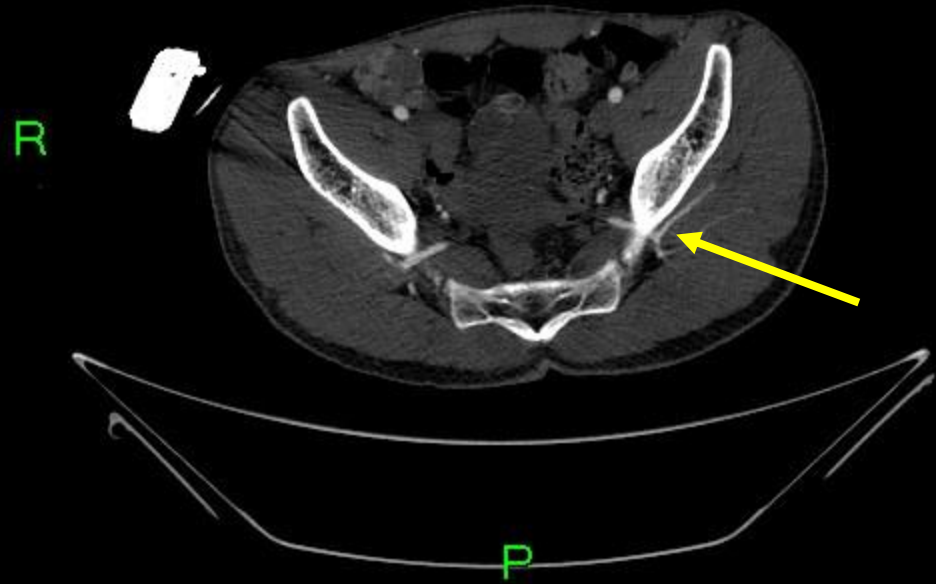




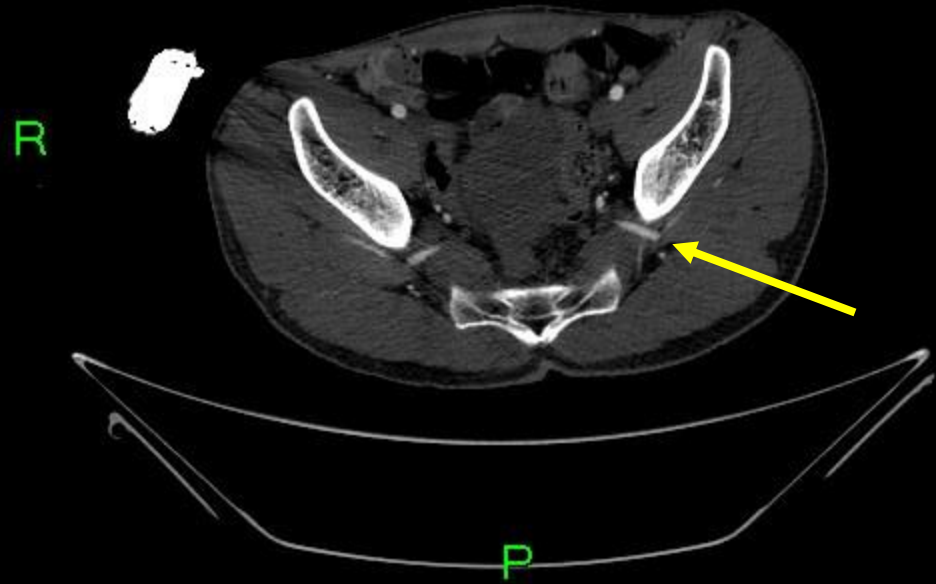
Superior gluteal artery



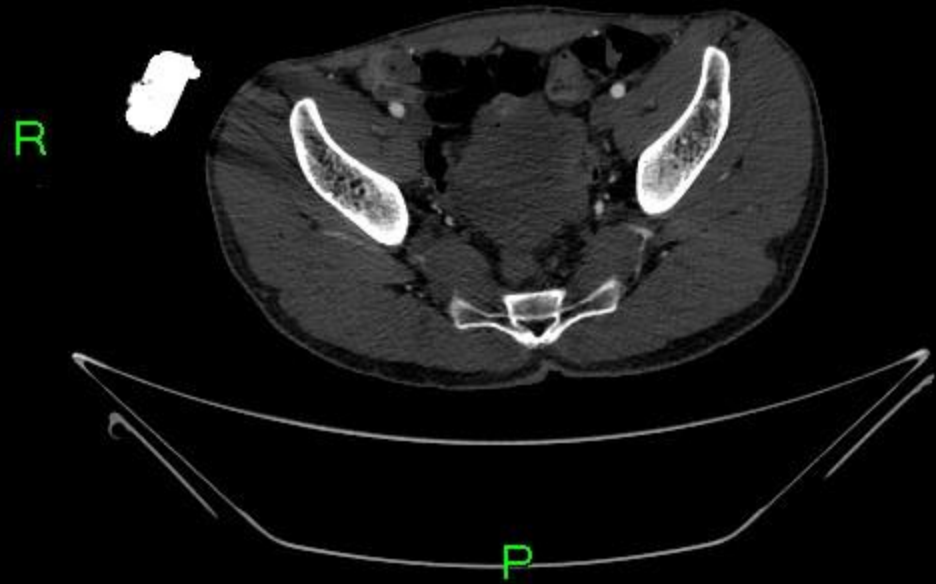


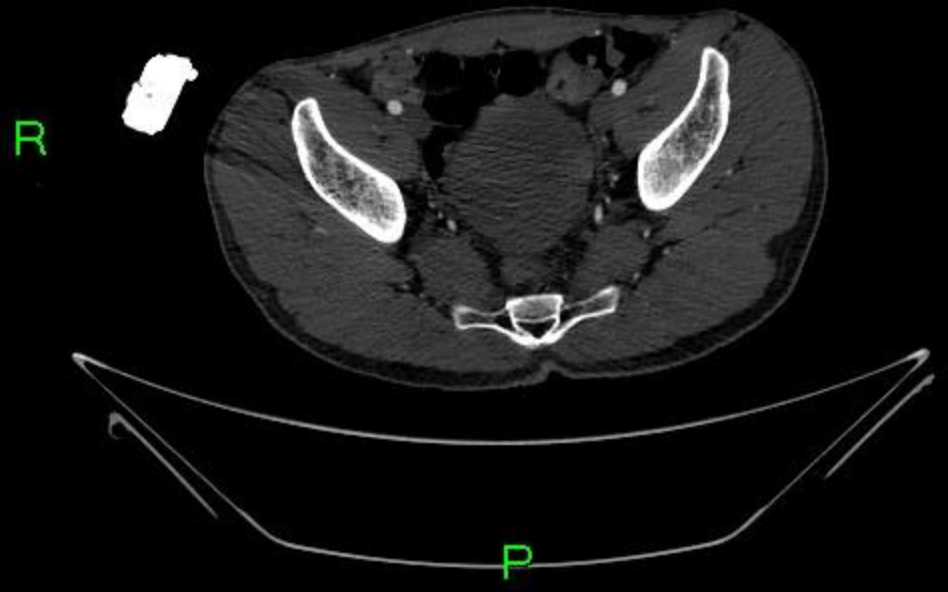


Superior gluteal artery

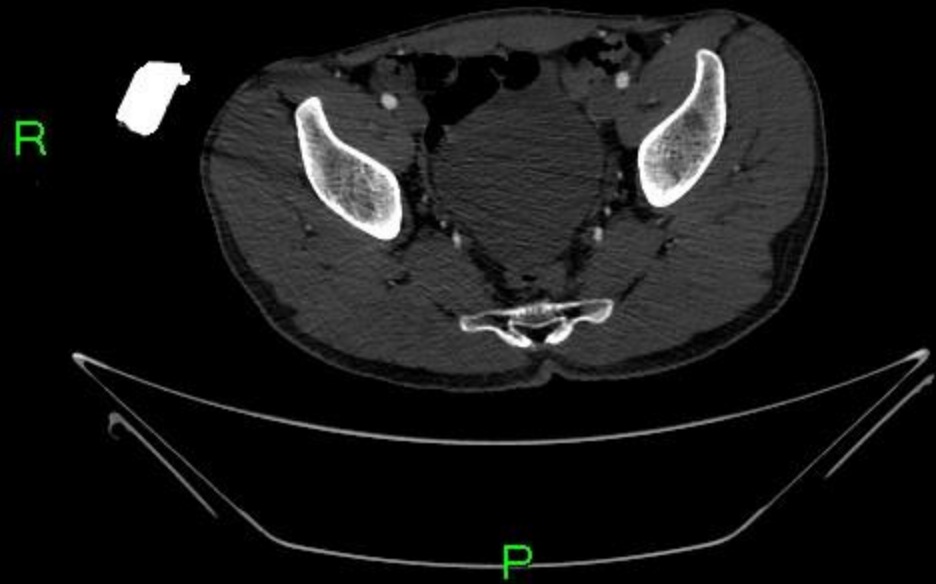


Superior gluteal artery



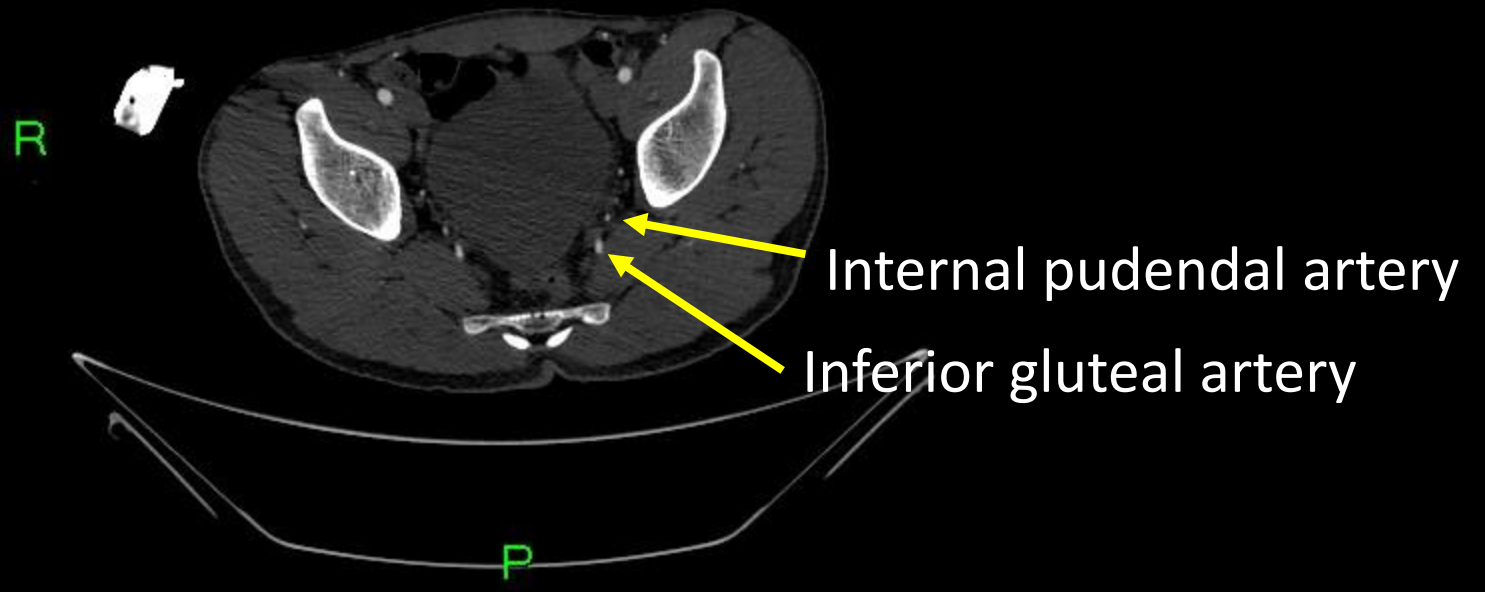






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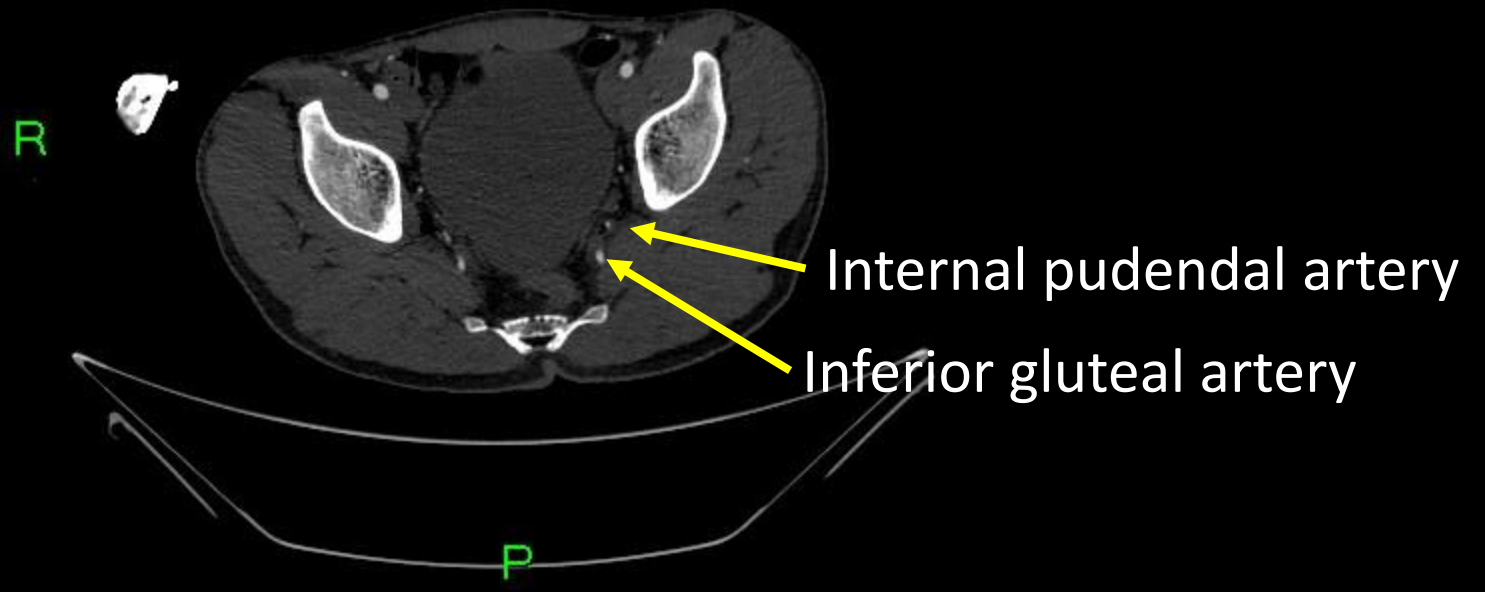


R

Internal pudendal artery

Inferior gluteal artery

P

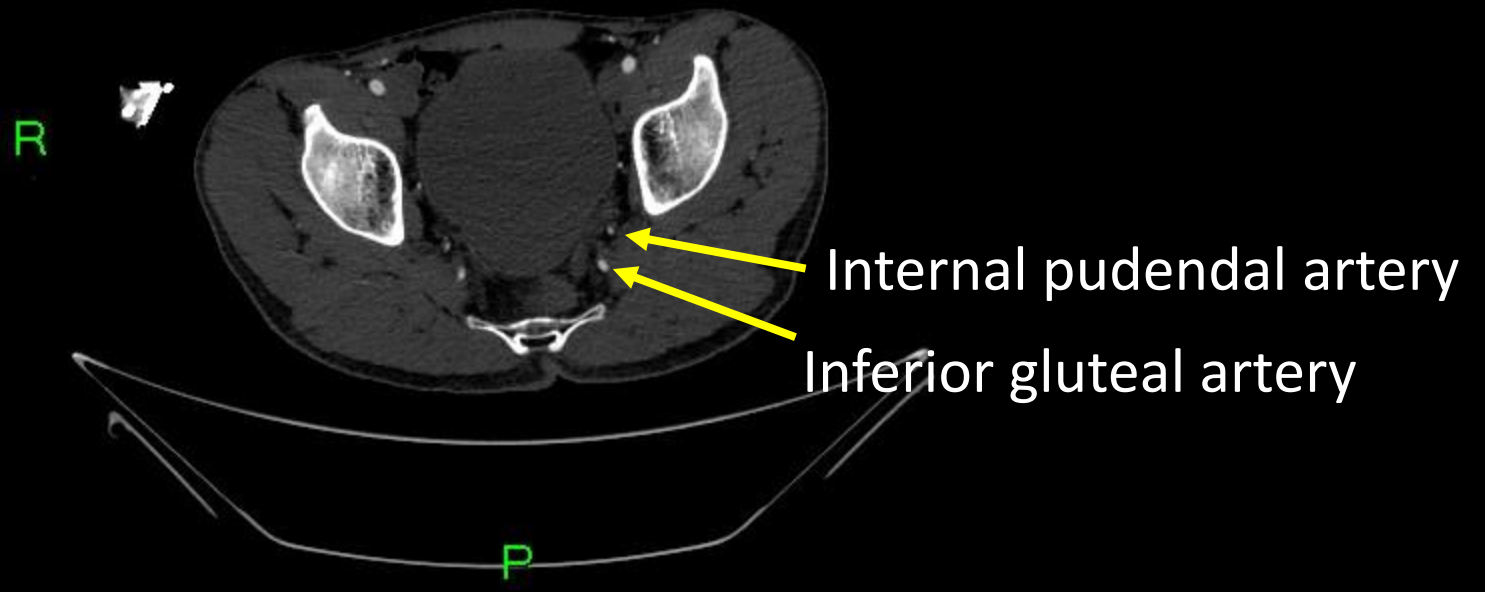


R

Internal pudendal artery

Inferior gluteal artery

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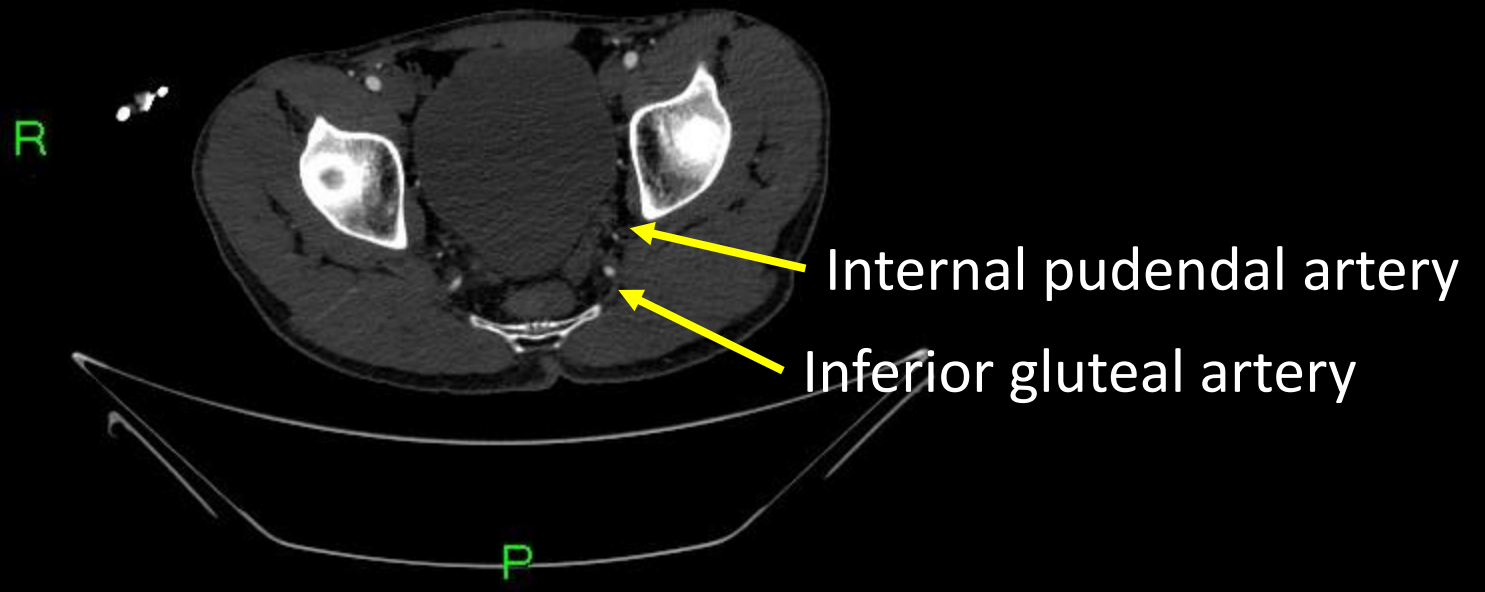


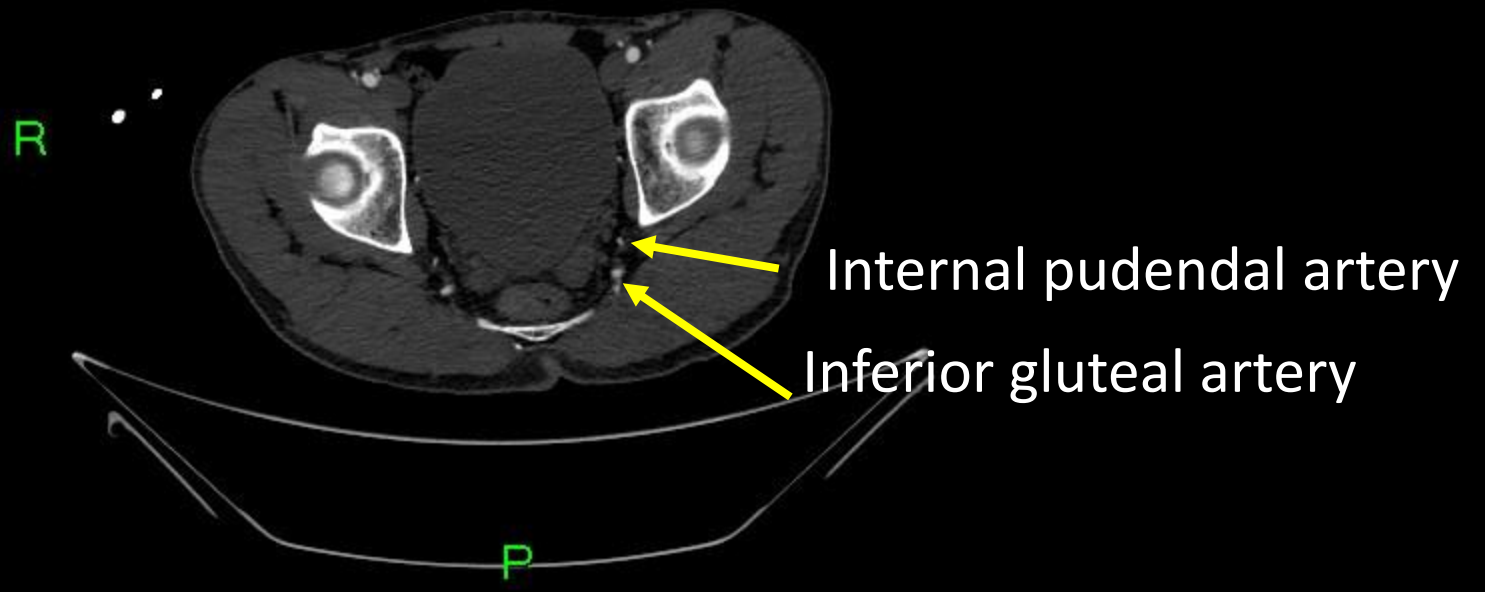
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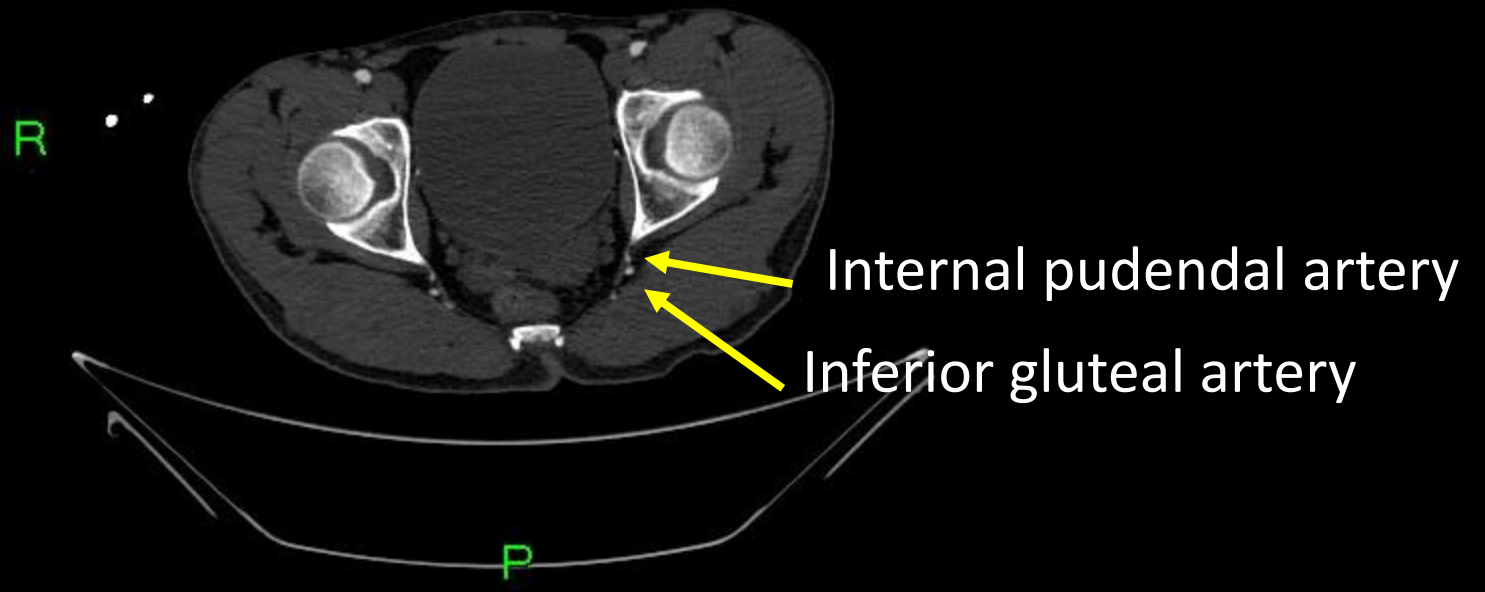
Internal pudendal artery

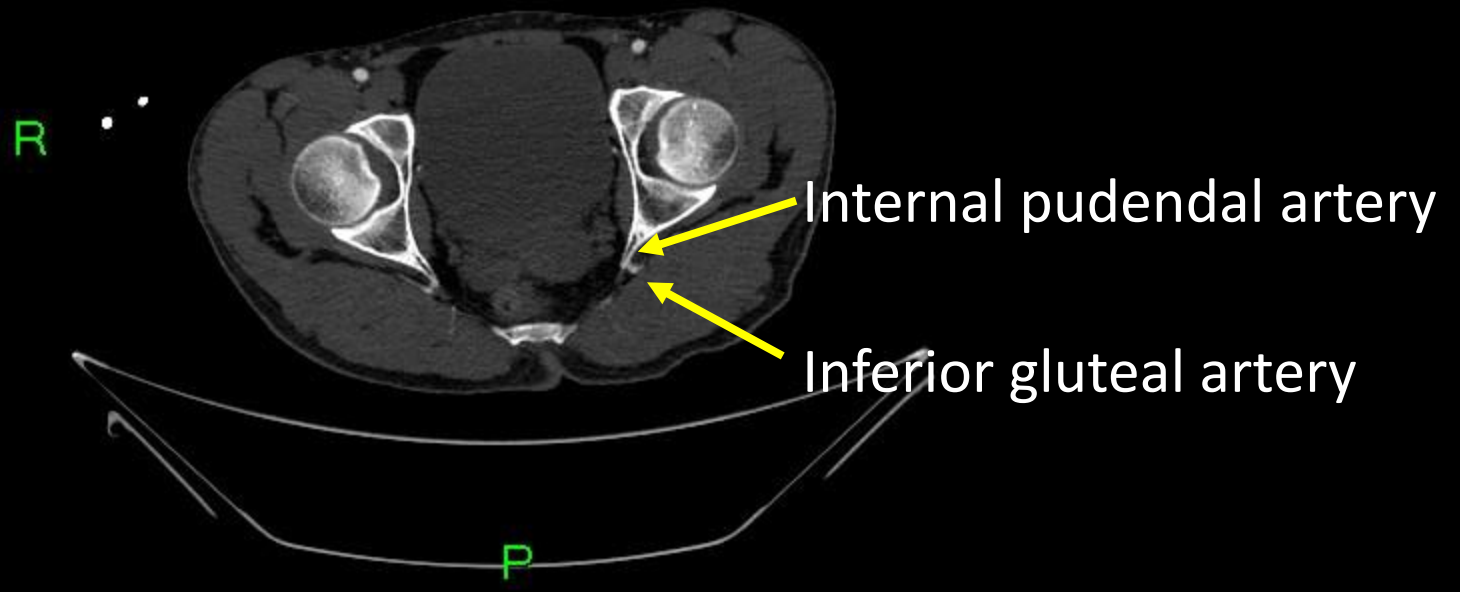
Inferior gluteal artery

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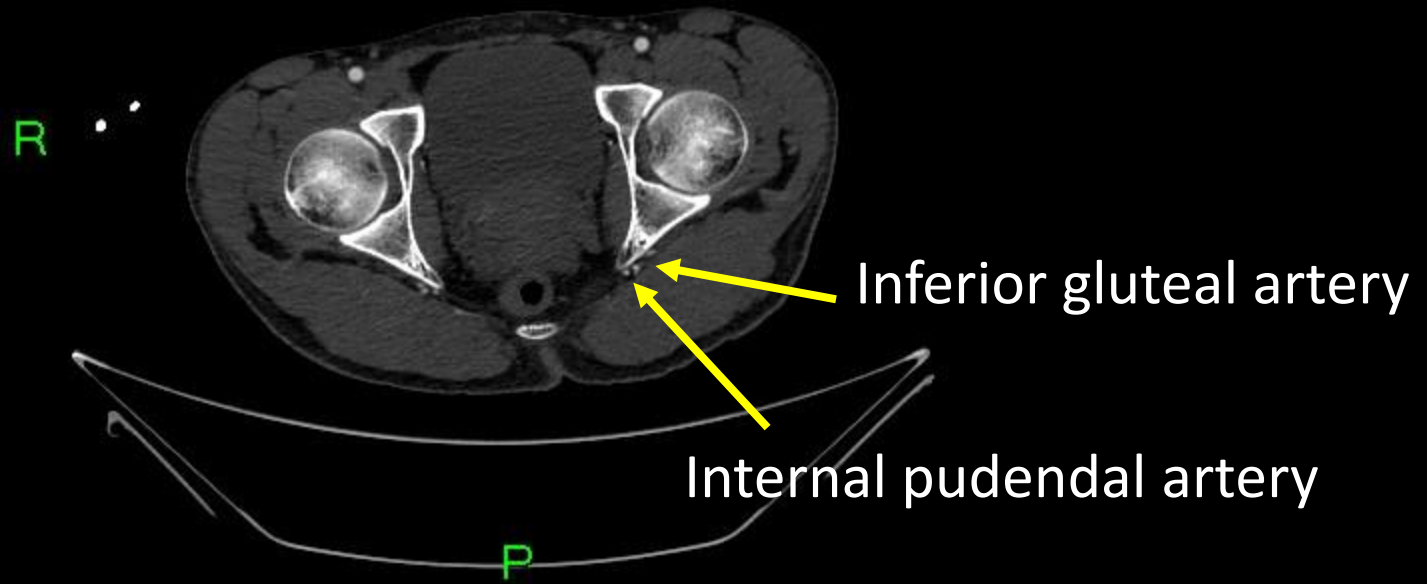
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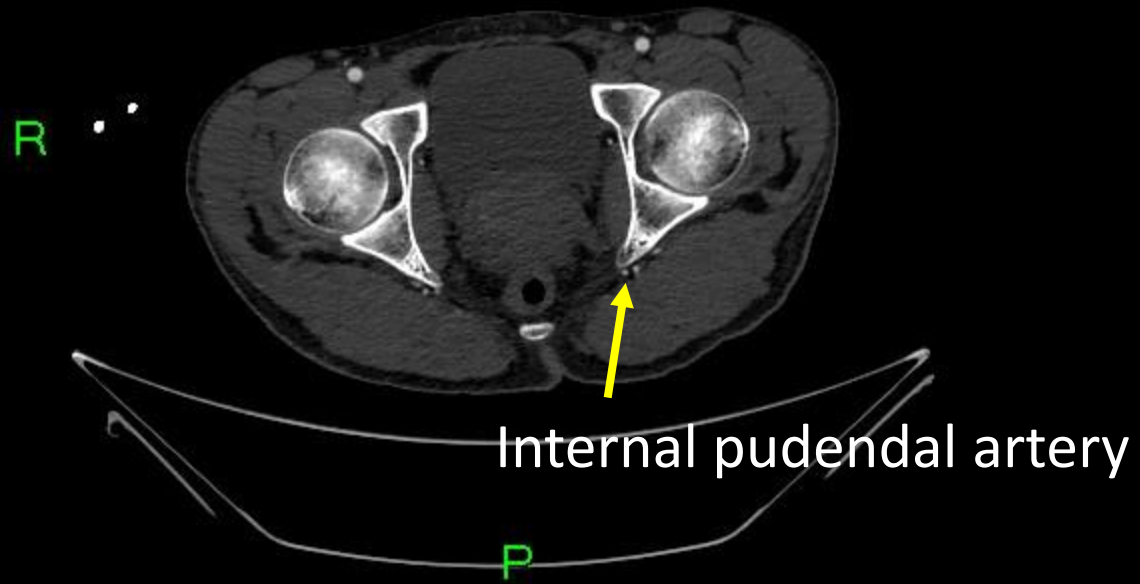
Internal pudendal artery

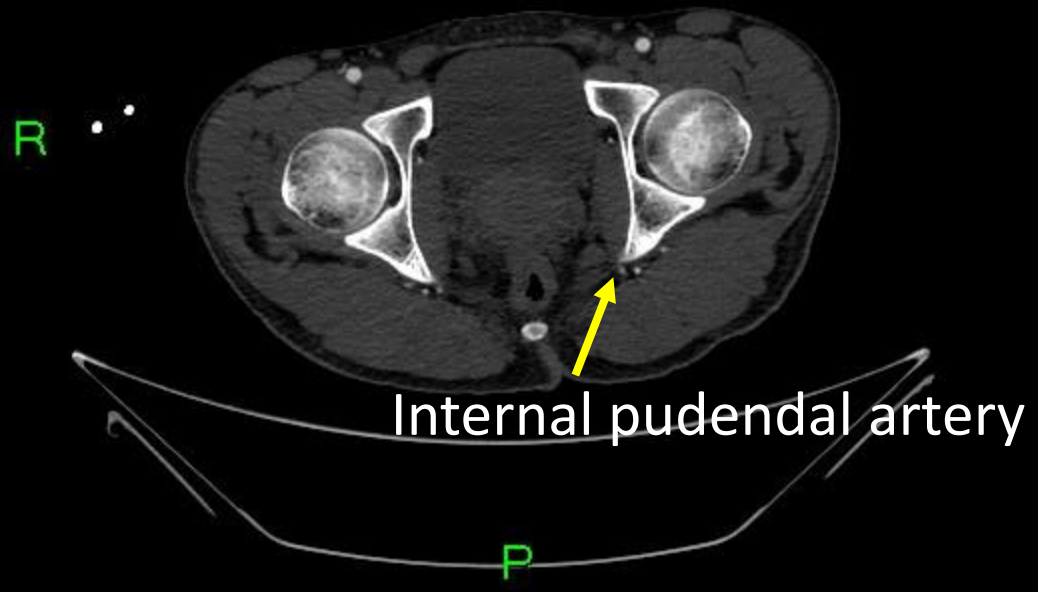
Inferior gluteal artery

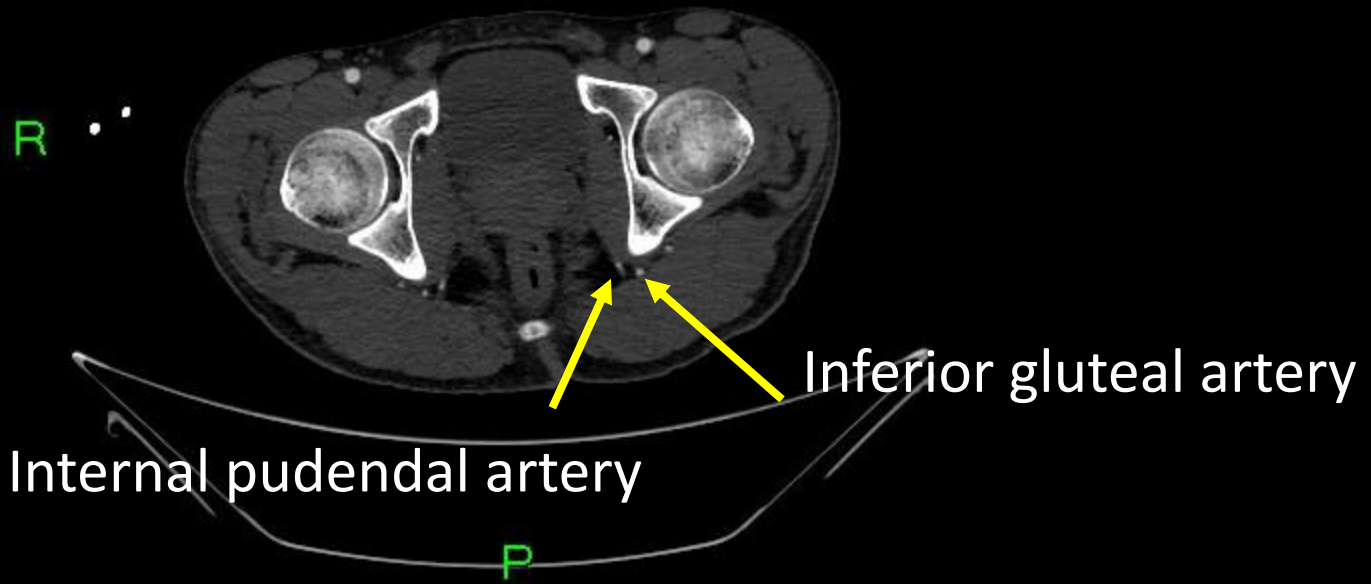
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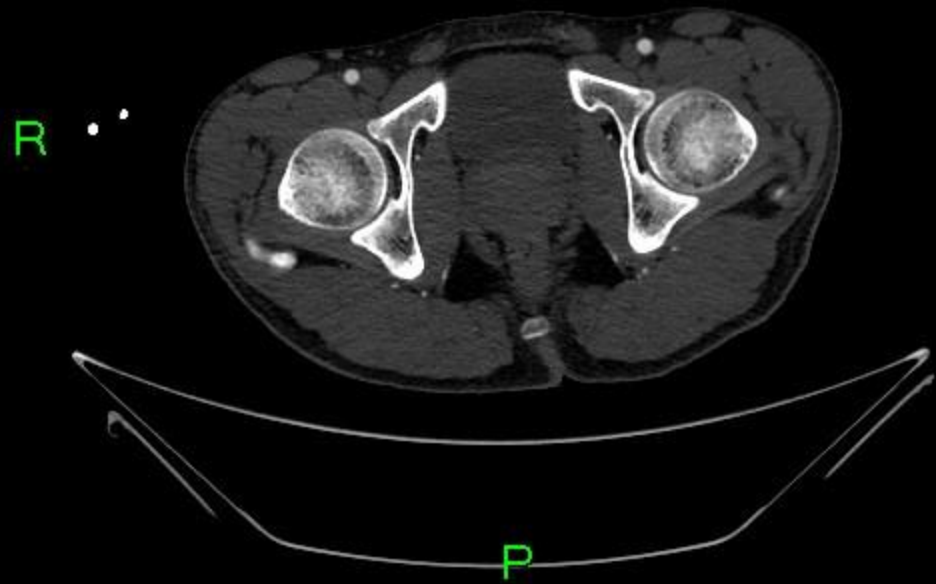


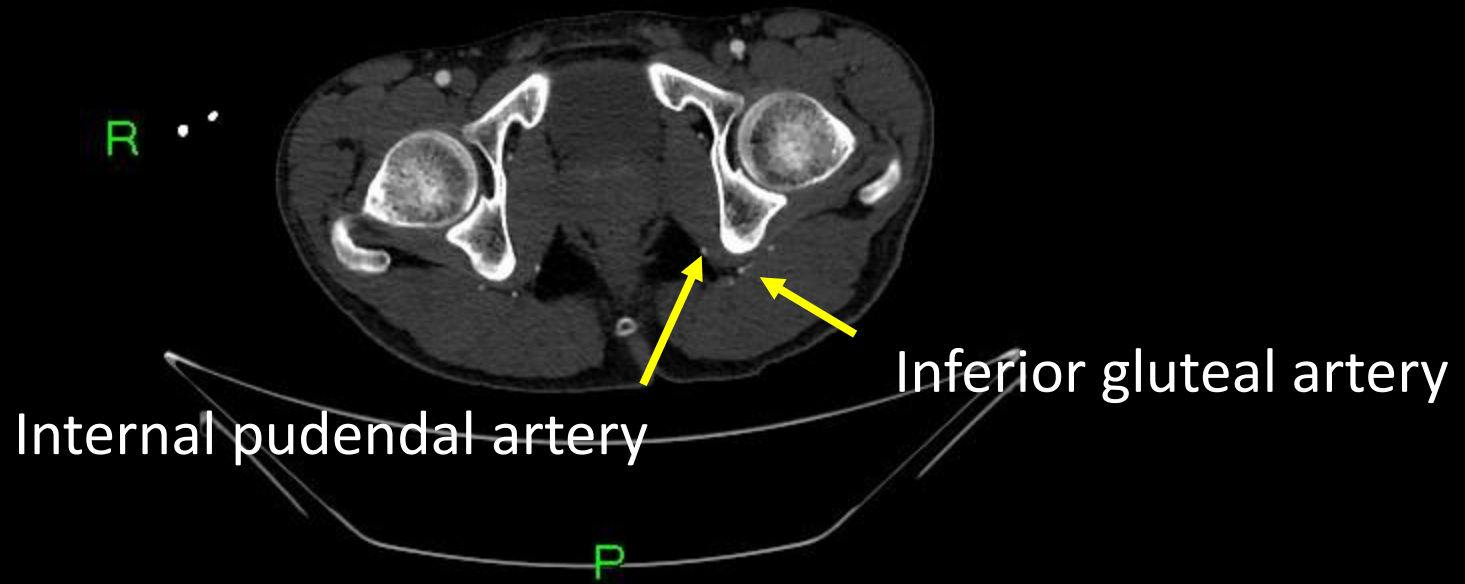
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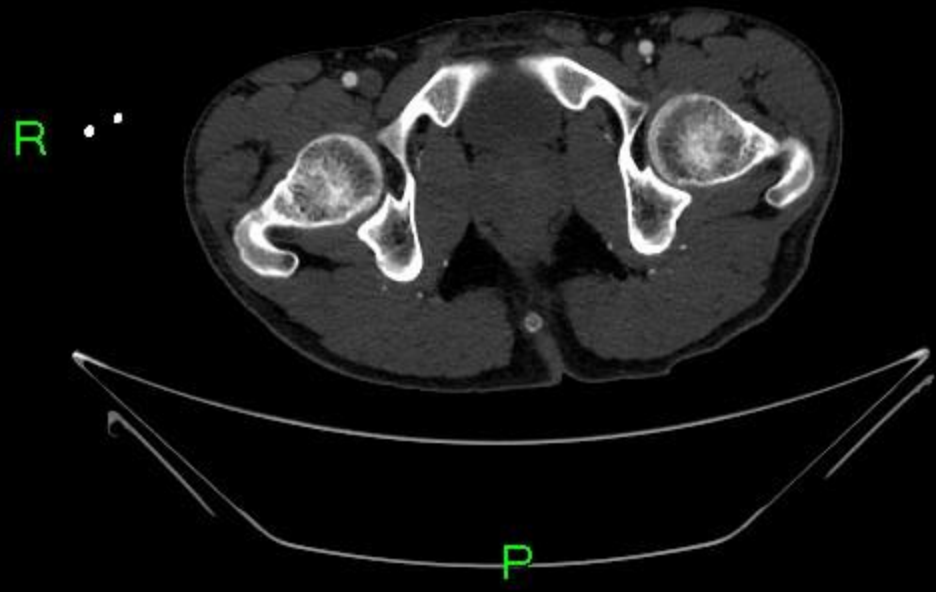
Inferior gluteal artery

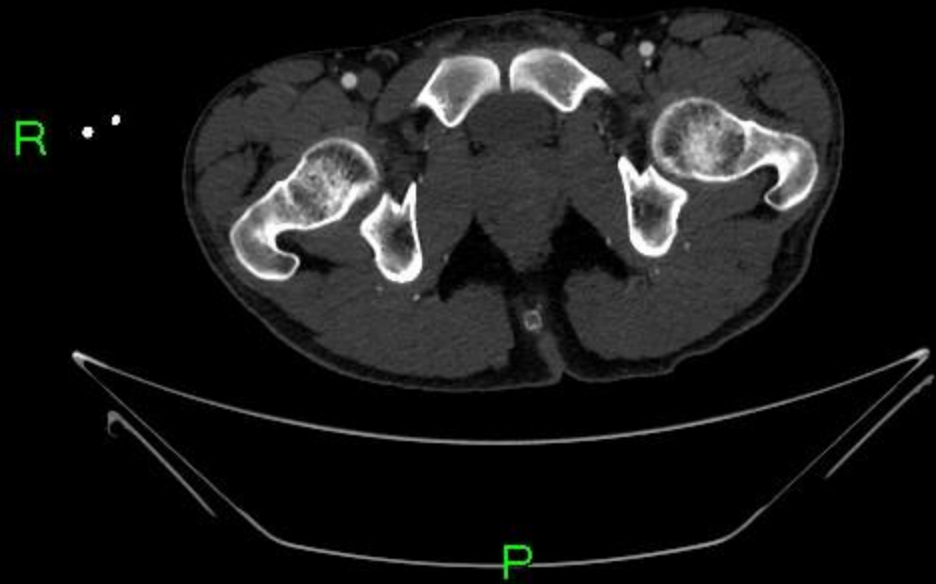
Internal pudendal artery

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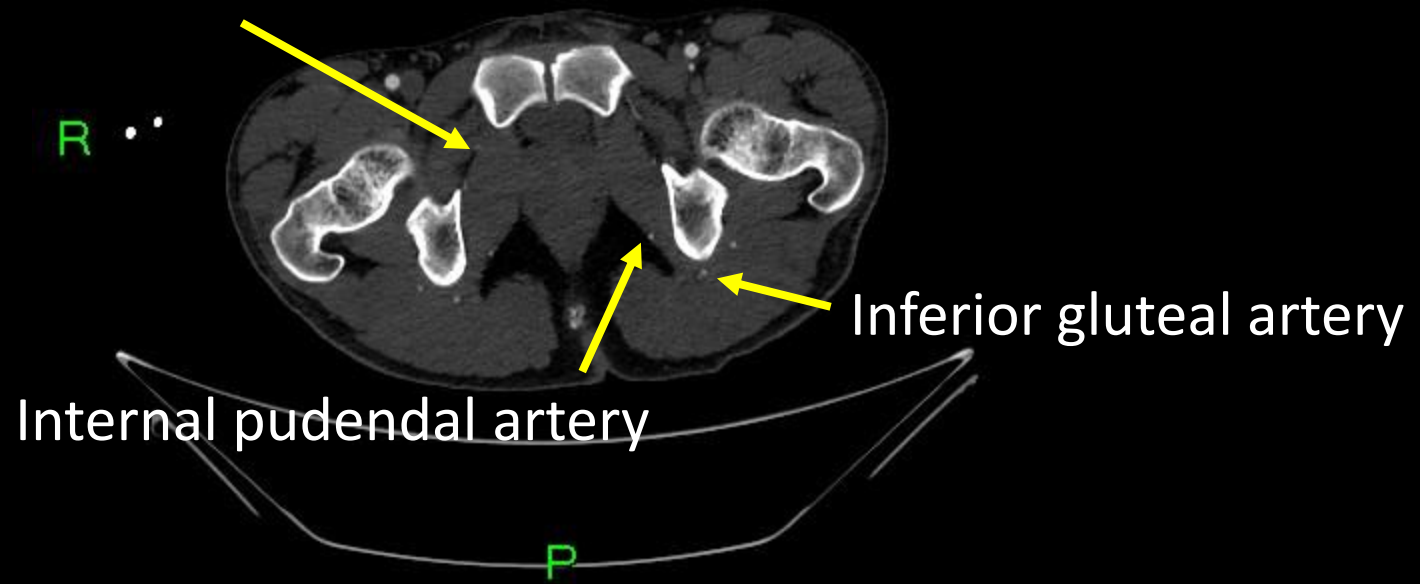


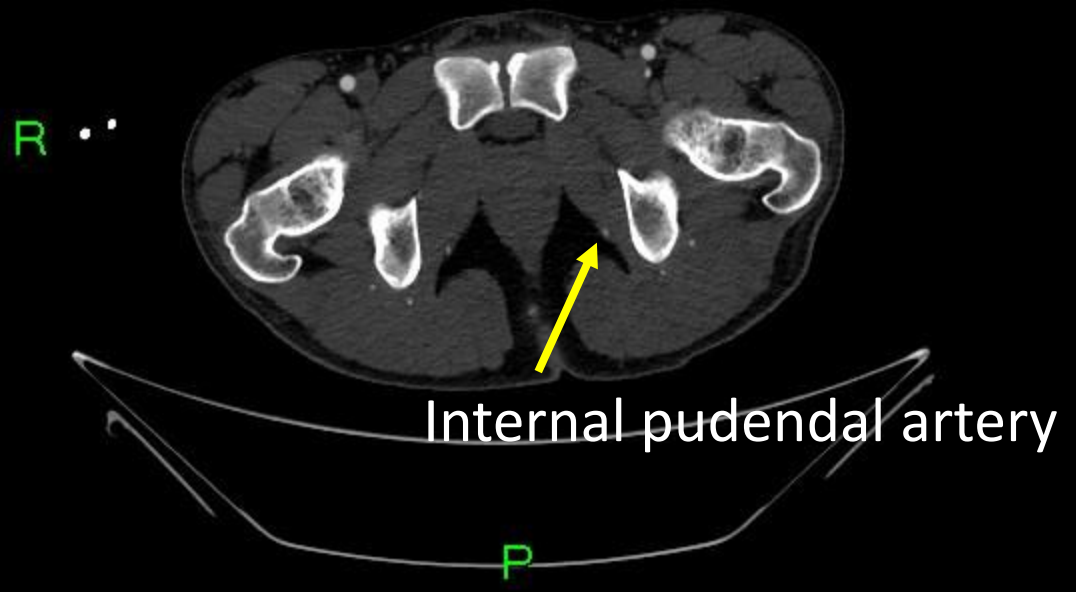






Obturator artery

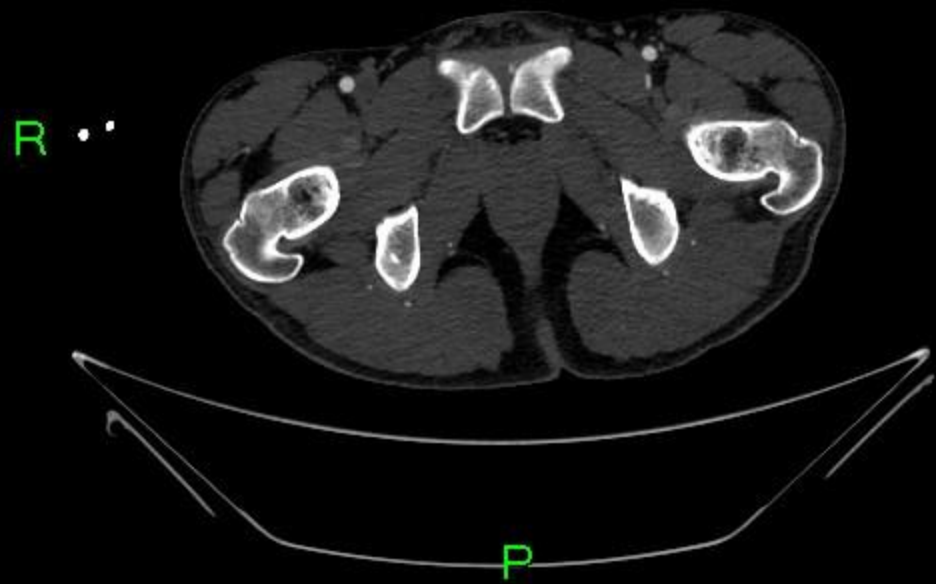


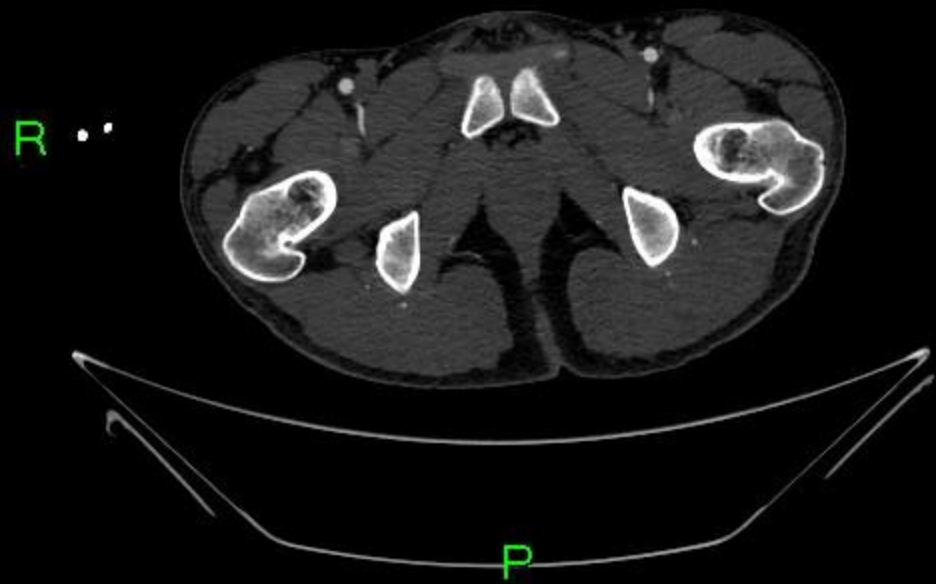


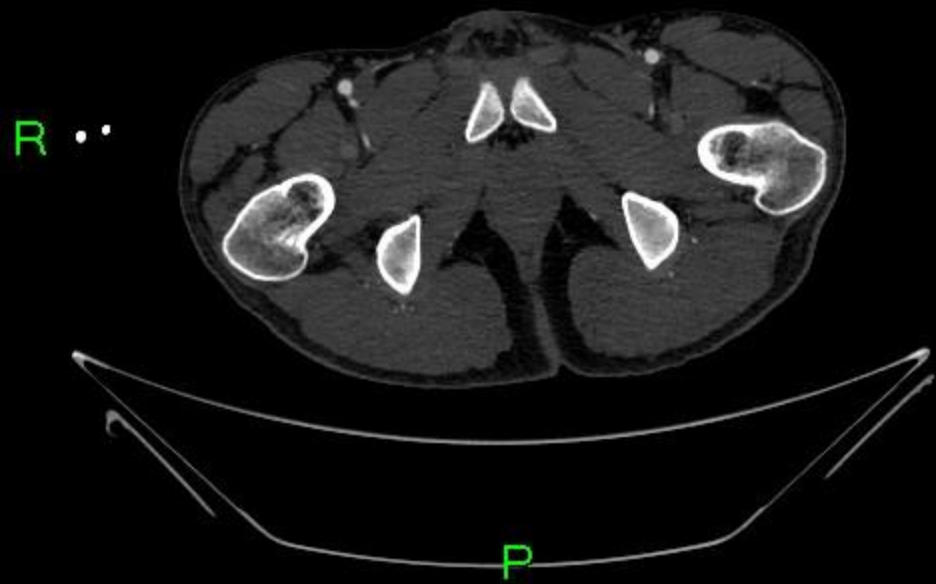
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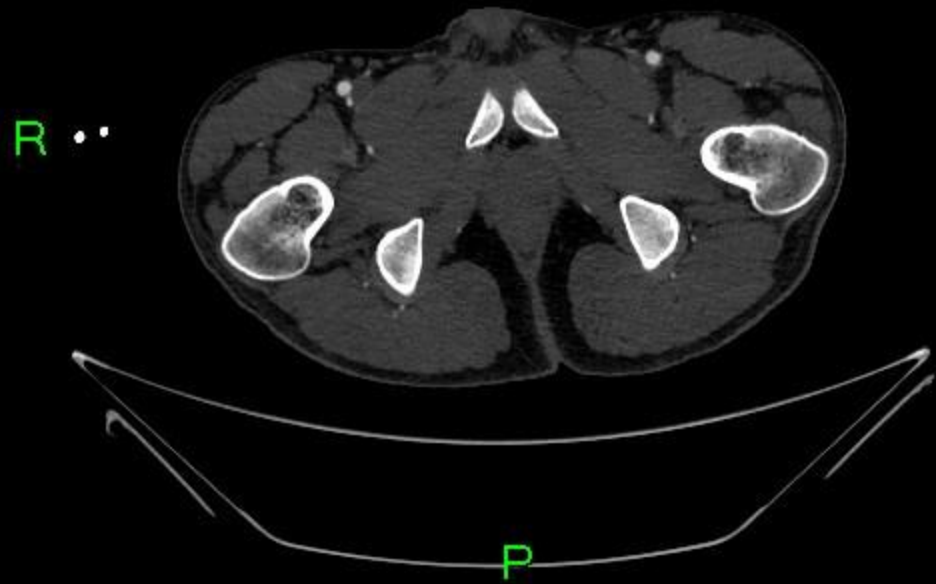
Internal pudendal artery

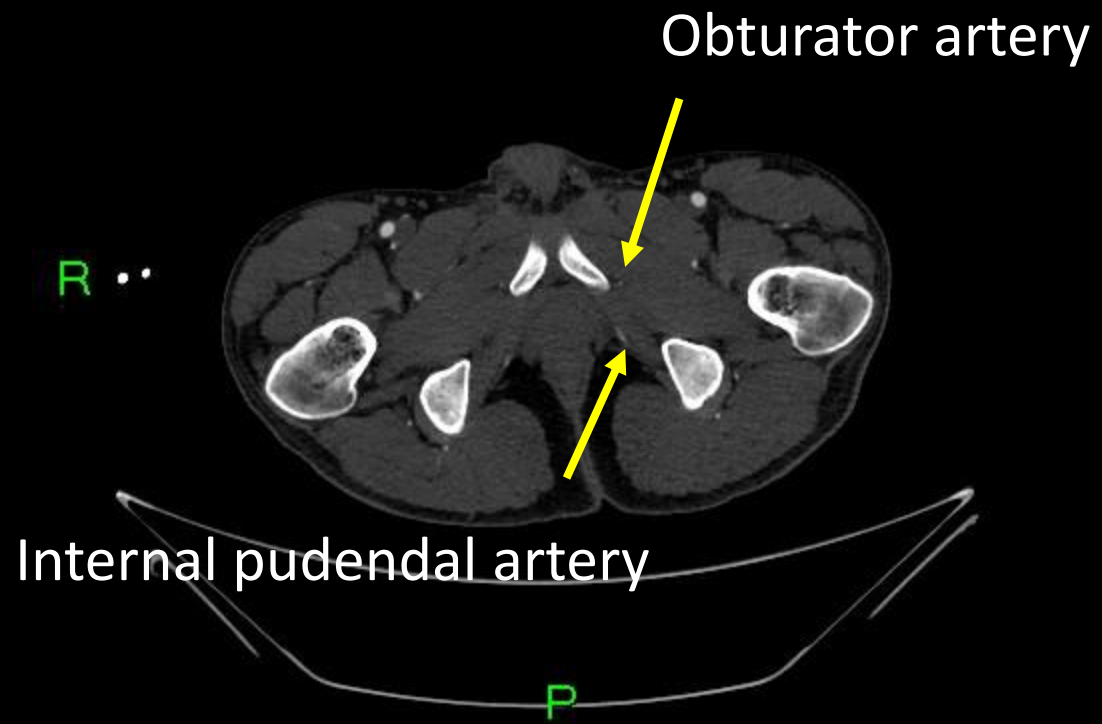
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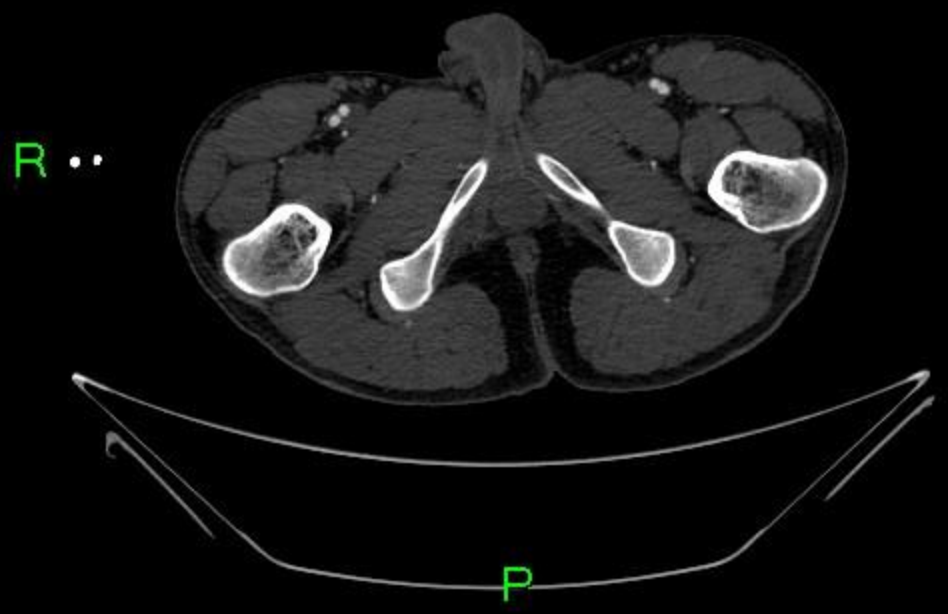


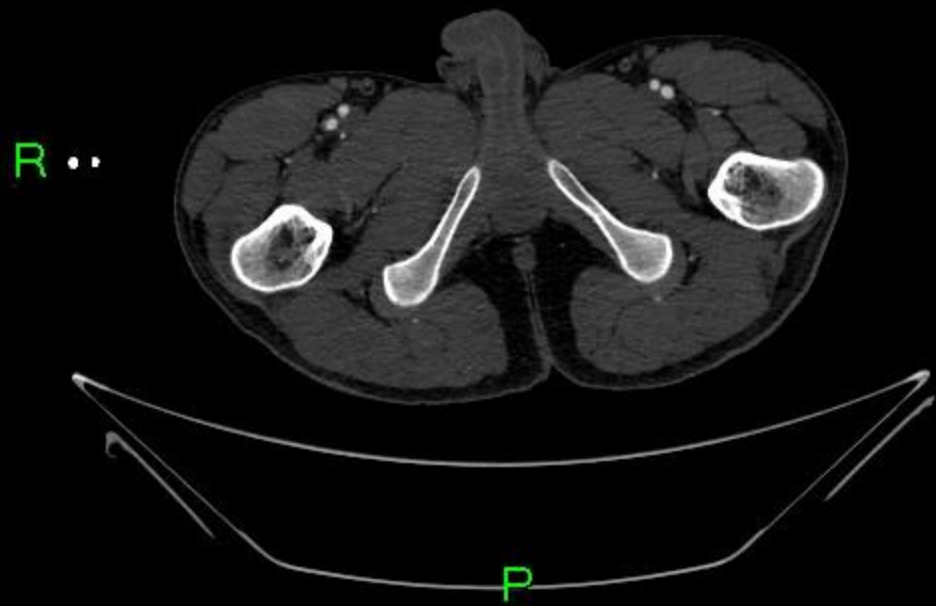












Vascular injury - arterial

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LOOK FOR

- Active extravasation
- Pseudoaneurysm
- Transection (abrupt cut off)
- Dissection

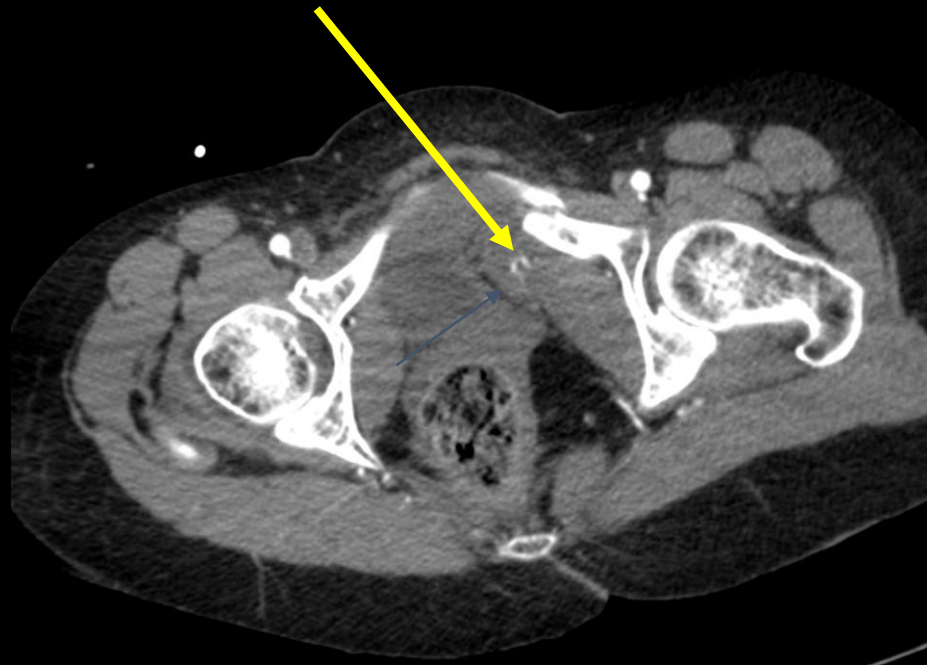


High Speed Road Traffic Accident

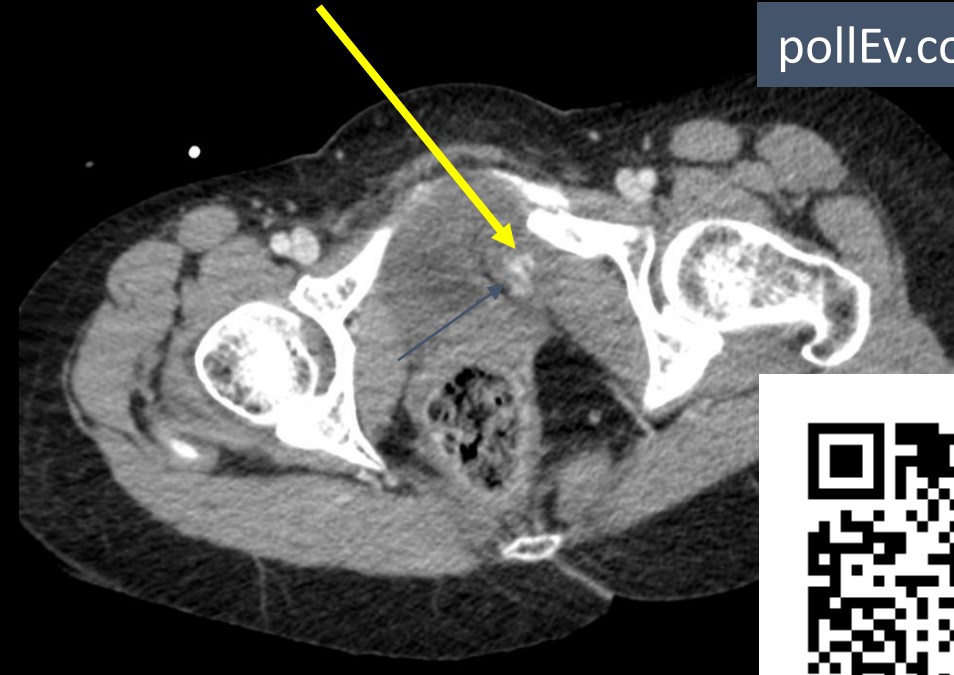
Active arterial contrast extravasation within left obturator internus muscle

CASE 2

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Arterial



Venous



Which Branch? Internal pudendal A OR Inferior gluteal A?

Which artery is bleeding coming from

internal pudendal artery

0%

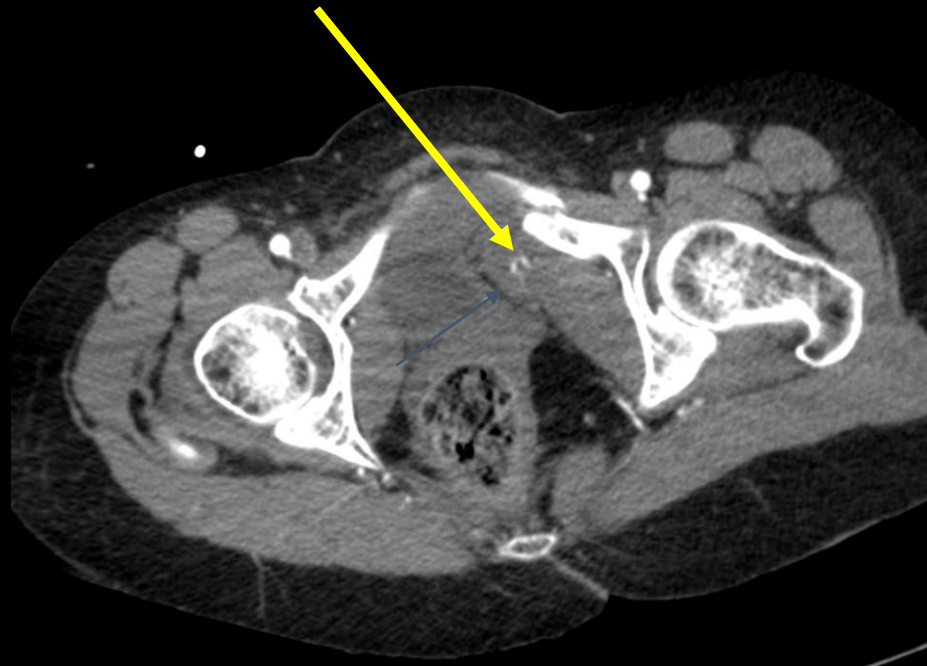
inferior gluteal artery

0%

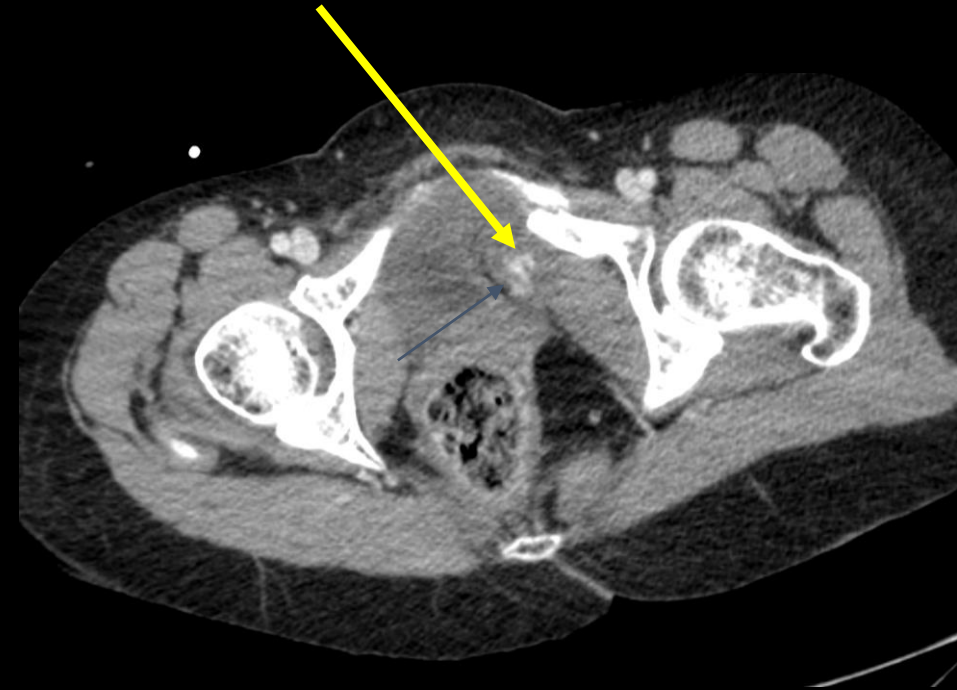
High Speed Road Traffic Accident

Active arterial contrast extravasation within left obturator internus muscle

CASE 2



Arterial

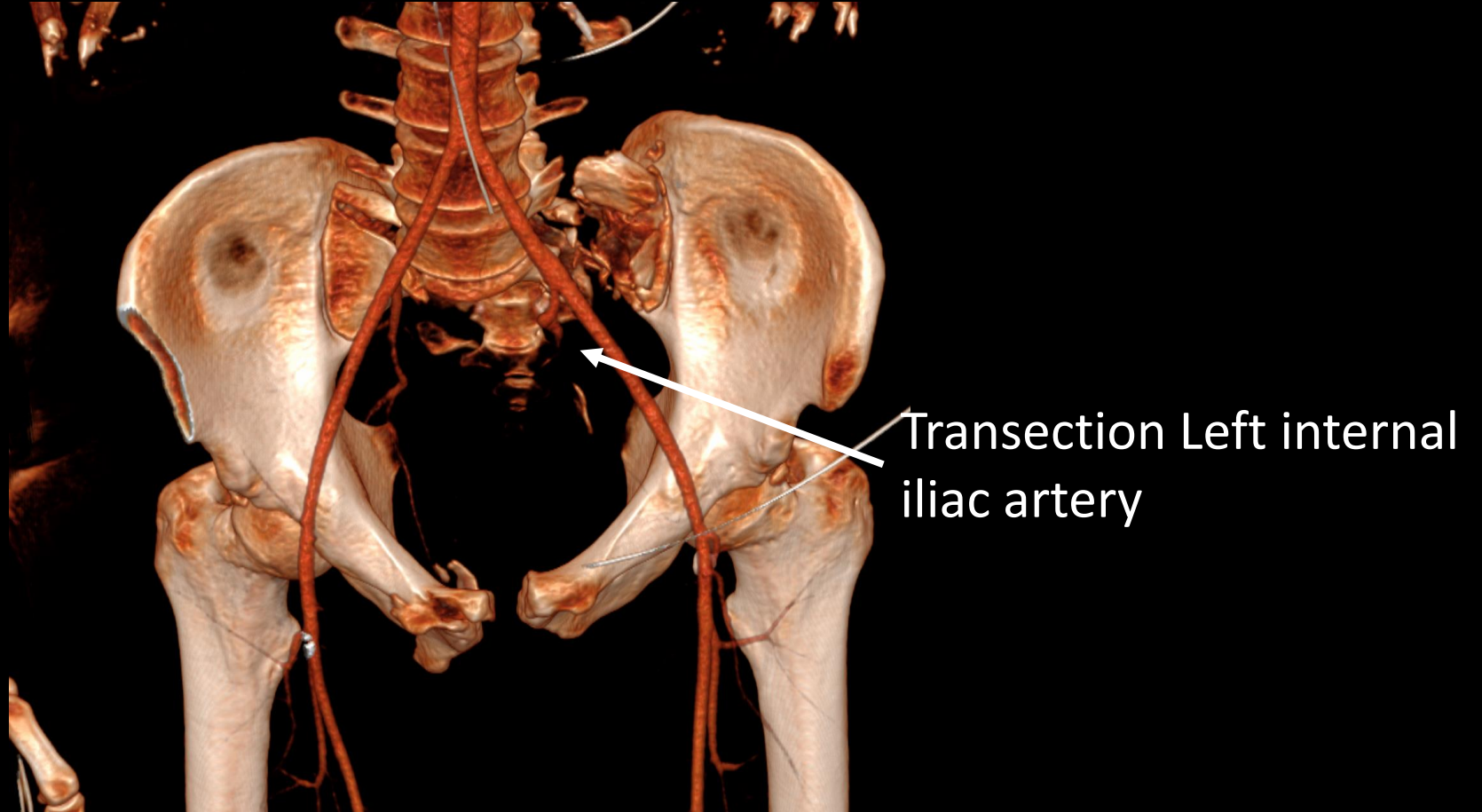


Venous

Which Branch: **Internal pudendal A**

Unstable open book fracture, Code red (requires +++ blood)

CASE 3



Sacral fracture

Large left pelvic side wall haematoma

CASE 3



Sacral fracture

Large left pelvic side wall haematoma

CASE 3



Watch left internal iliac artery

Left internal iliac thrombus & irregular contour

CASE 3



Watch left internal iliac artery

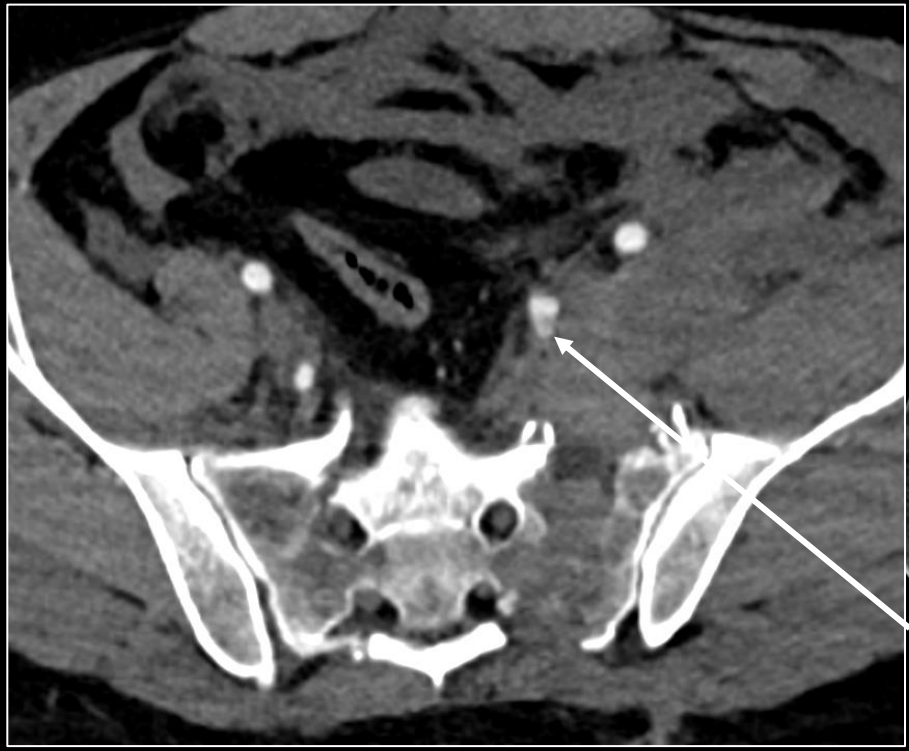
Left internal iliac thrombus & irregular contour

CASE 3



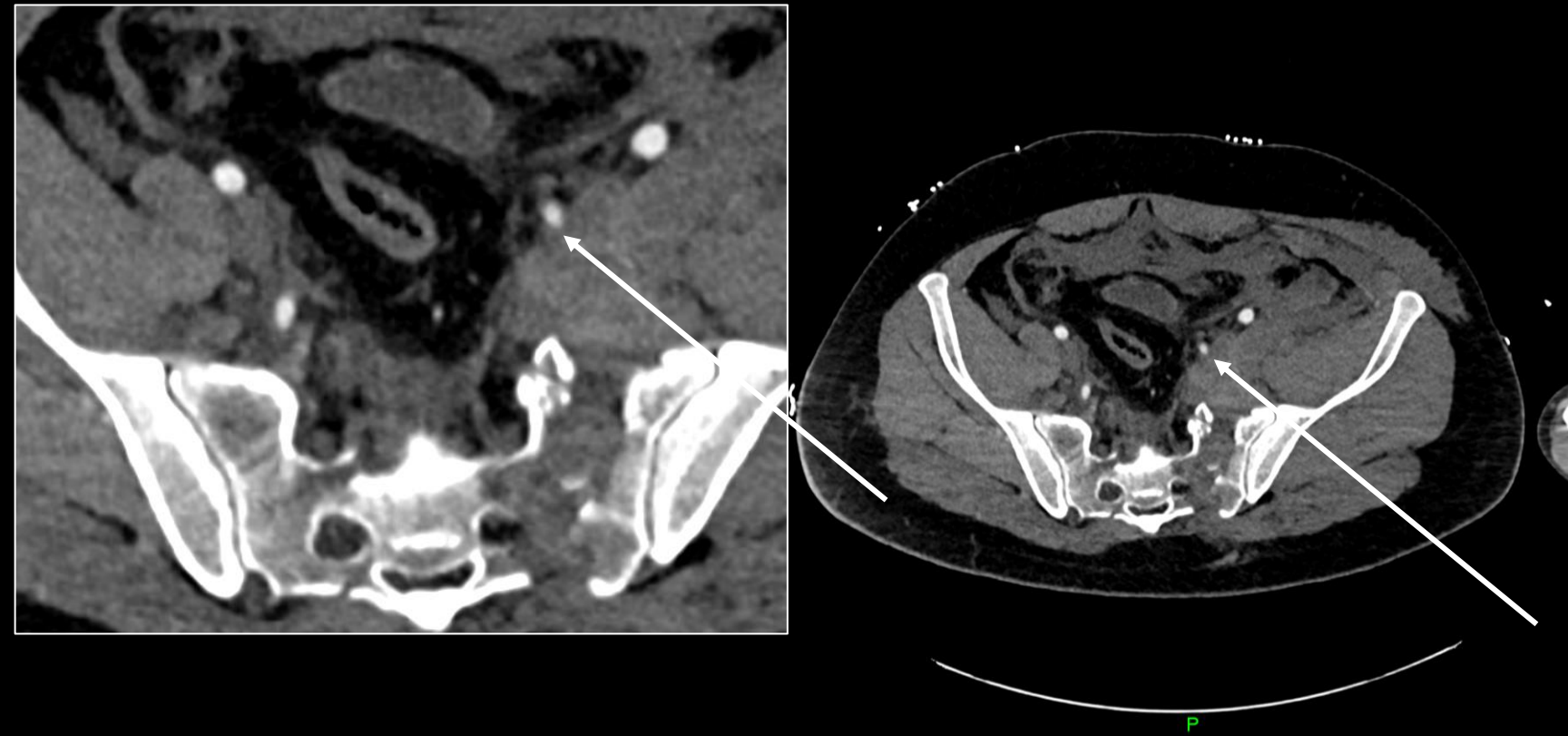
Left internal iliac thrombus & irregular contour

CASE 3



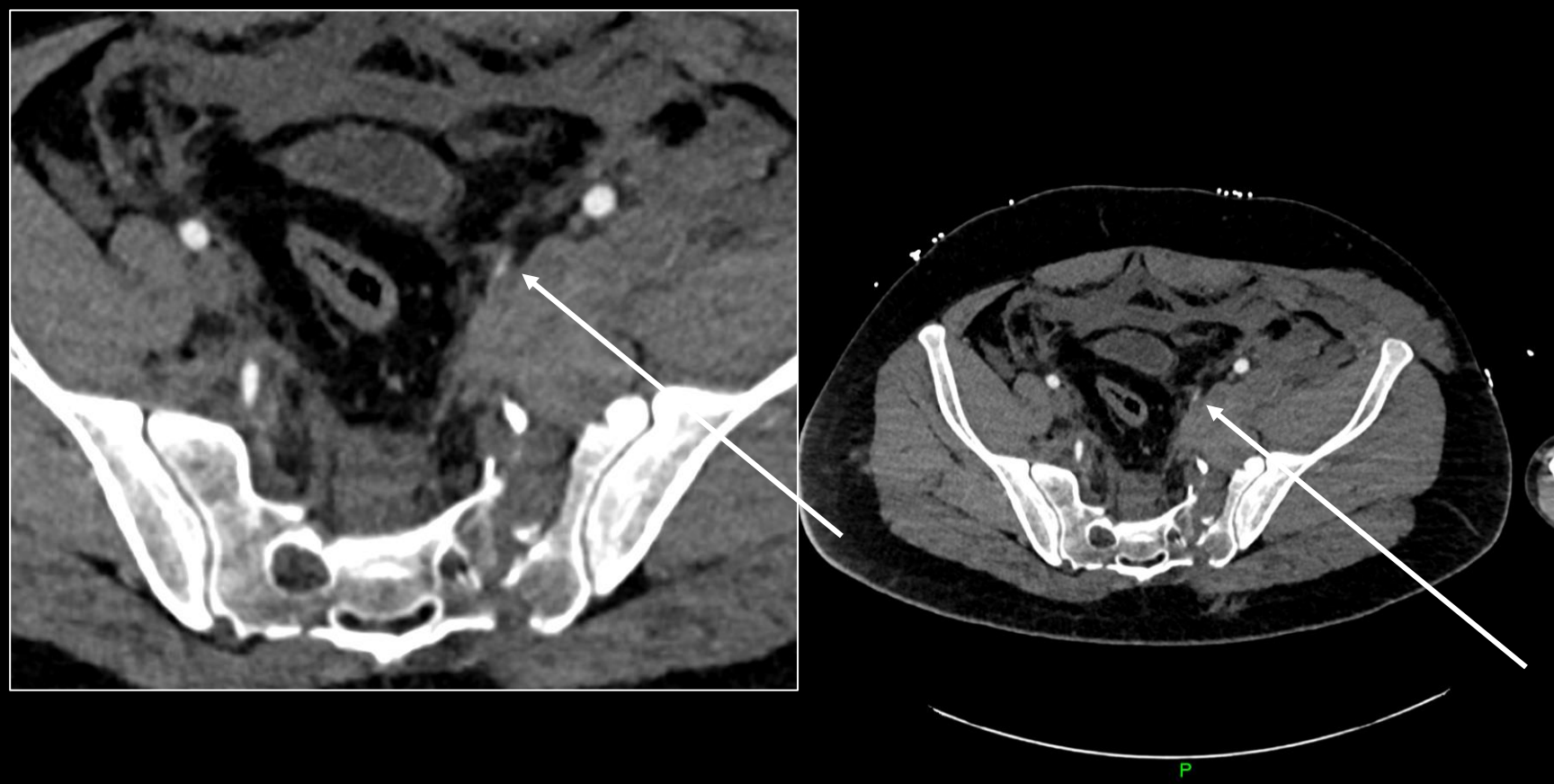
Left internal iliac becomes small and disappears

CASE 3



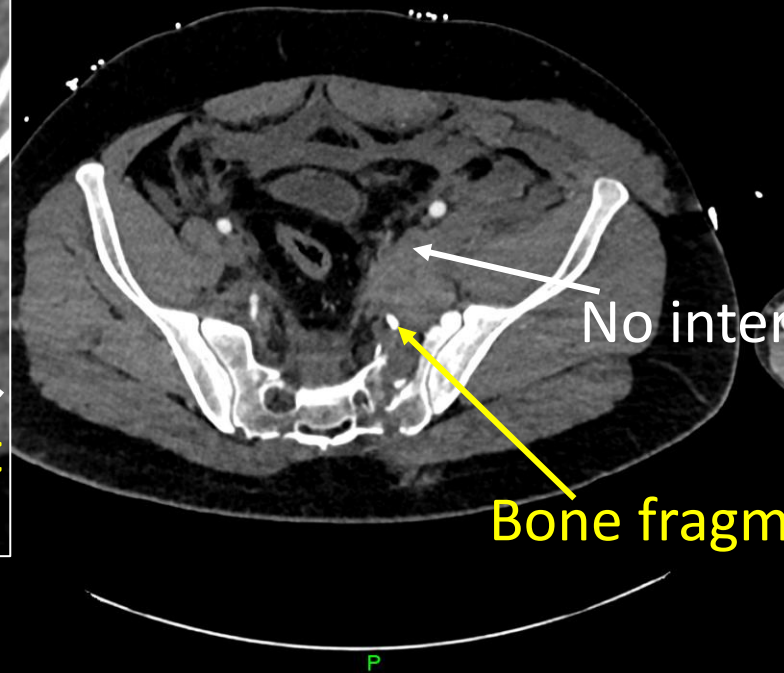
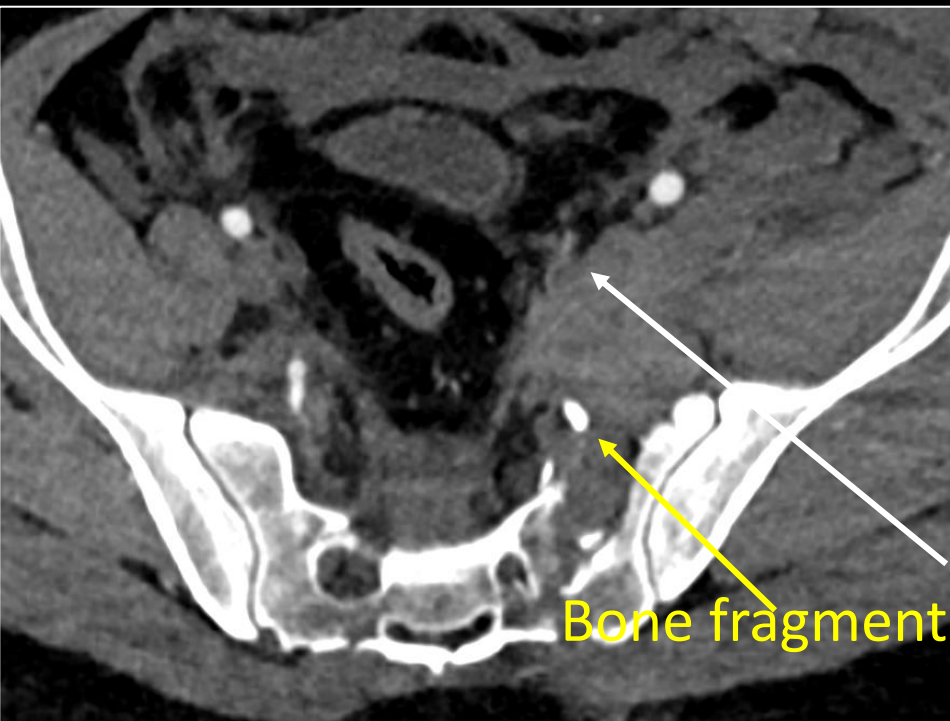
Left internal iliac artery disappears

CASE 3



Left internal iliac artery transected

CASE 3



No internal iliac artery

Bone fragment

Left internal iliac artery transected

CASE 3



No internal iliac artery

Left Internal Iliac Artery transection confirmed and repaired at surgery

CASE 3



Pelvic side wall and anterior abdominal wall haematoma

Left Internal Iliac Artery transection confirmed and repaired at surgery

CASE 3

Learning Point:

Large haematoma plus artery truncation: transection and risk of active bleeding



Pelvic side wall and anterior abdominal wall haematoma

Frail elderly person - Low Energy Injury

CASE 4

Fall off chair

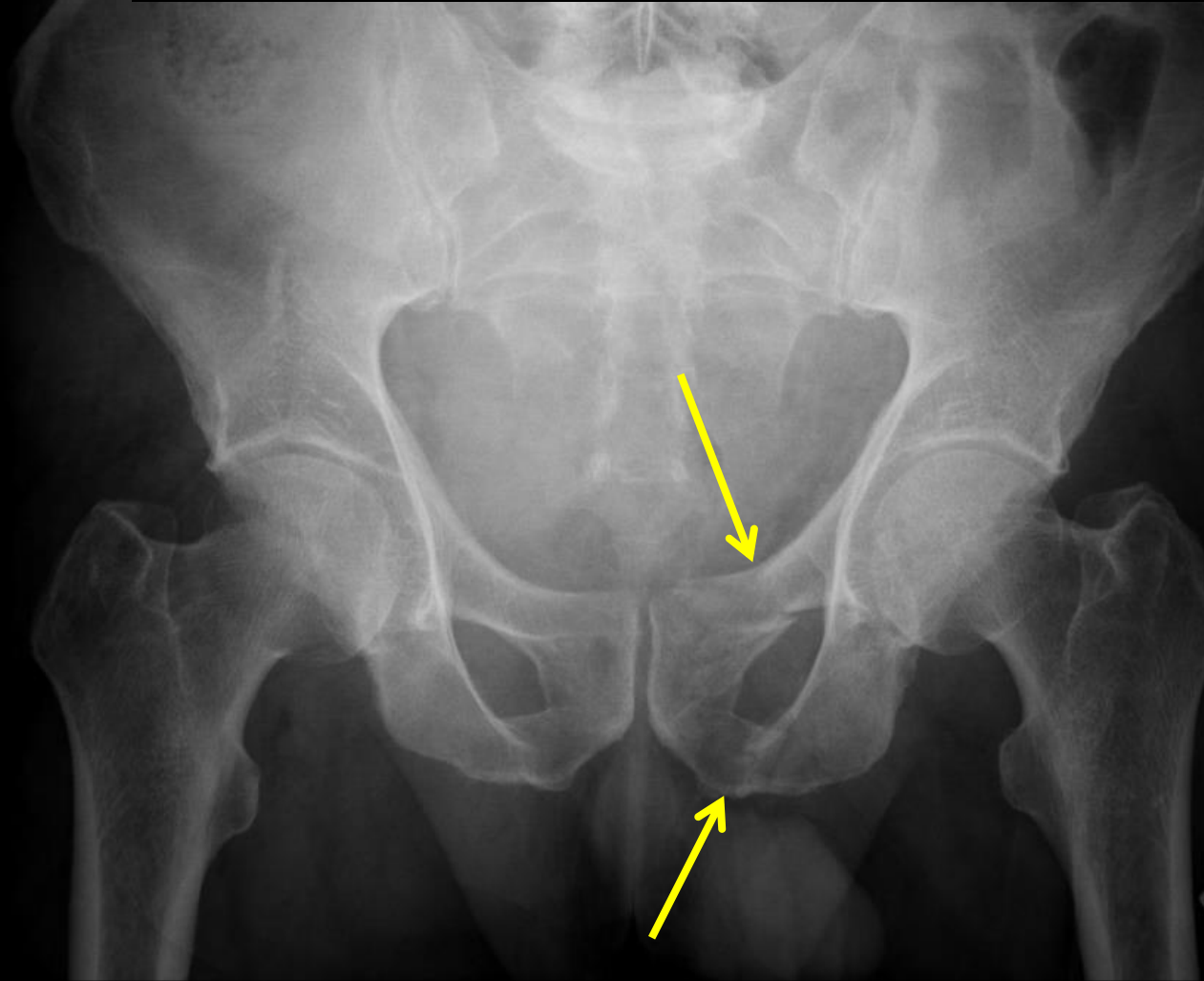


CASE 4

Fall off chair

left superior/inferior pubic rami

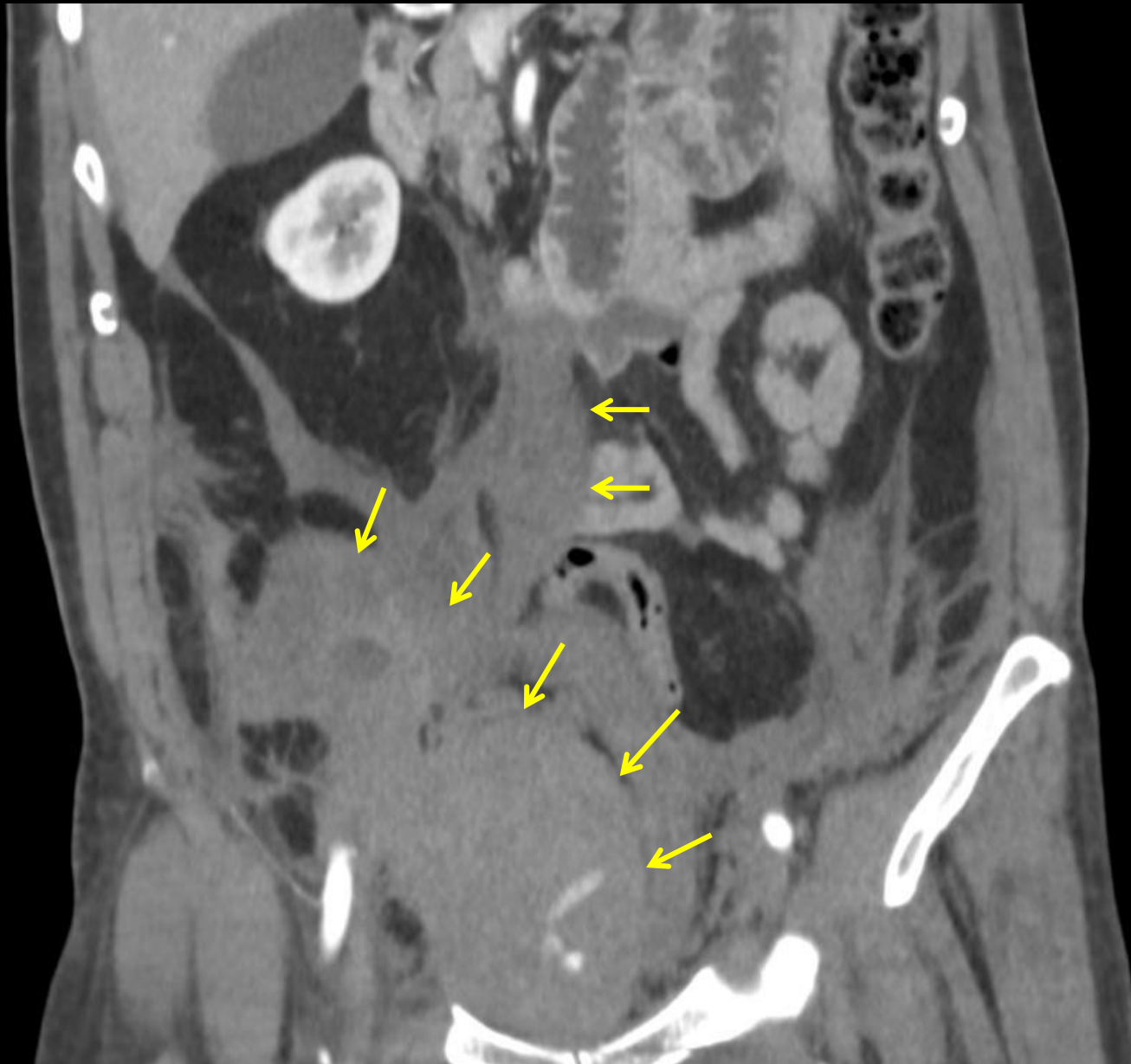
CASE 4



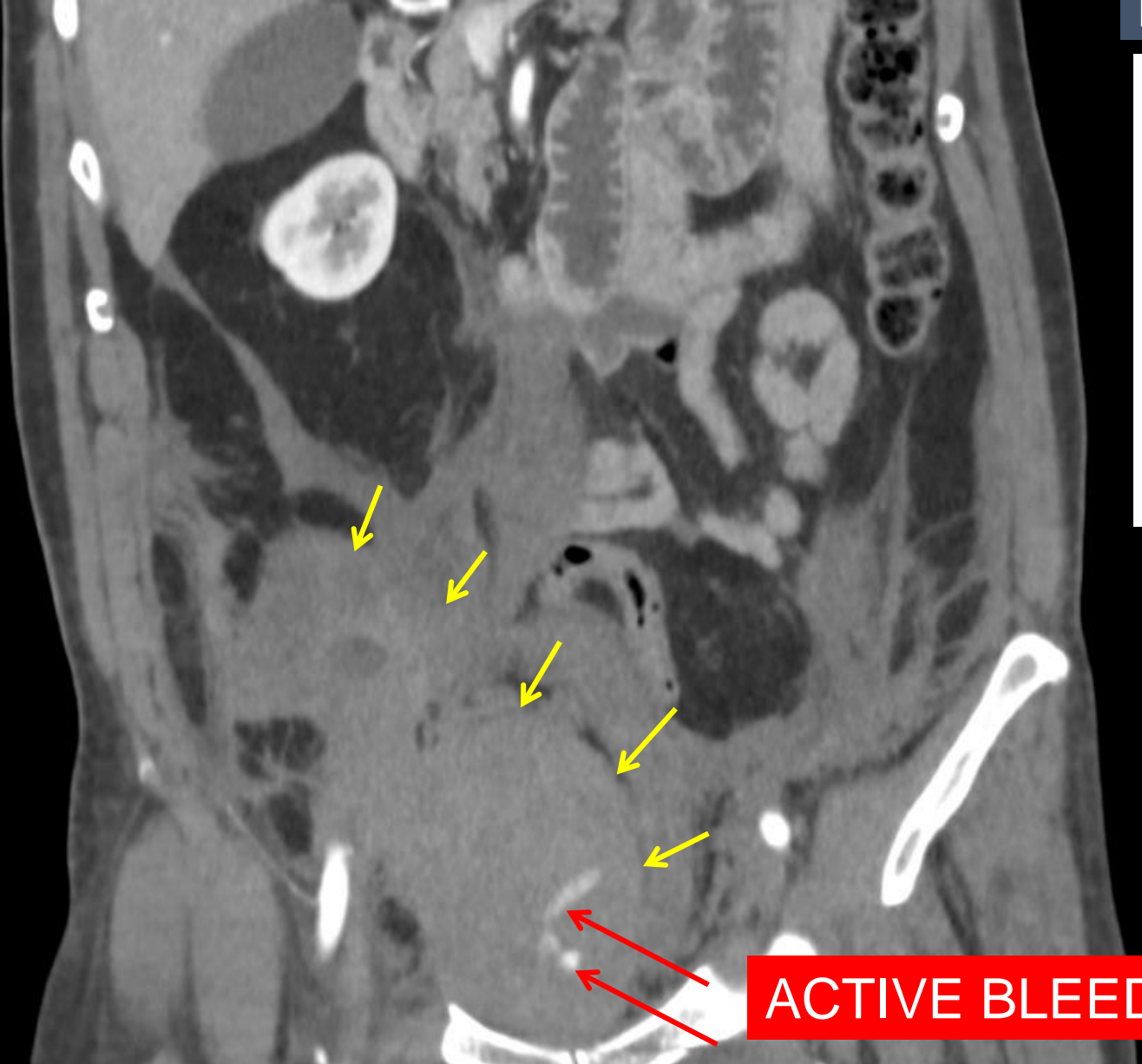


CASE 4

CASE 4

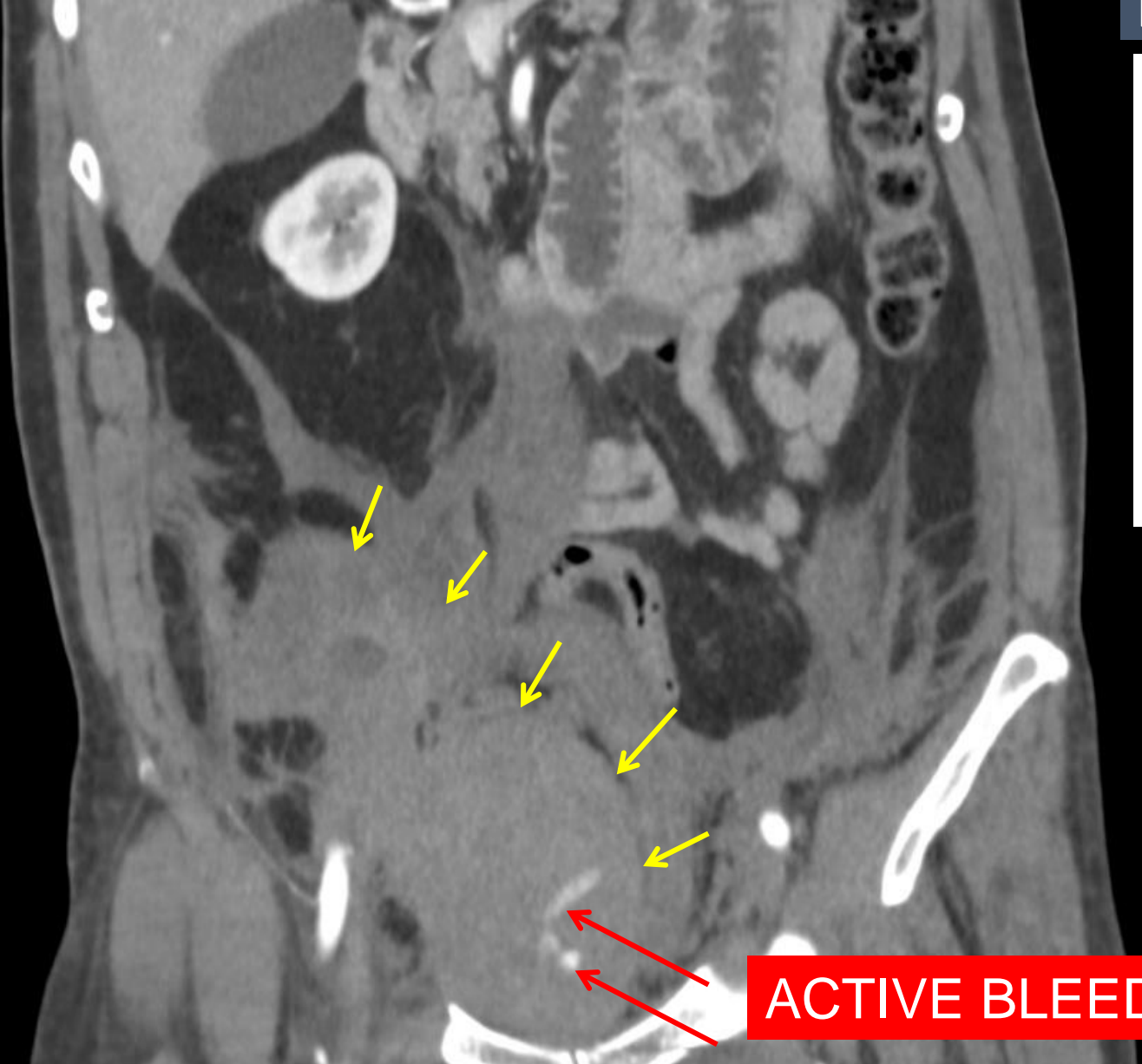


Pelvic sidewall and retroperitoneal haematoma



ACTIVE BLEEDING

Pelvic sidewall and retroperitoneal haematoma



ACTIVE BLEEDING

Pelvic sidewall and retroperitoneal haematoma

What treatment do you think the patient is on?

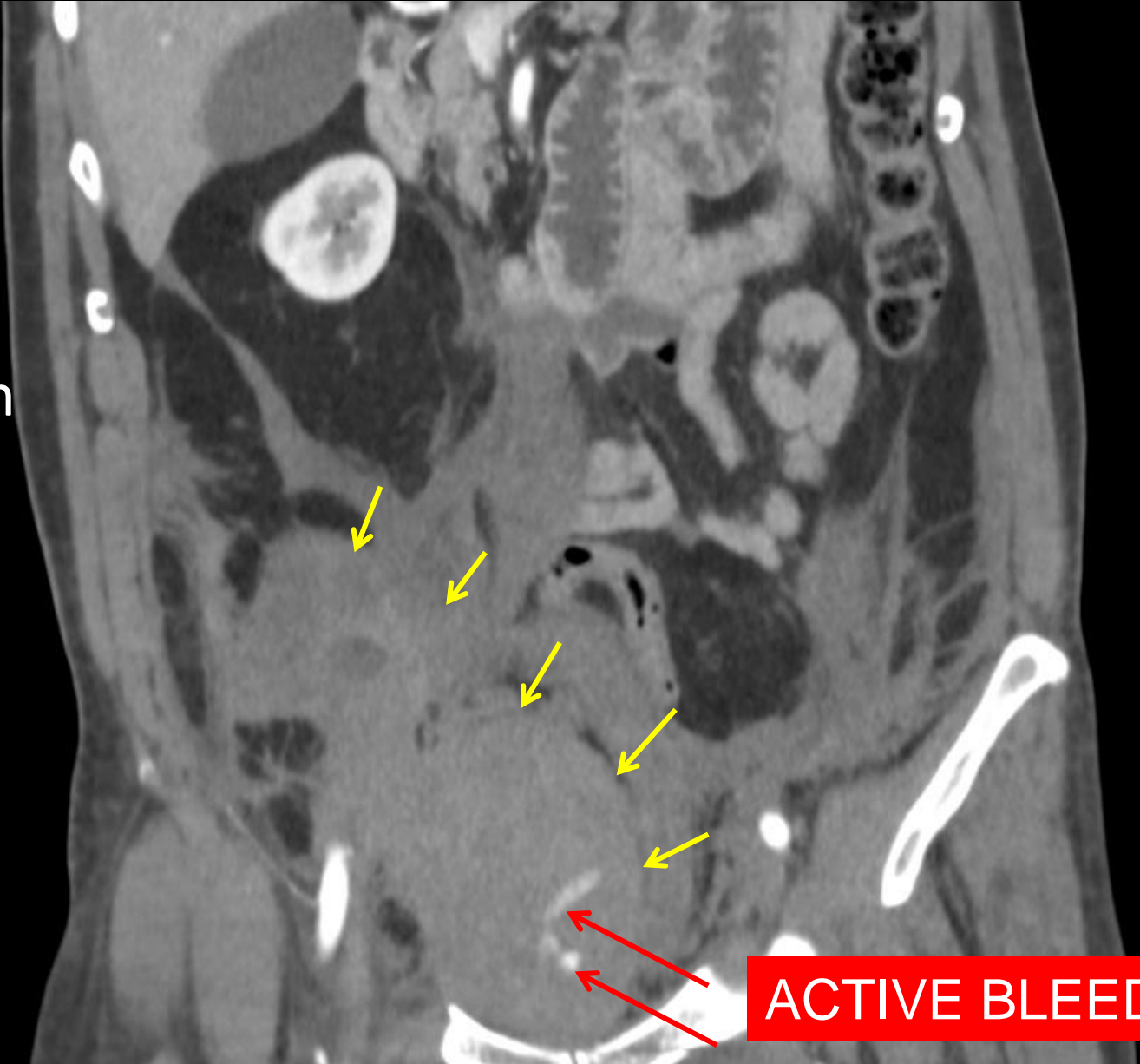
What treatment do you think this patient is on? que tipo de tratamiento cree que estaba recibiendo

Nobody has responded yet.

Hang tight! Responses are coming in.

CASE 4

On DOAC - Apixaban



ACTIVE BLEEDING

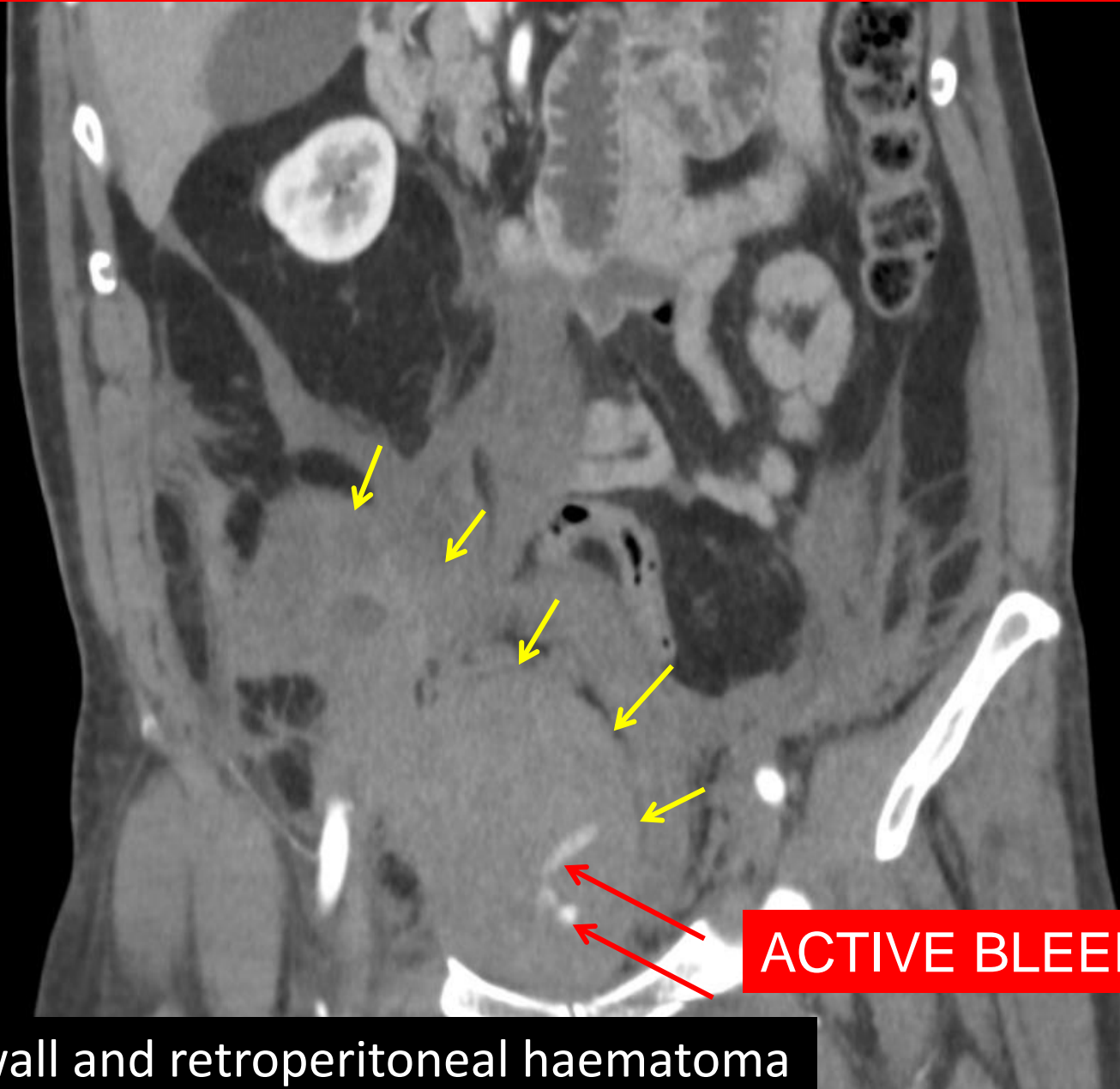
Pelvic sidewall and retroperitoneal haematoma

Learning Points:

- **Beware anticoagulation with DOACs** (direct oral anticoagulation, Factor Xa inhibitor, patient will bleed, and bleed, and bleed)
- **Beware elderly** 8 x risk of significant pelvic bleeding > younger adults

Corona Mortis artery, obturator to external iliac artery anastomosis

CASE 4



ACTIVE BLEEDING

Pelvic sidewall and retroperitoneal haematoma

Learning Points:

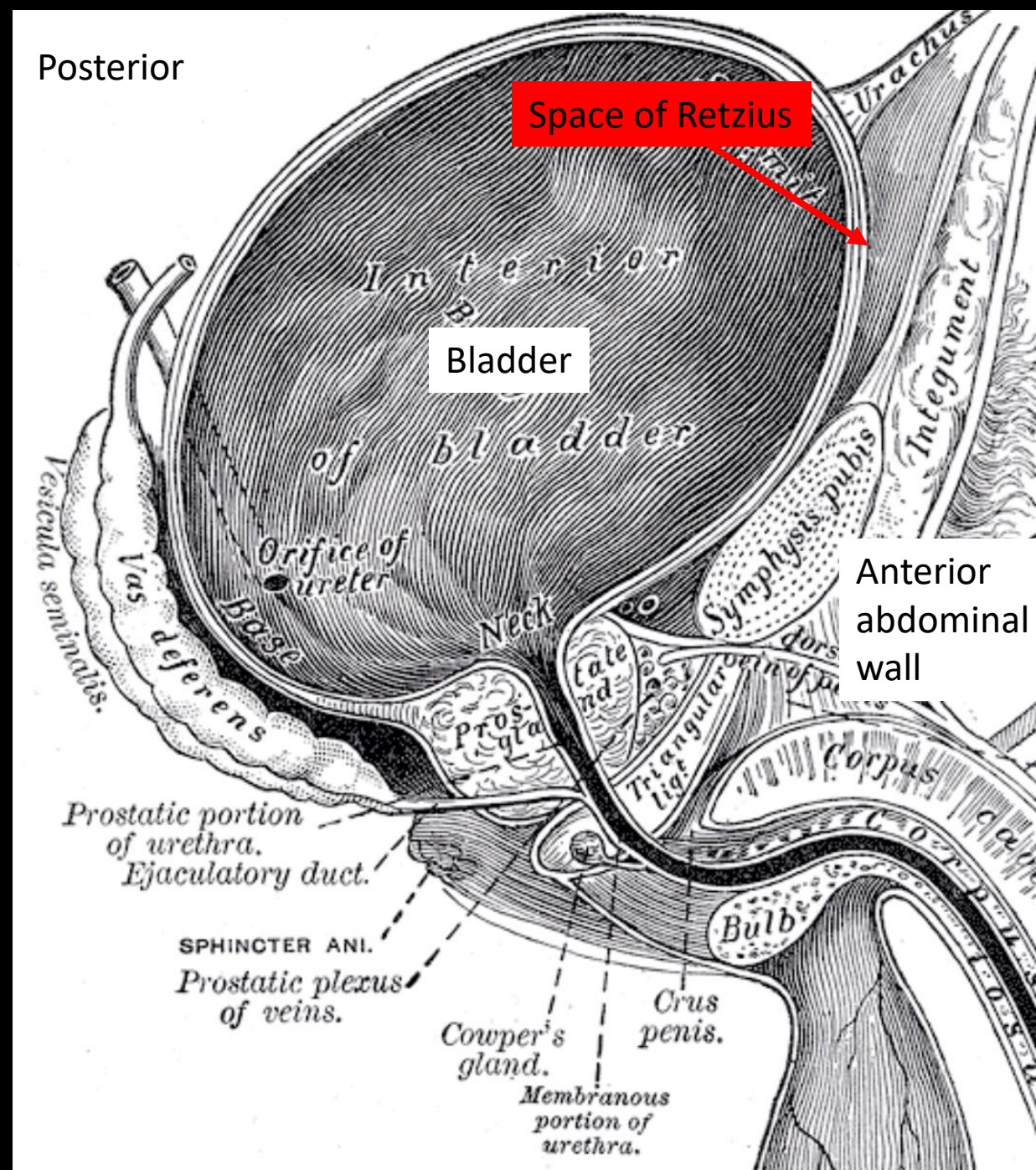
- **Beware anticoagulation with DOACs** (direct oral anticoagulation, Factor Xa inhibitor, patient will bleed, and bleed, and bleed)
- **Beware elderly** 8 x risk of significant pelvic bleeding > younger adults
- **Beware Corona Mortis artery** – if present, high risk of bleeding +++++

Checklist

1. Binder
2. Bleeding
 - Haematoma volume
 - Active bleeding
3. Anterior abdominal wall
4. Bladder and urethra
5. Perineum (vagina)
6. Anorectum
7. Nerves (lumbosacral plexus, sciatic nerve, obturator nerve)
8. External muscles and soft tissues

Learning Points

- Be able to differentiate between intra and extraperitoneal blood
- Space of Retzius (anterior to the bladder) is EXTRAPERITONEAL
- Space of Retzius can fill up with +++ blood
- Blood can spread to perineum



High Energy Injury

CASE 5

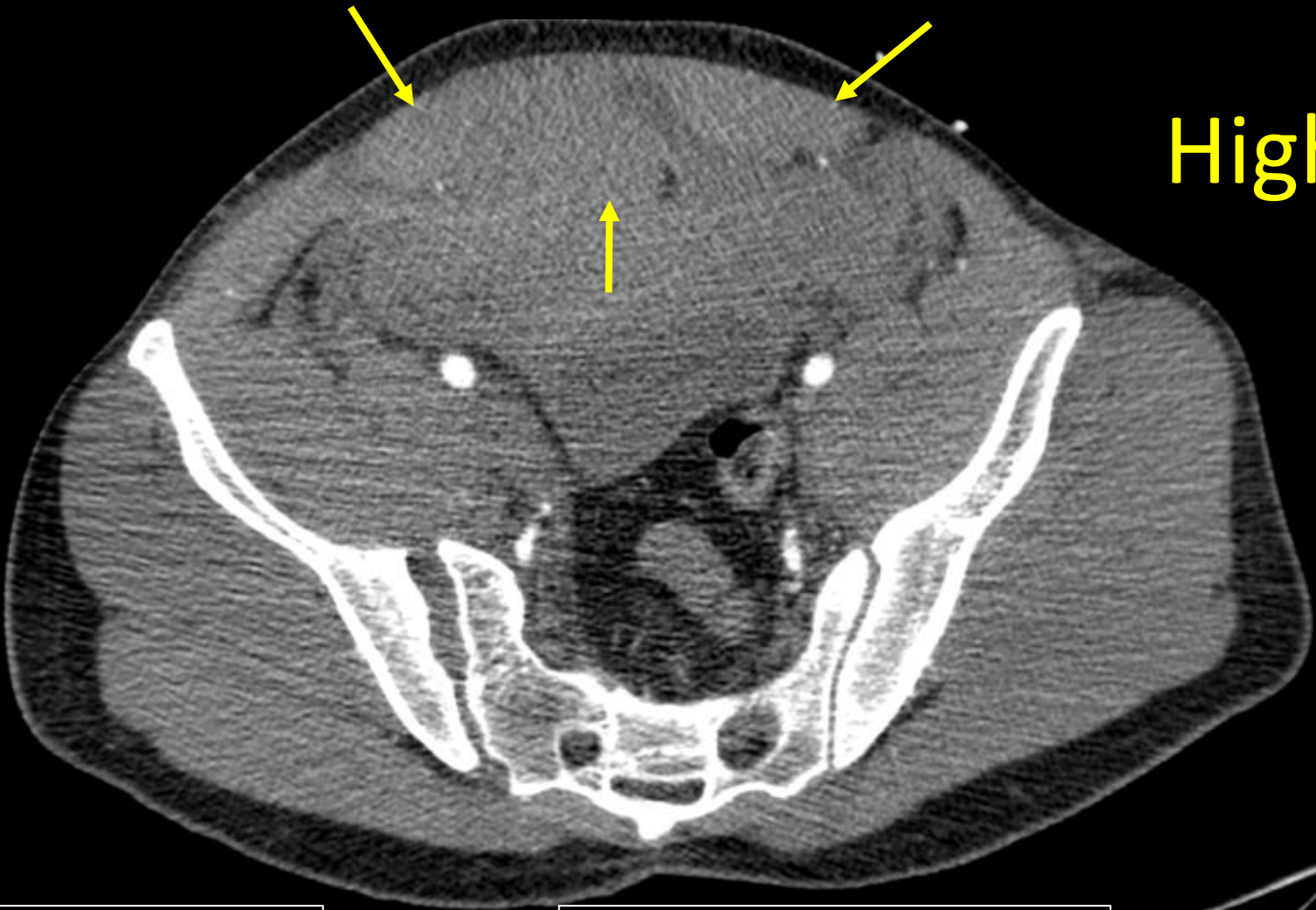


ARTERIAL PHASE

Unstable Pelvis
R Sacroiliac Joint wide

High Energy Injury

CASE 5



ARTERIAL PHASE

Unstable Pelvis
R Sacroiliac Joint wide

CASE 5



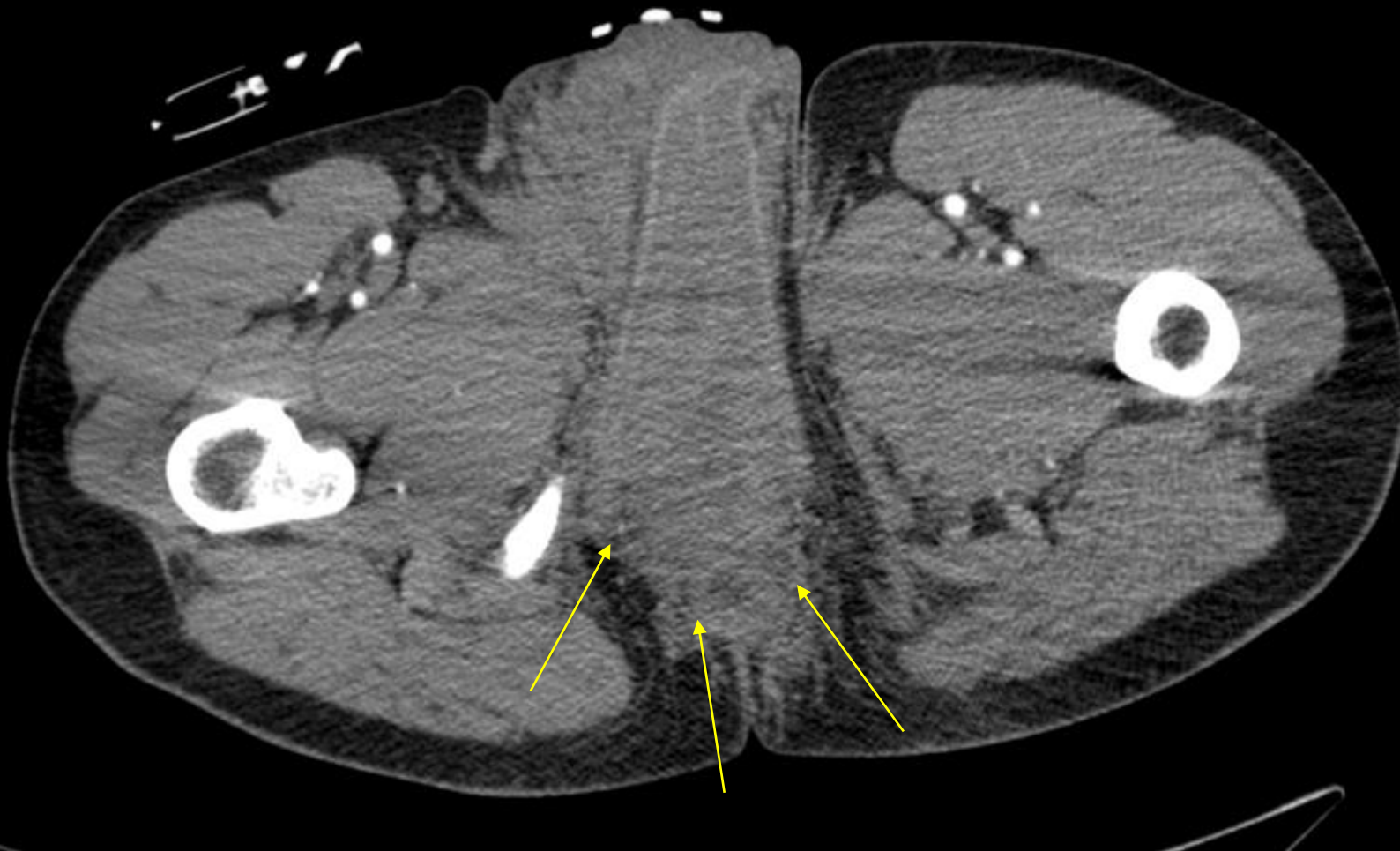
Haematoma –Anterior abdominal wall & space of Retzius

CASE 5



Haematoma –Anterior abdominal wall & space of Retzius

CASE 5



Scrotal haematoma, ischiocavernosus muscle haematoma

Checklist

1. Binder
2. Bleeding
 - Haematoma volume
 - Active bleeding
3. Anterior abdominal wall
4. Bladder and urethra
5. Perineum (vagina)
6. Anorectum
7. Nerves (lumbosacral plexus, sciatic nerve, obturator nerve)
8. External muscles and soft tissues

Urethral Injury

- Assoc w anterior & pubic bone injuries
- Important to identify anatomical site and partial/complete urethral transection
- Signs of Urethral Injury on CT: loss of normal fat planes, muscle haematoma
- Retrograde urethrography

Normal Anatomy Pre-prostatic fat

In-filling of pre
prostatic fat?
Consider
urethral injury



Ali, Safriel et al, CT signs of urethral injury, Radiographics 2003
Ramchandani Buckler, Imaging of GU Trauma, AJR 2009

Normal pre- prostate fat

In-filling of pre
prostatic fat?
Consider
urethral injury



Normal Anatomy

Ischiorectal fat
stranding/narrowed?
Consider urethral
injury

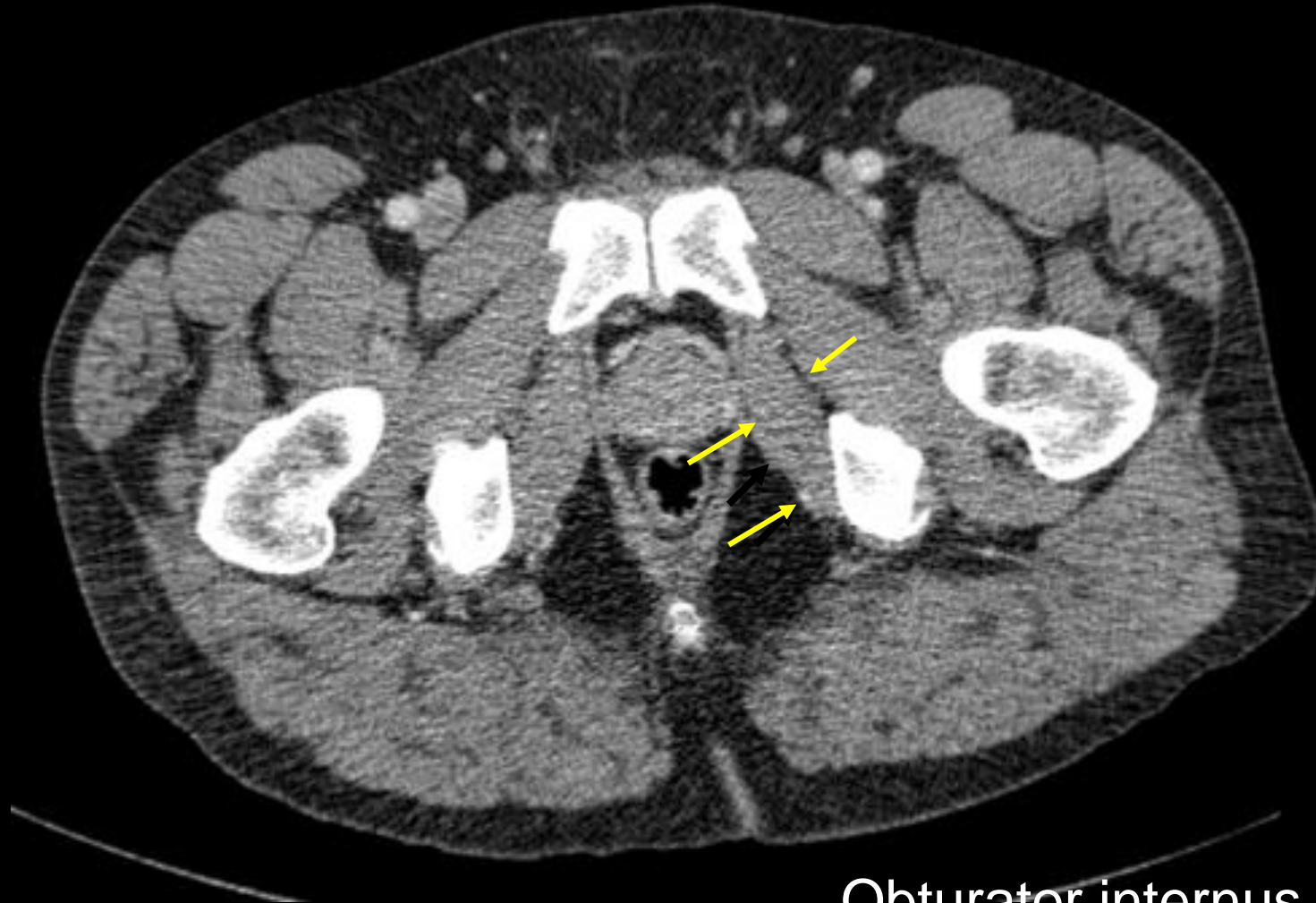


Puborectalis muscle

Urogenital diaphragmatic fat/ischiorectal fat

Normal Anatomy – Obturator Internus Muscle

Obturator internus expanded?
Consider urethral injury



Obturator internus

Normal Anatomy

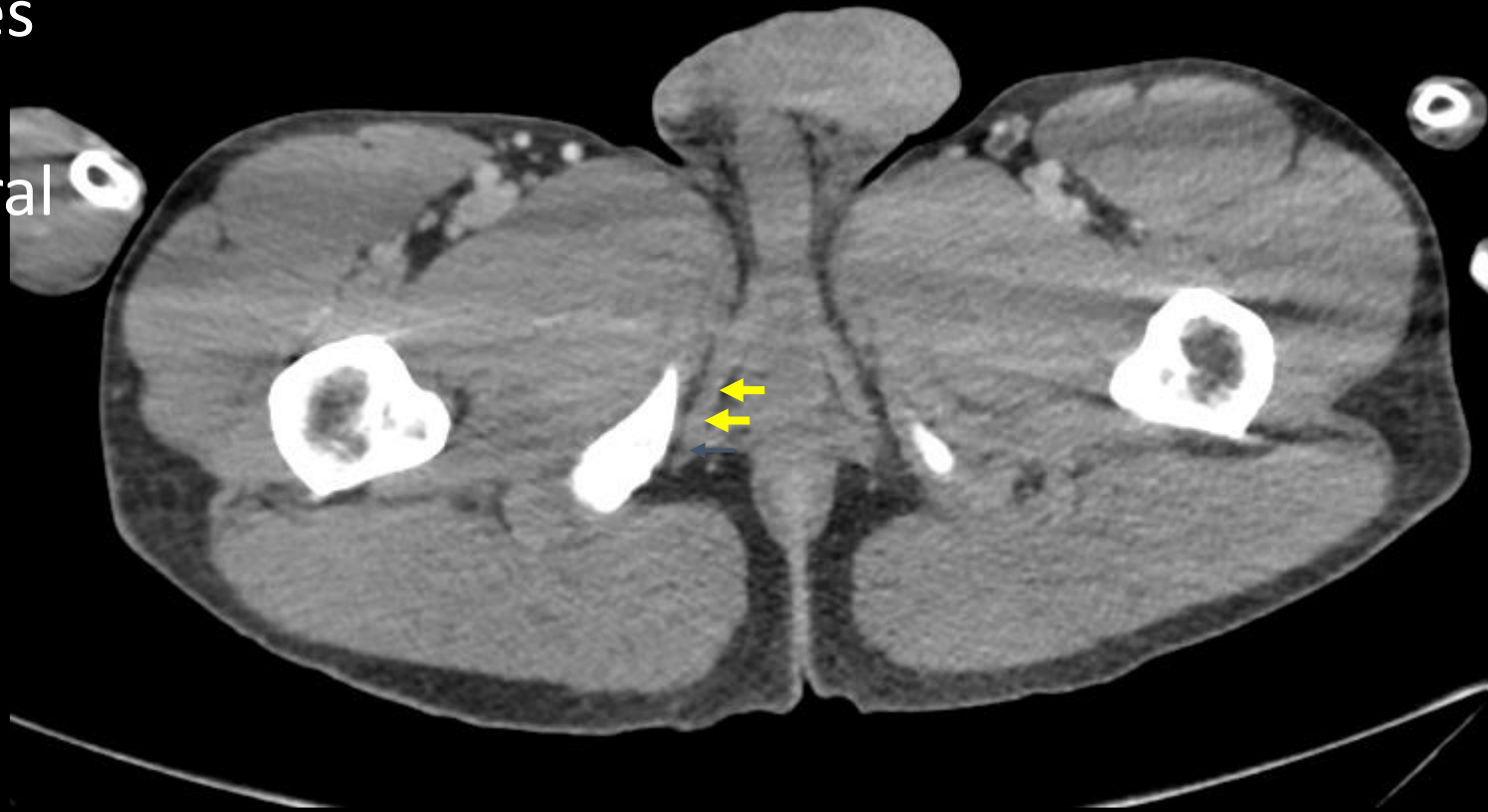
Perineal muscles
expanded?
Consider urethral
injury



Ali, Safriel et al, CT signs of urethral injury, Radiographics 2003
Ramchandani Buckler, Imaging of GU Trauma, AJR 2009

Normal Anatomy

Perineal muscles
expanded?
Consider urethral
injury



Ischiocavernosus muscle

Normal Anatomy

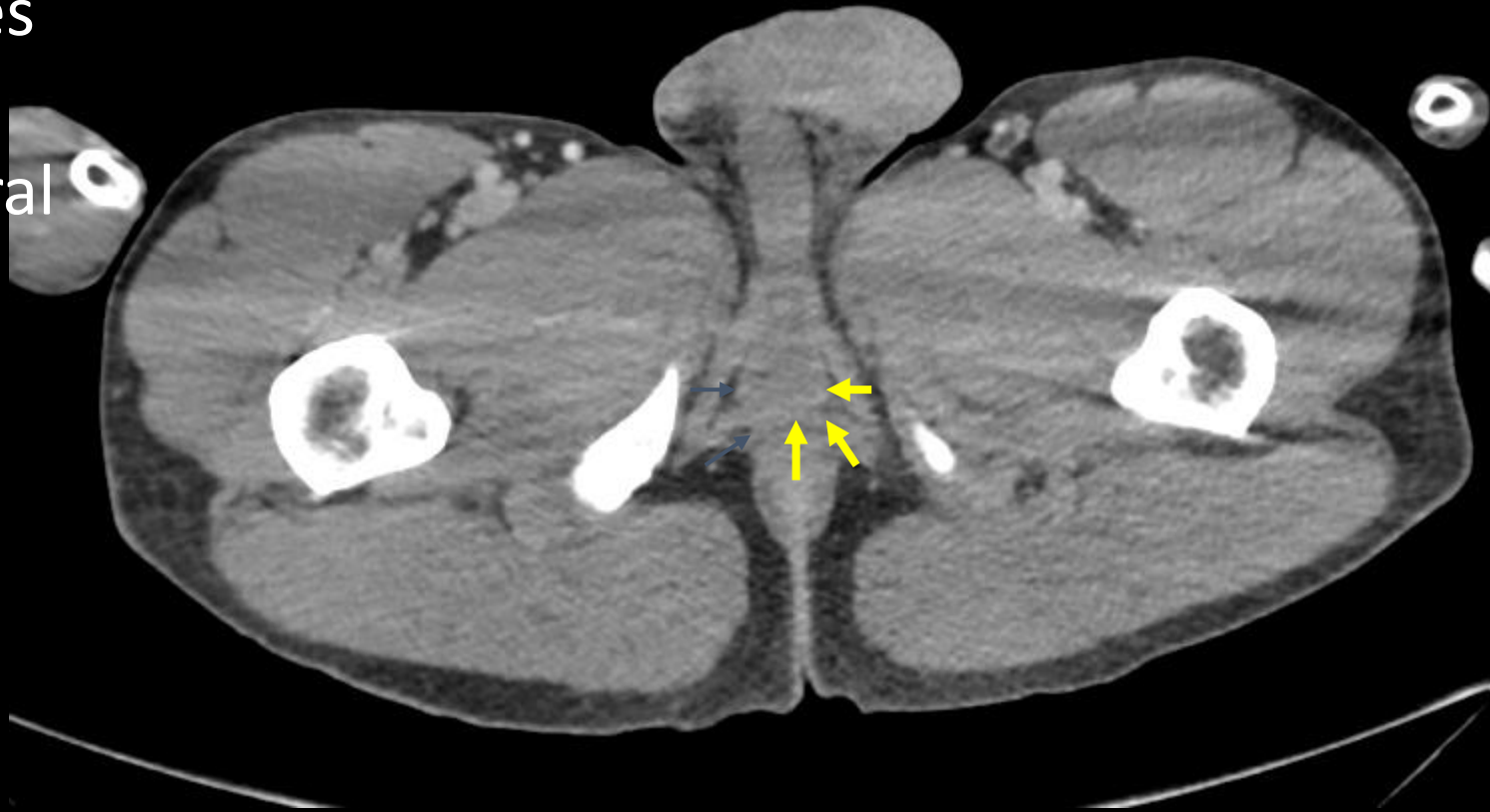
Perineal muscles
expanded?
Consider urethral
injury



Superficial transverse perineal muscle

Normal Anatomy

Perineal muscles
expanded?
Consider urethral
injury



Bulbospongiosa muscle surrounds bulb

Normal Anatomy

Learning Point: Use fat plane obliteration and pelvic muscle haematoma to pick up urethral injury



Bulbospongiosa muscle surrounds bulb

Urethrogram Anatomy

CASE 6

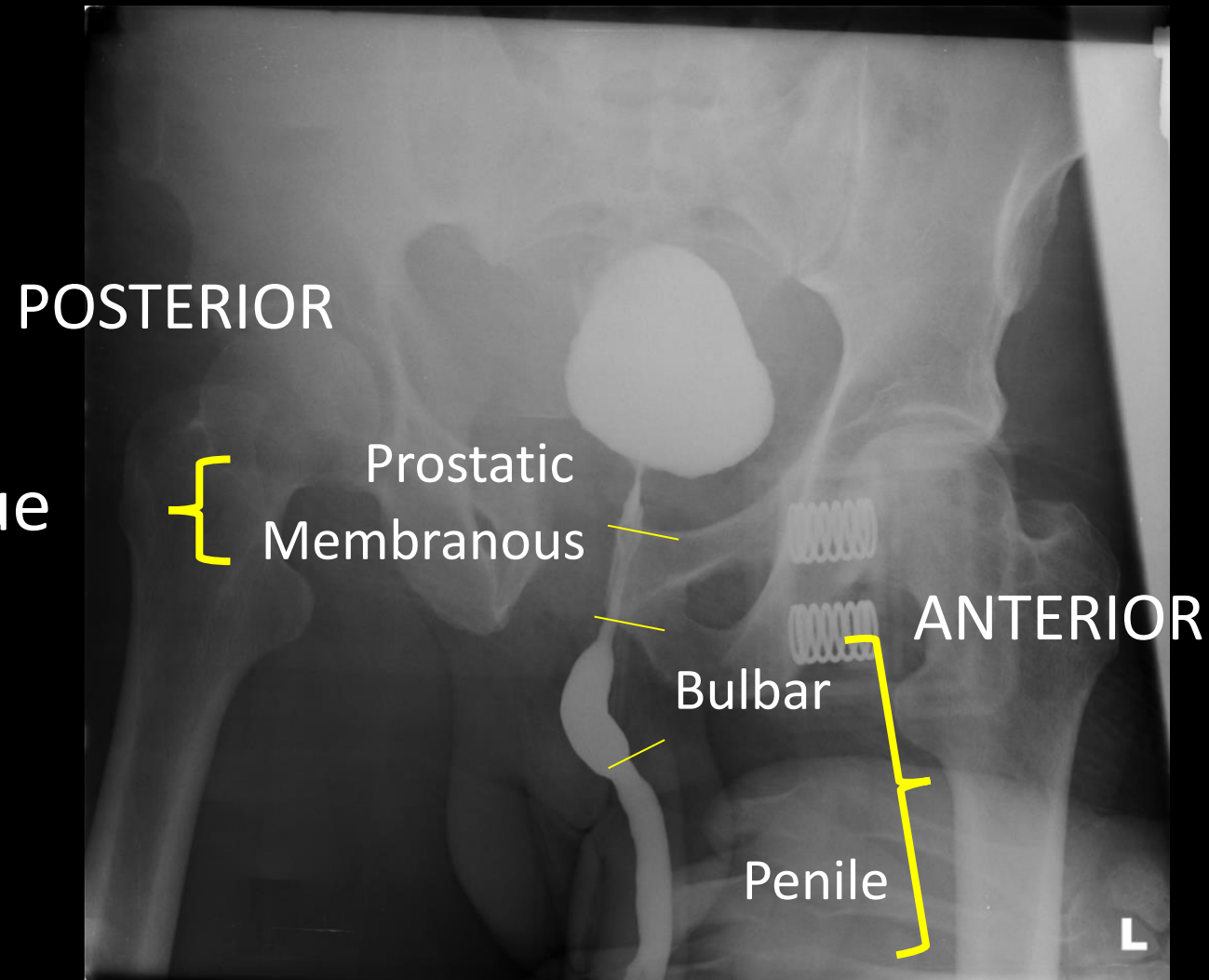
- Open book fracture
- Elongated Stretched Urethra due to pelvic side wall haematoma
- No urethral rupture



Urethrogram Anatomy

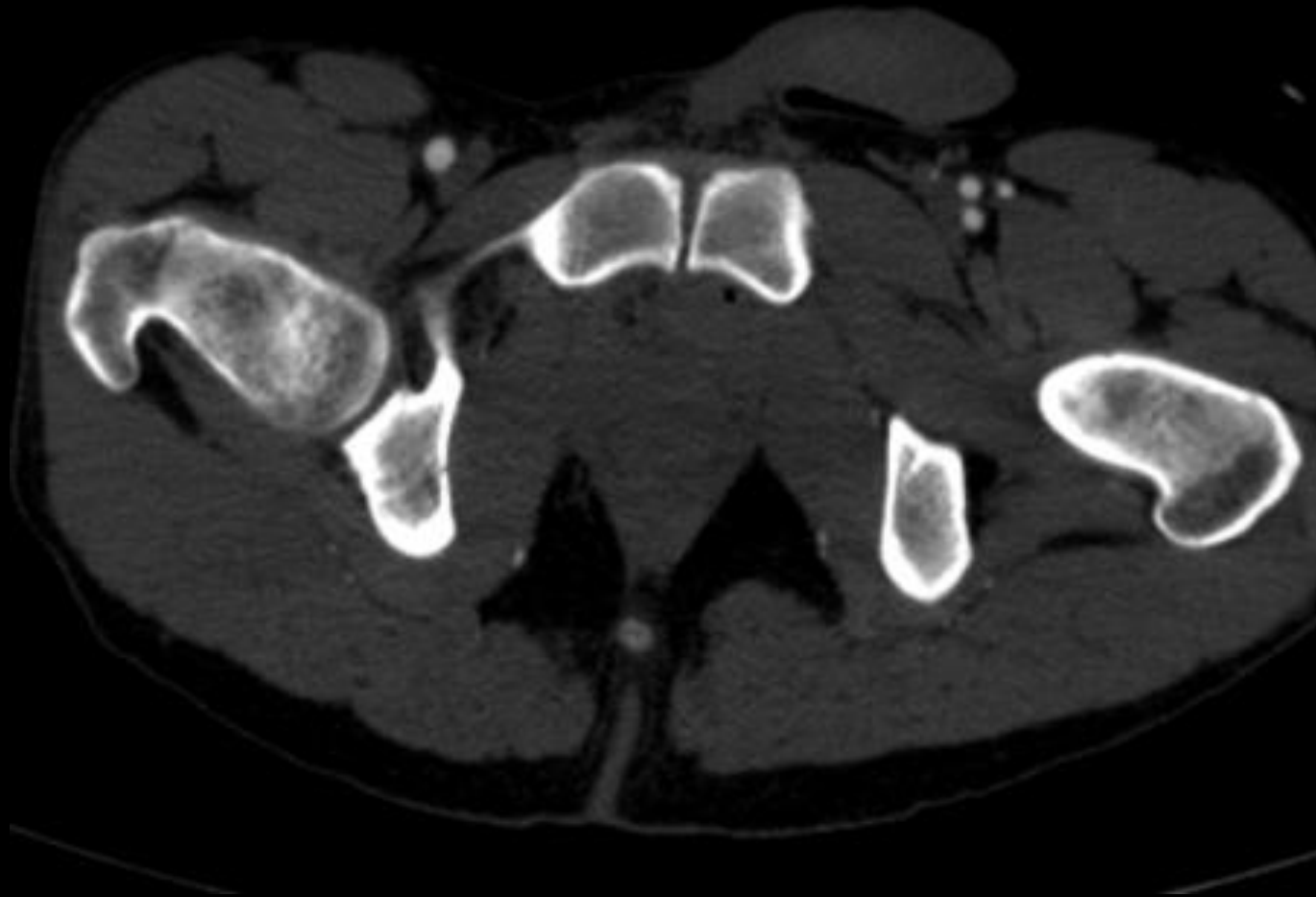
CASE 6

- Open book fracture
- Elongated Stretched Urethra due to pelvic side wall haematoma
- No urethral rupture



Pt #: ? Urethral injury –Motorbike accident

CASE 7



- Right buttock and perineal injury

Pt #: ? Urethral injury –Motorbike accident

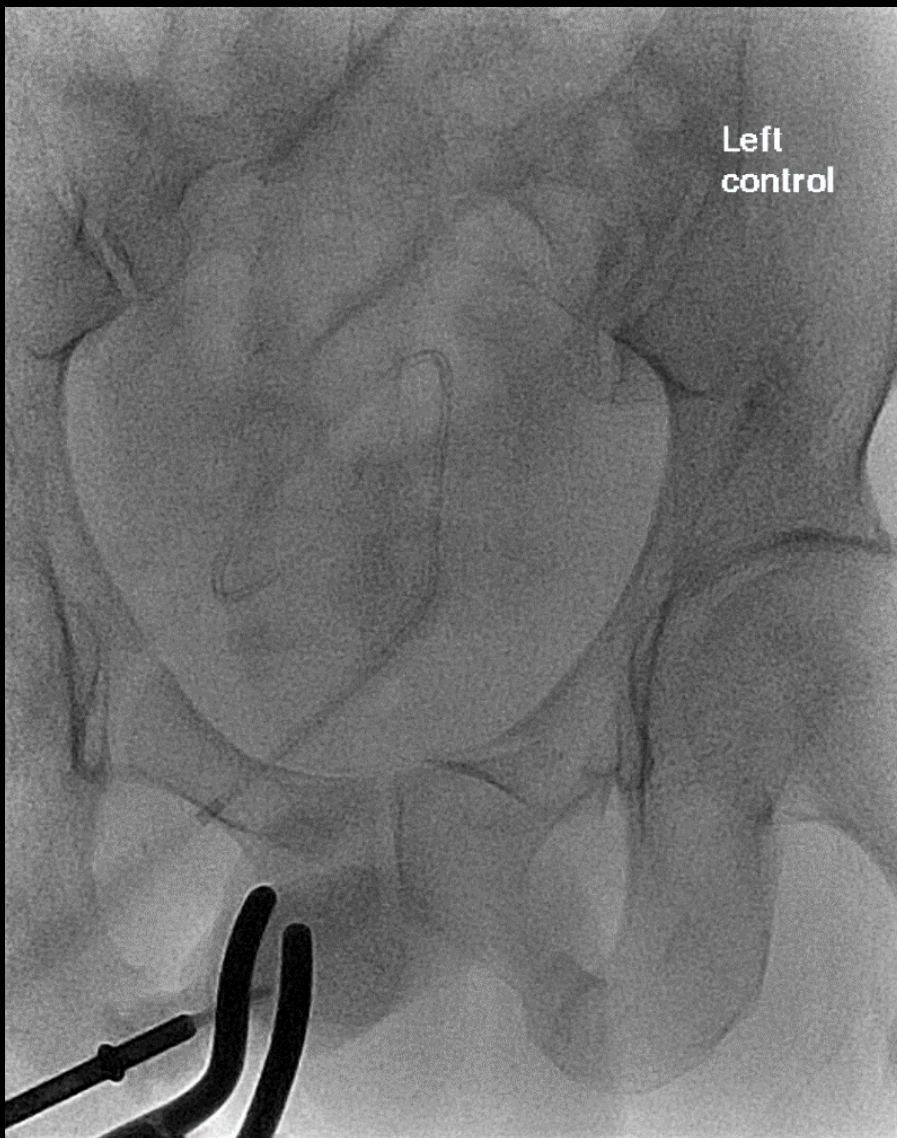
CASE 7



- Right buttock and perineal injury
- Pre-prostatic fat infilling
- Air pre-prostate
- Obturator Internus muscle haematoma

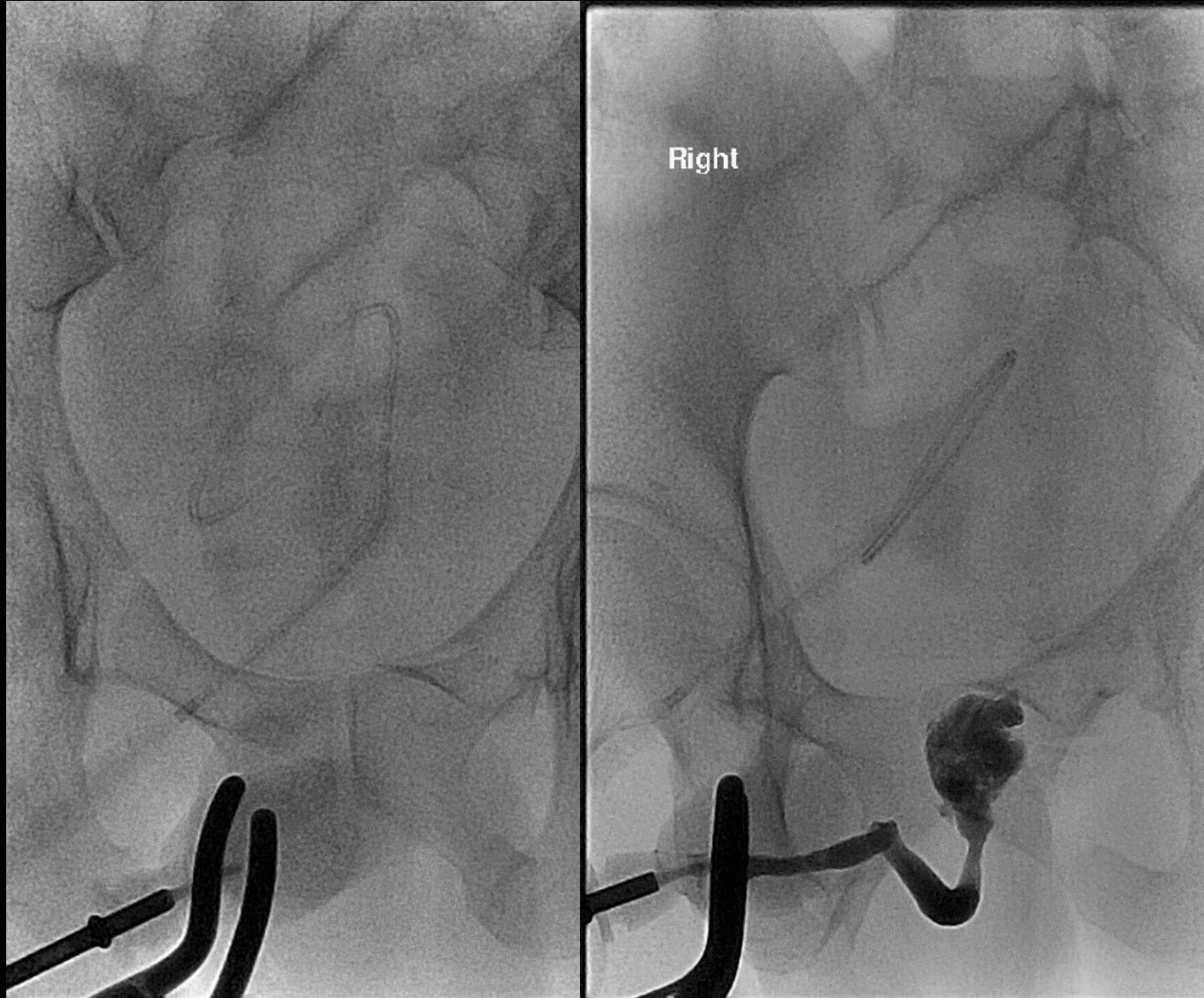
Urethrogram (suprapubic in situ)

CASE 7



Urethrogram (suprapubic in situ)

CASE 7



Where is the urethral rupture?

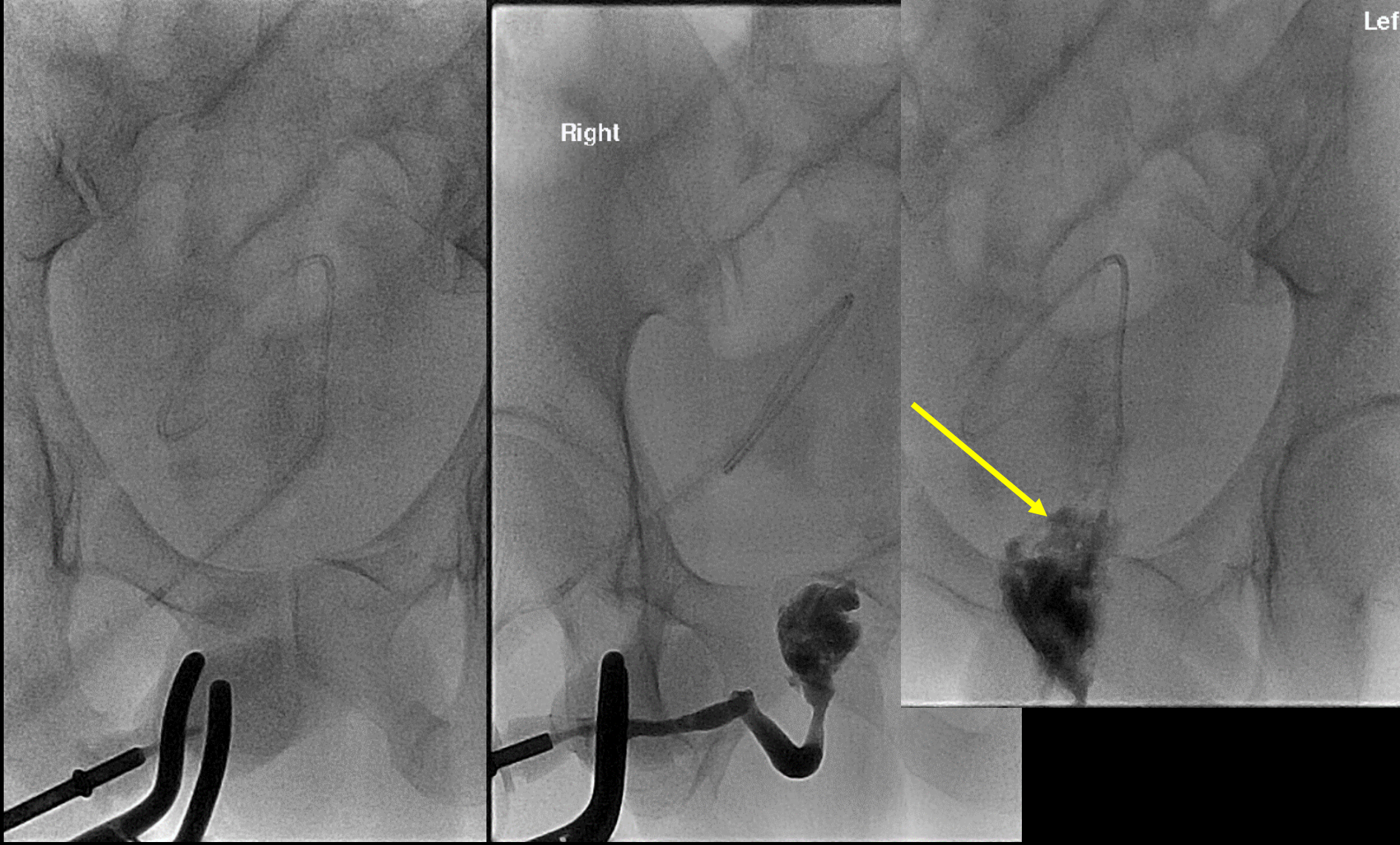


point to the the urethral rupture/ donde esta la lesion uretral

0

Contrast extravasation, prostatic urethra = rupture

CASE 7



Bladder

Checklist

1. Binder
2. Bleeding
 - Haematoma volume
 - Active bleeding
3. Anterior abdominal wall
4. Bladder and urethra
5. Perineum (including vagina)
6. Anorectum
7. Nerves (lumbosacral plexus, sciatic nerve, obturator nerve)
8. External muscles and soft tissues

Checklist

1. Binder
2. Bleeding
 - Haematoma volume
 - Active bleeding
3. Anterior abdominal wall
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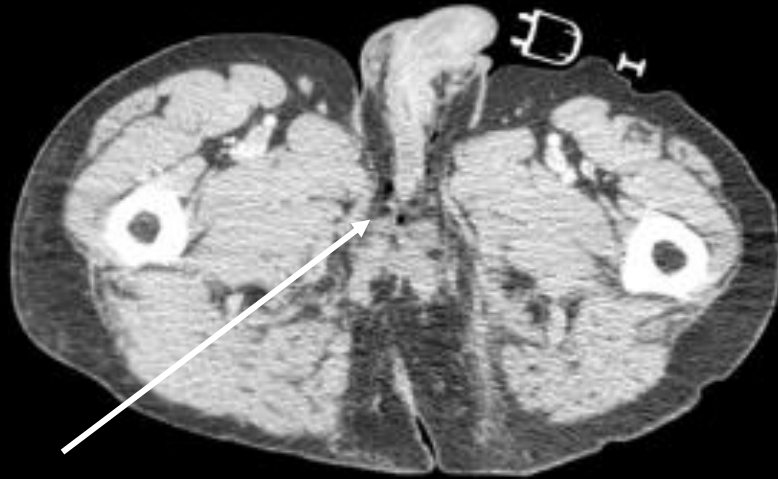
Anorectal injury

- Suspect in straddle injuries (eg motorcycle) – pelvic floor torn open

Leenen. Pelvic Fractures: Soft tissue Trauma E J Trauma Em Surg, 2010,

Collinge Tornetta Soft tissue injuries associated with pelvic fractures Orth Clin N Am 2004

Hit by Tram Perineal & Perirectal air & stranding



Perineal air & haematoma

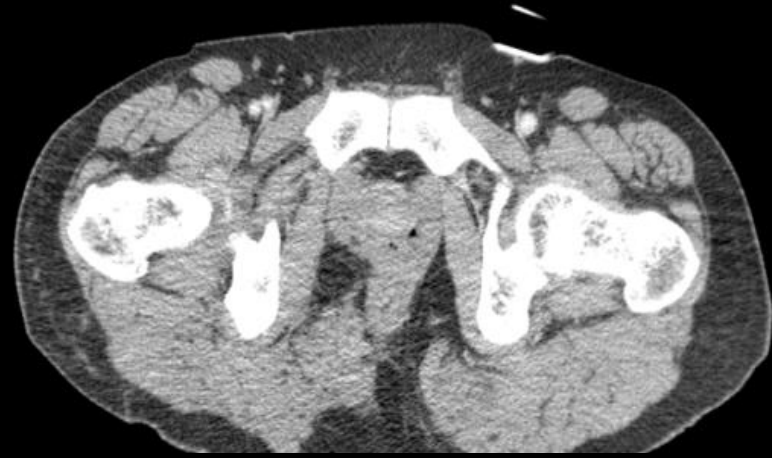
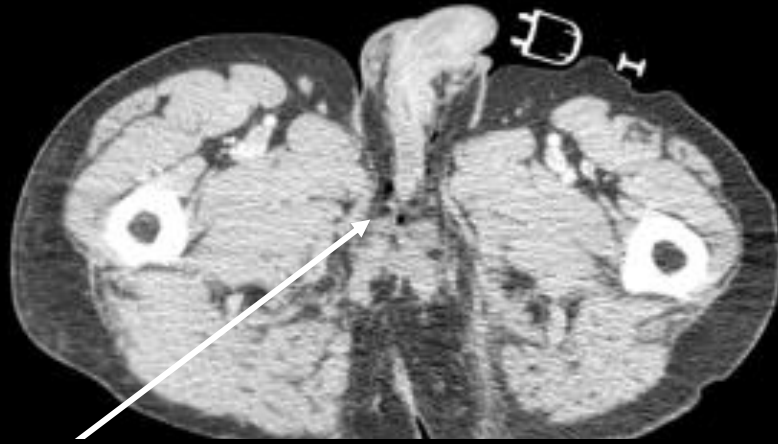


Stranding mesorectal fat



Ischiorectal fat haematoma

Perineal & Perirectal air & stranding



Learning Point: Rectal contrast will show anorectal breach

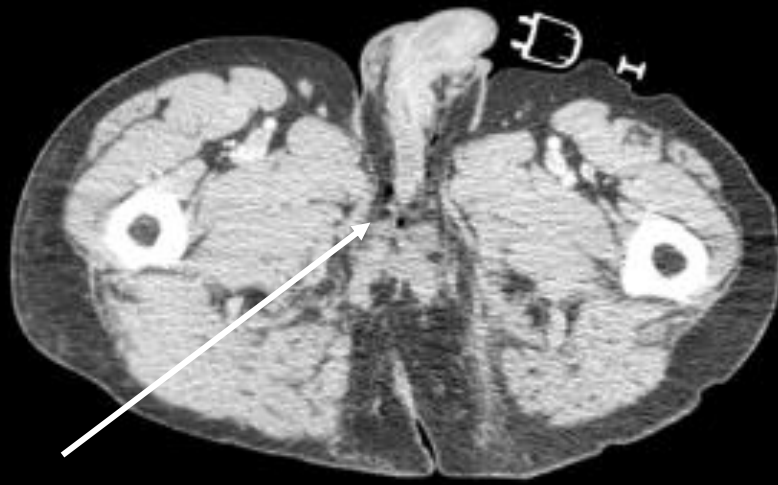


Ischioanal fat haematoma



Stranding mesorectal fat

Perineal & Perirectal air & stranding - Rx defunctioning stoma



Perineal air & haematoma



Ischioanal fat haematoma



Stranding mesorectal fat

What is the rationale for defunctioning colostomy (one correct answer only)? Por que le hicieron una colostomia

Easier to nurse patient in hospital/mas facil a la enfermera del paciente

0%

Avoids high risk of wound contamination by faeces/ riesgo de contaminacion fecal

0%

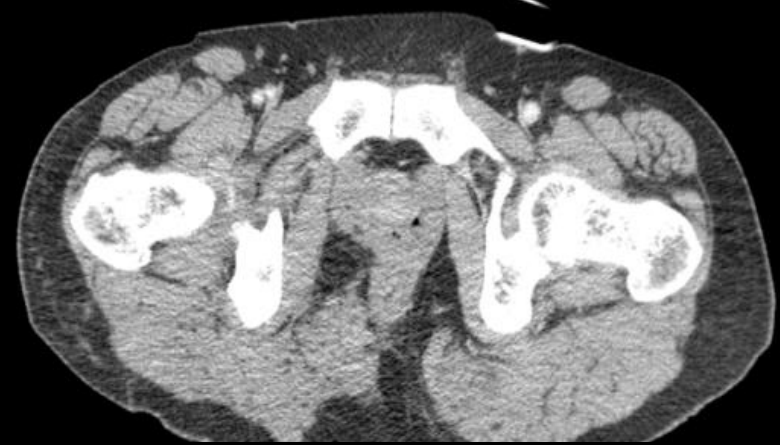
Patients prefer it/el paciente lo preferia

0%

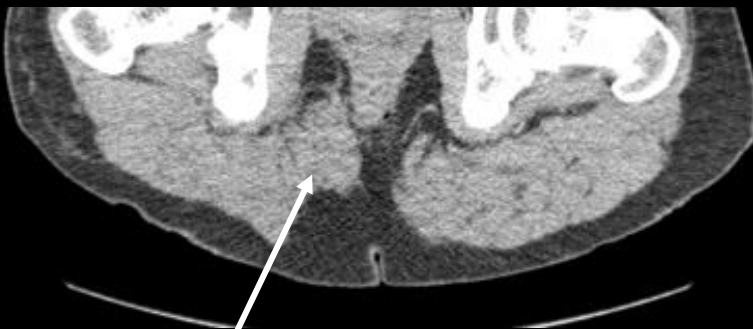
Avoids constipation/para evitar estreñimiento

0%

Perineal & Perirectal air & stranding - Rx defunctioning stoma



Learning Point: In anorectal and perineal injuries high risk (>70%) of secondary faecal contamination, therefore consider temporary diverting colostomy



Ischioanal fat haematoma

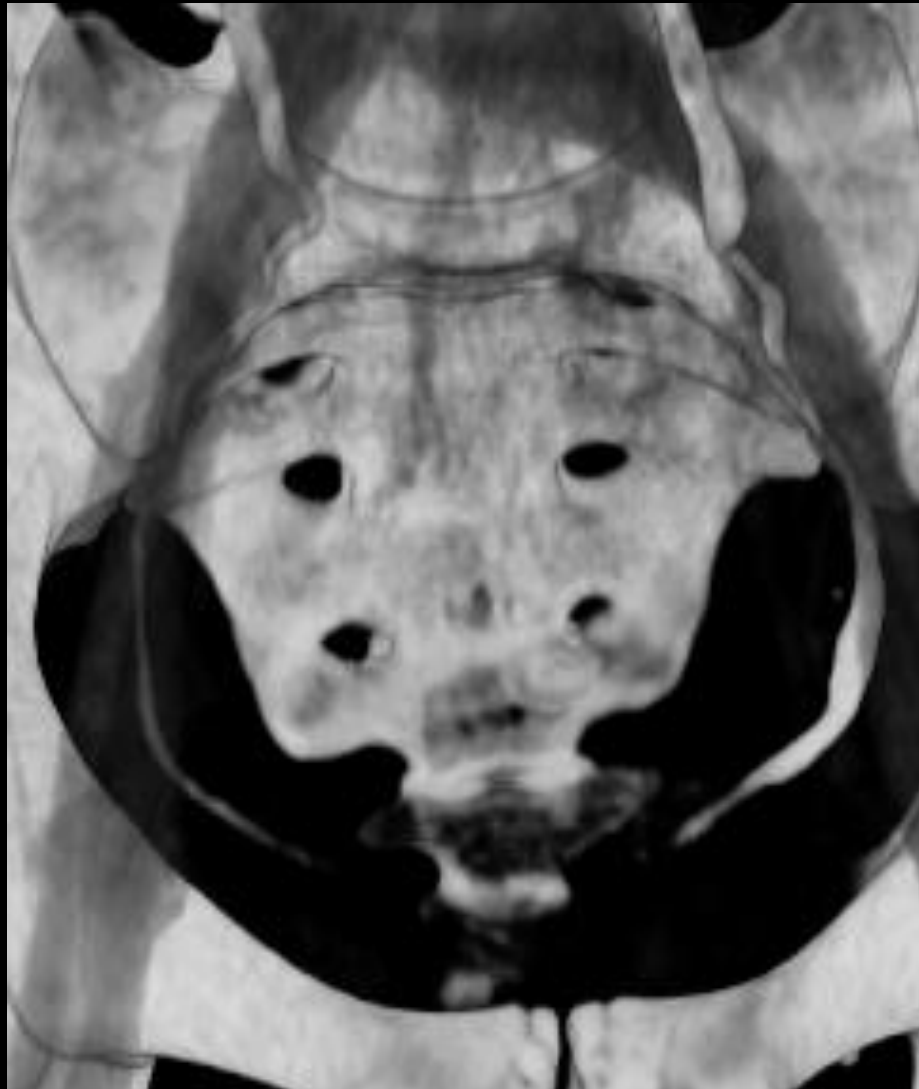


Stranding mesorectal fat

Checklist

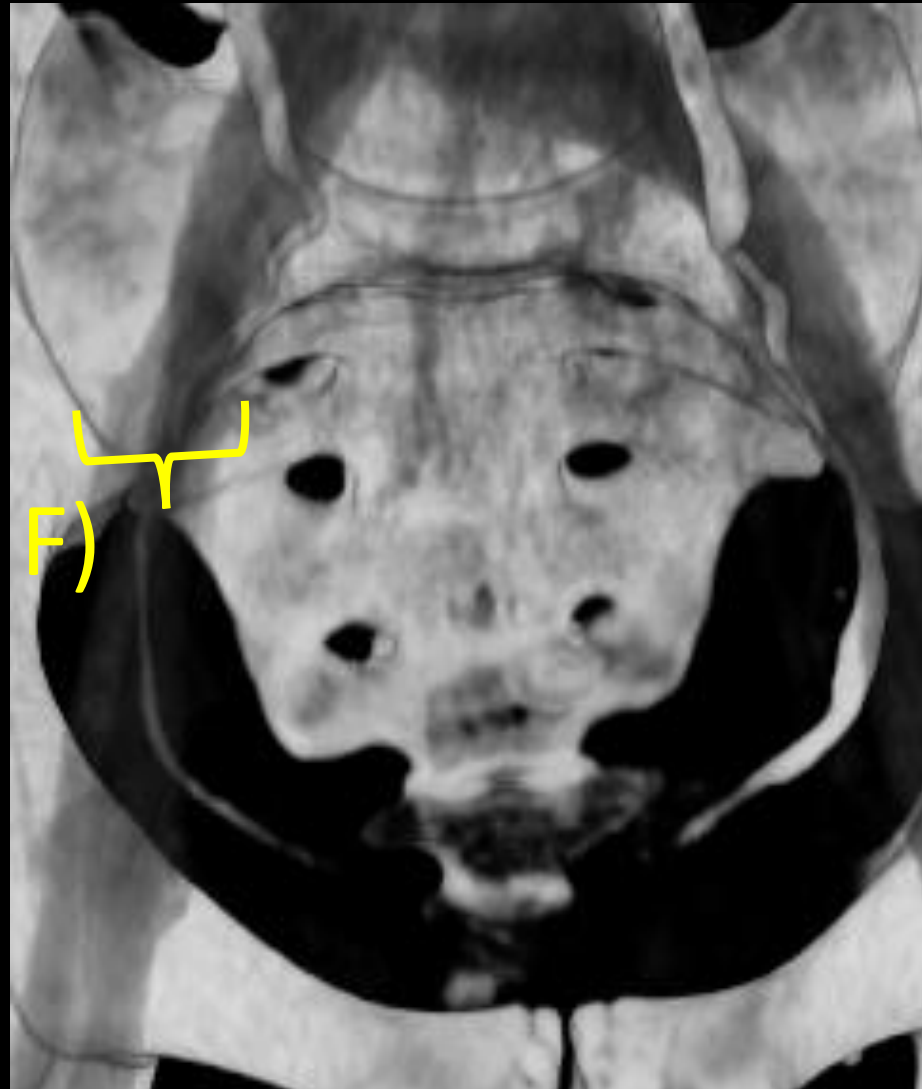
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Sacral fractures – Risk of sacral nerve or lumbosacral plexus injury



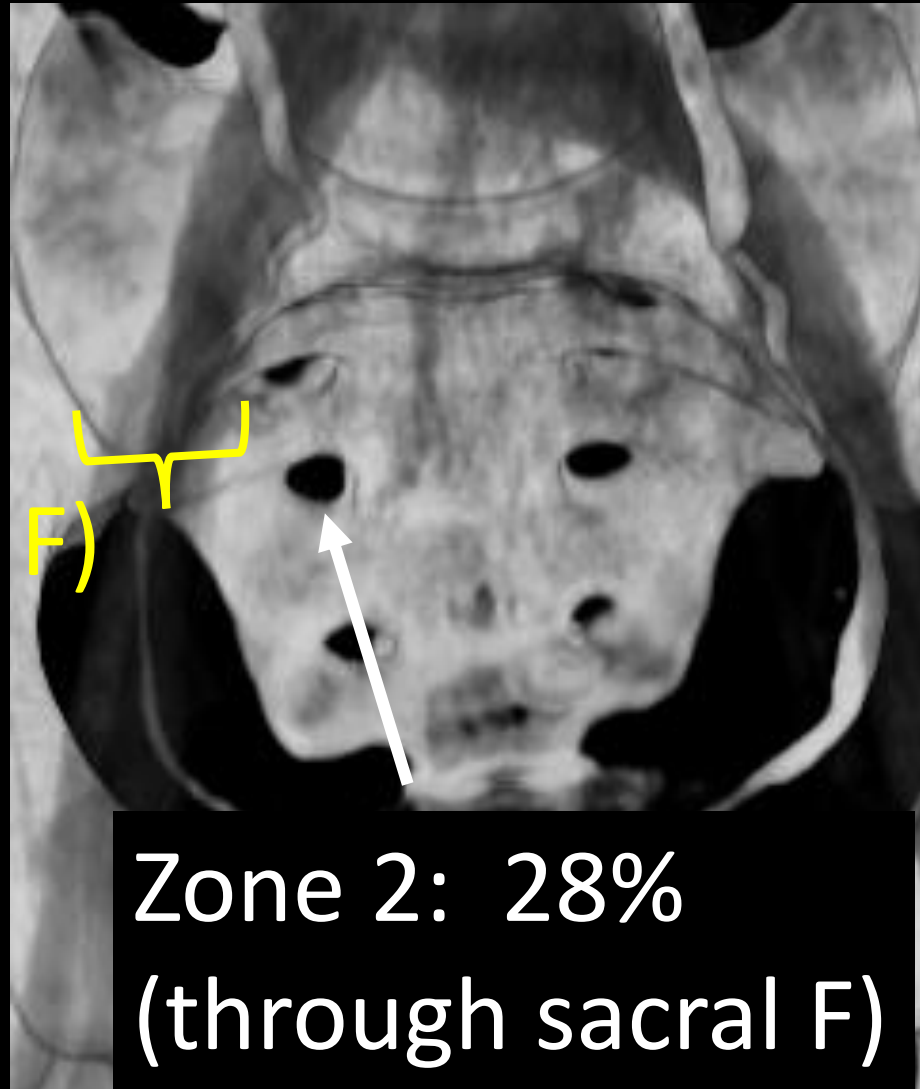
Sacral fractures – Risk of sacral nerve or lumbosacral plexus injury

Zone 1: 6%
(lat to sacral F)



Sacral fractures – Risk of sacral nerve or lumbosacral plexus injury

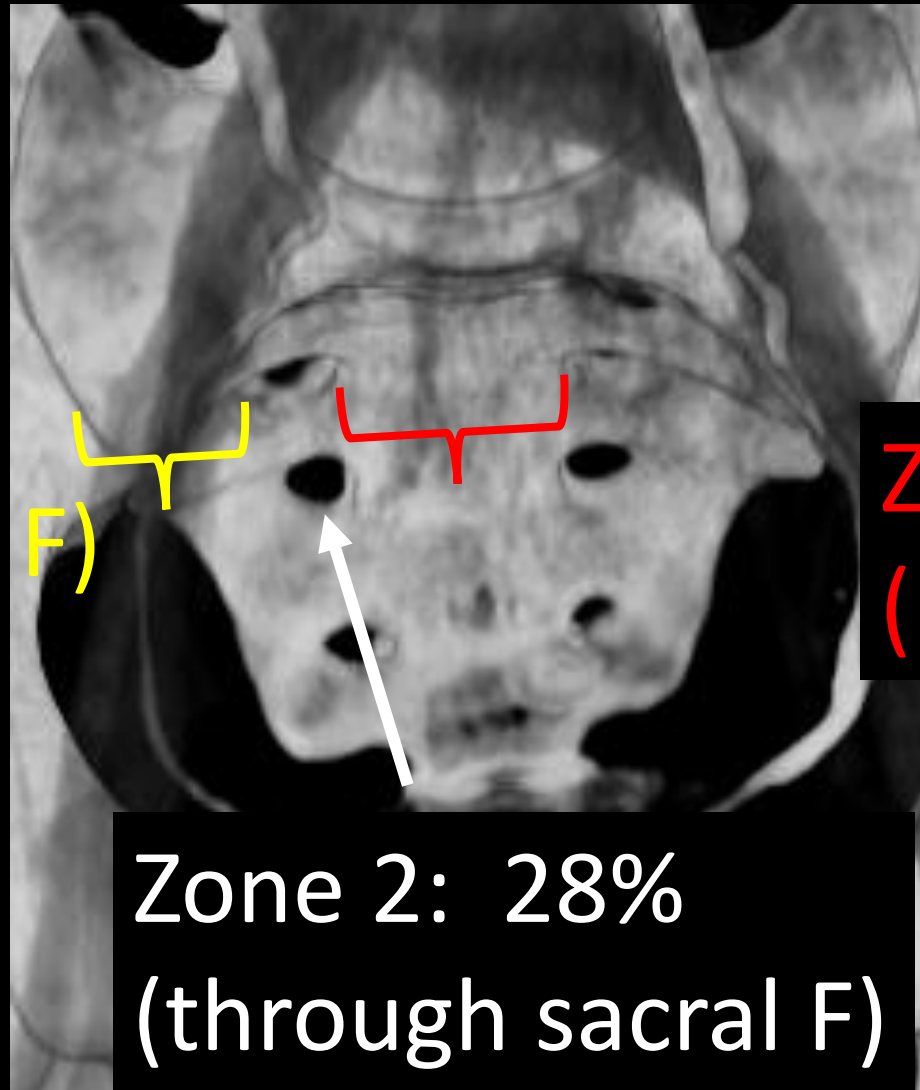
Zone 1: 6%
(lat to sacral F)



Zone 2: 28%
(through sacral F)

Sacral fractures – Risk of sacral nerve or lumbosacral plexus injury

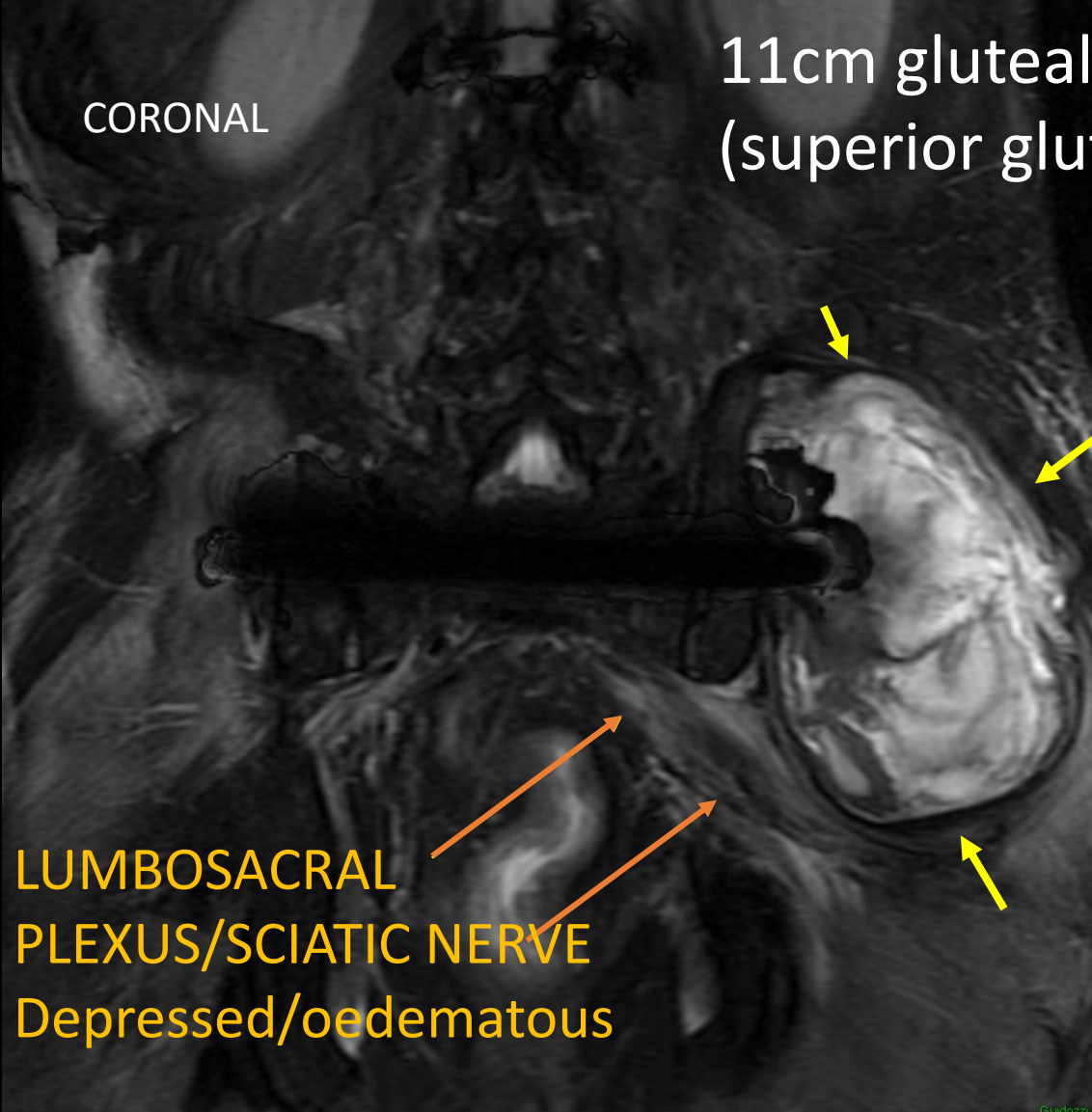
Zone 1: 6%
(lat to sacral F)



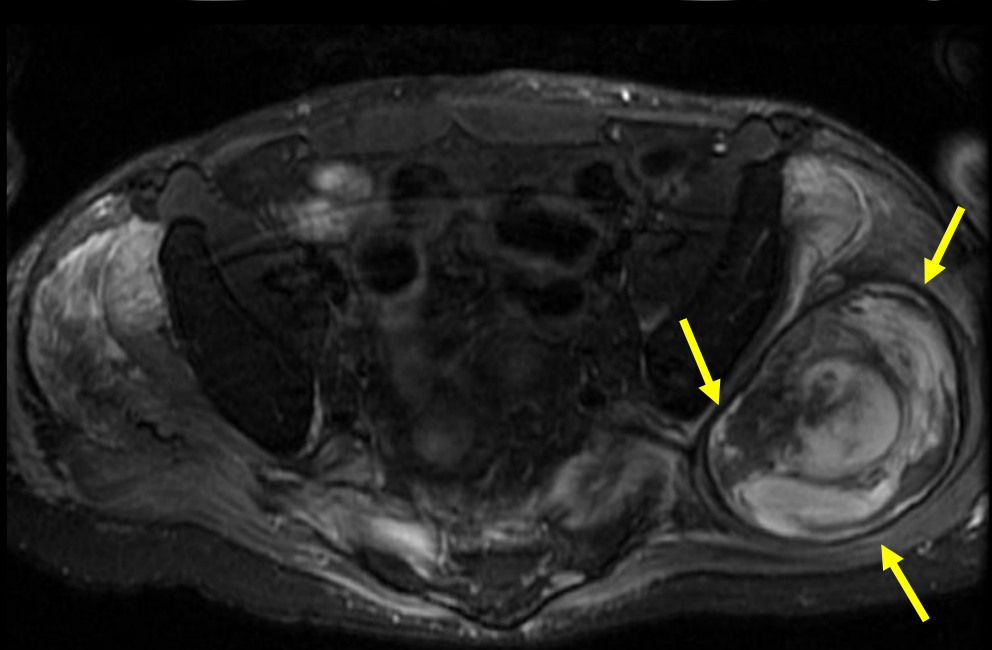
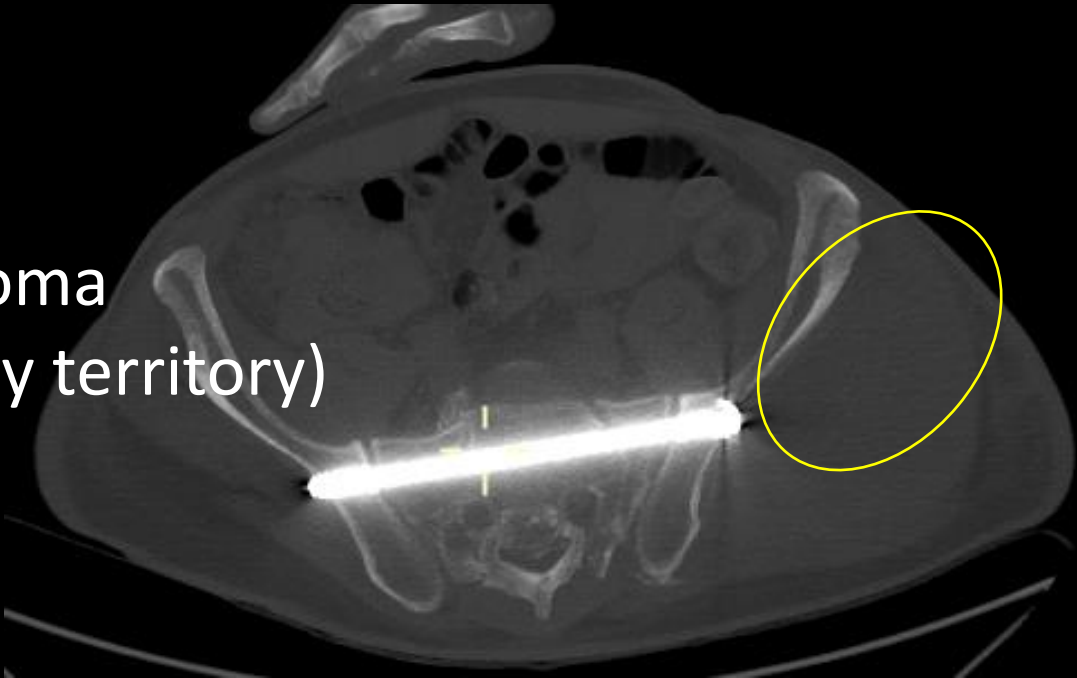
Zone 3: 50%
(medial to sacral F)

Zone 2: 28%
(through sacral F)

Left leg weakness

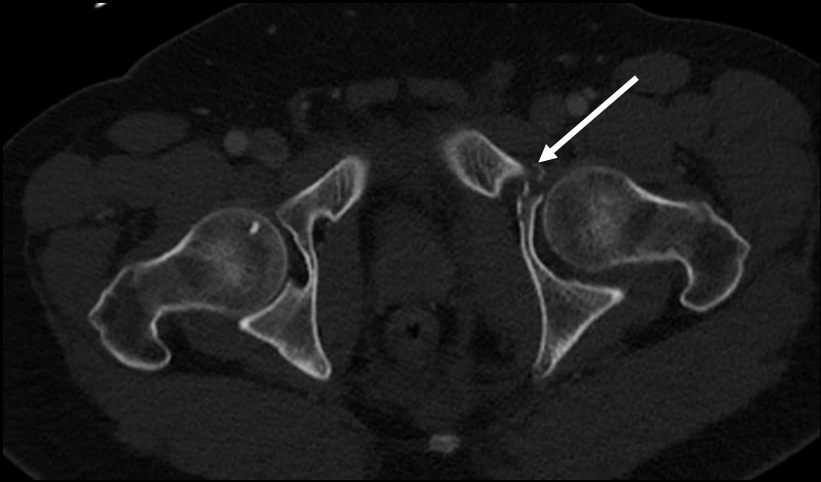


Coronal T2fatsat

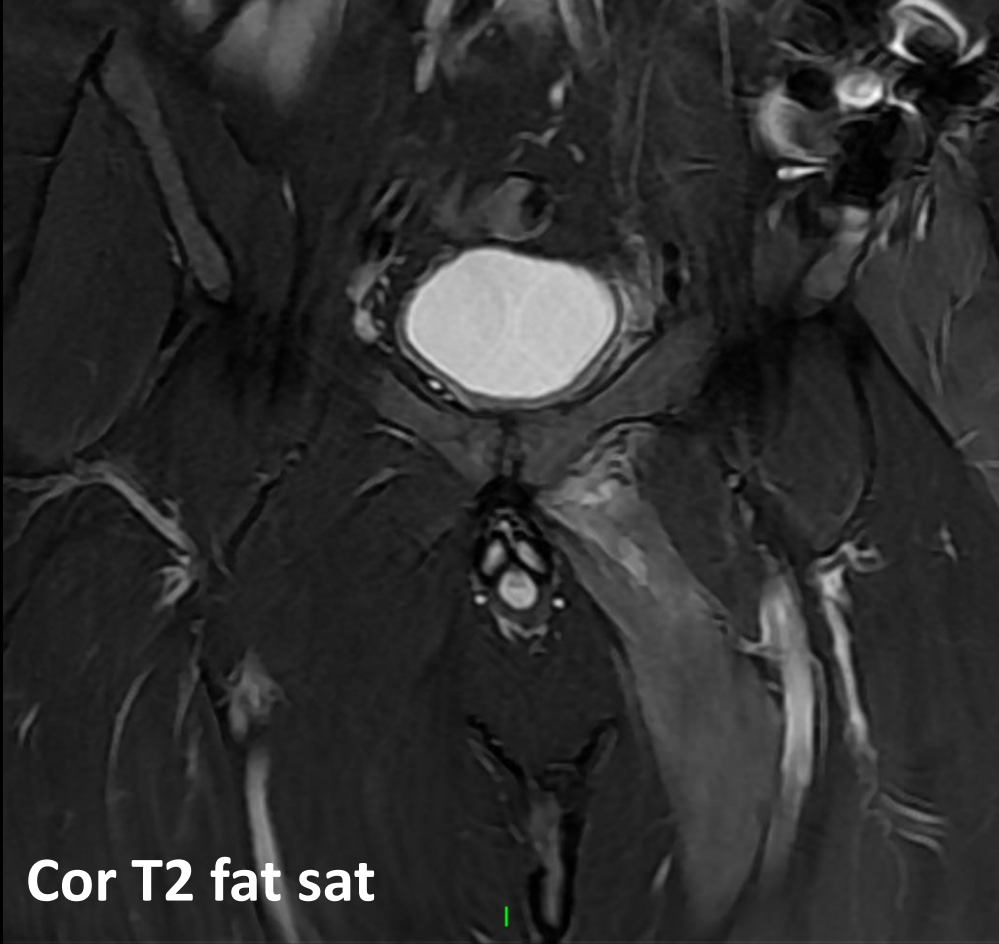
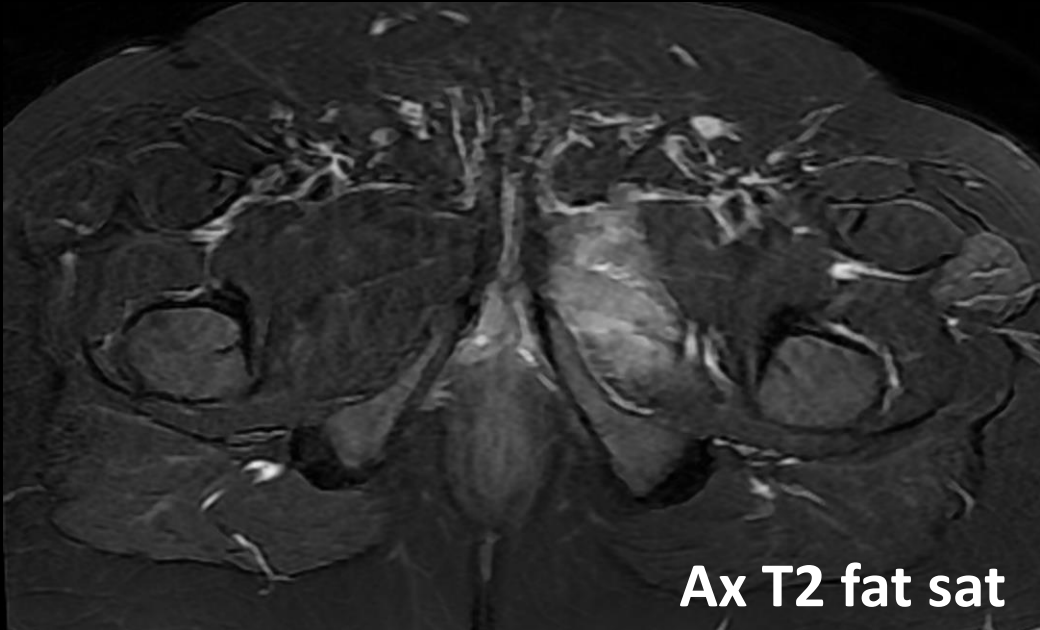
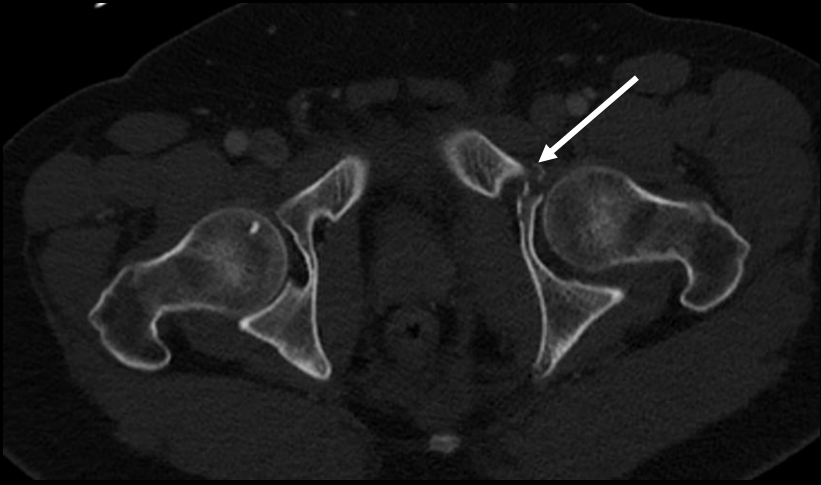


AX T2fatsat

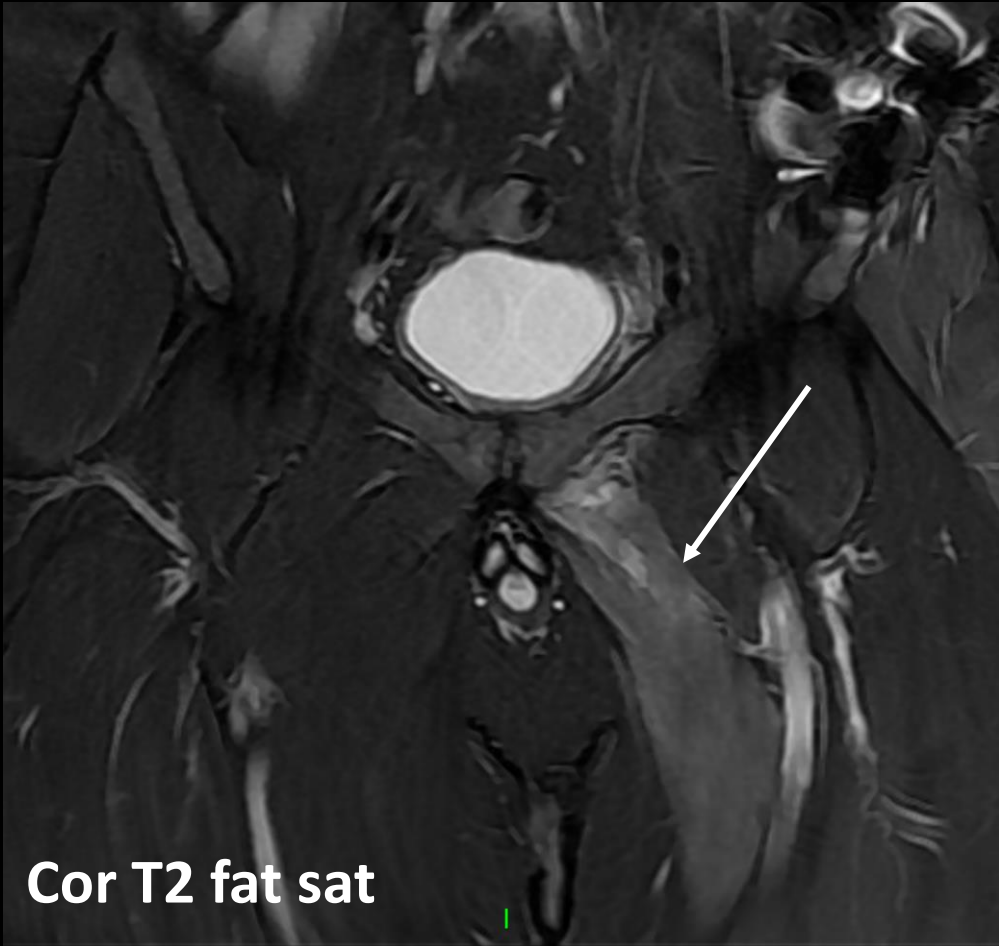
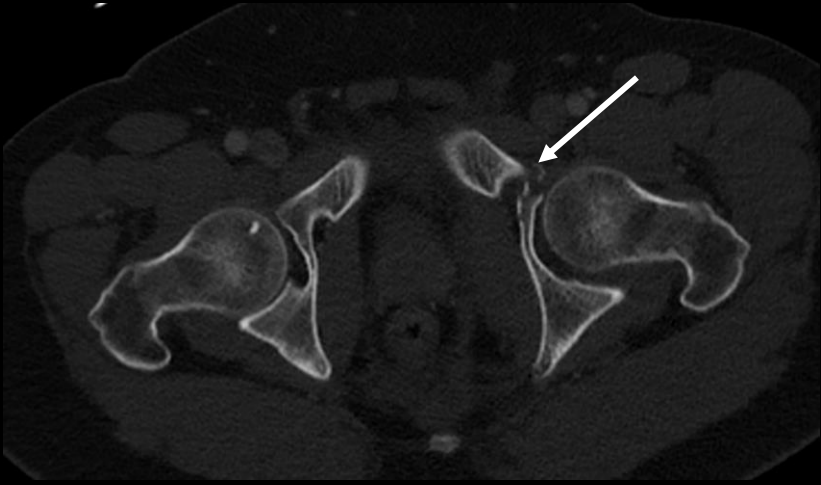
Left obturator foramen #. Obturator nerve damage & secondary muscle denervation



Left obturator foramen #. Obturator nerve damage & secondary muscle denervation

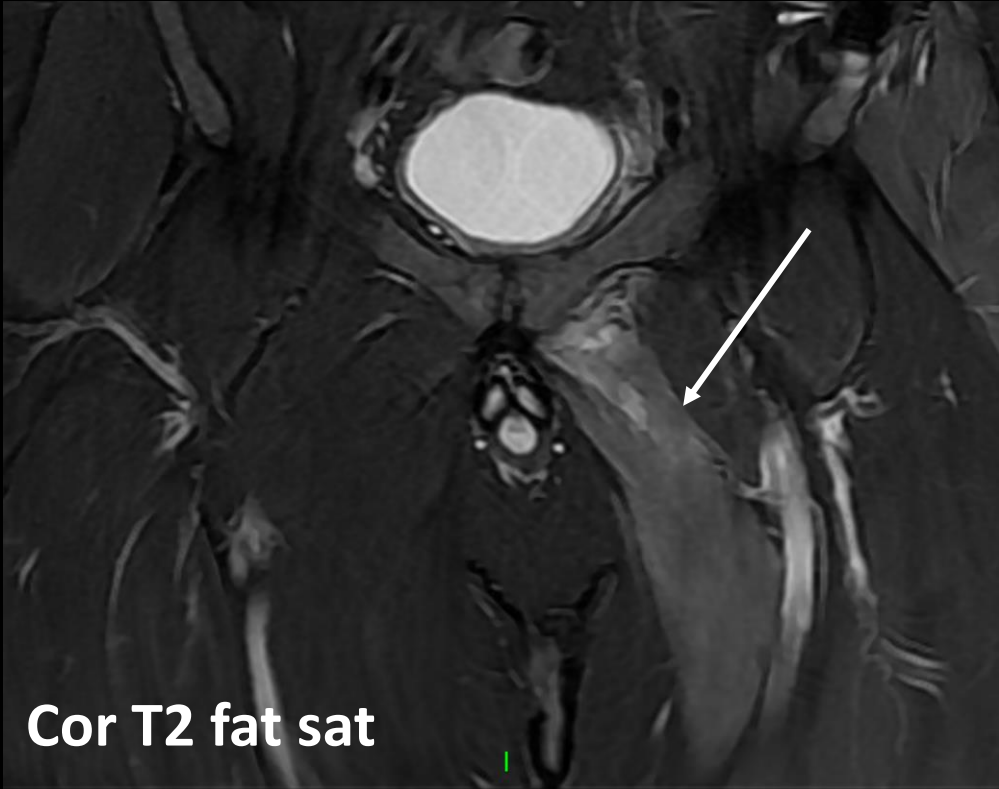
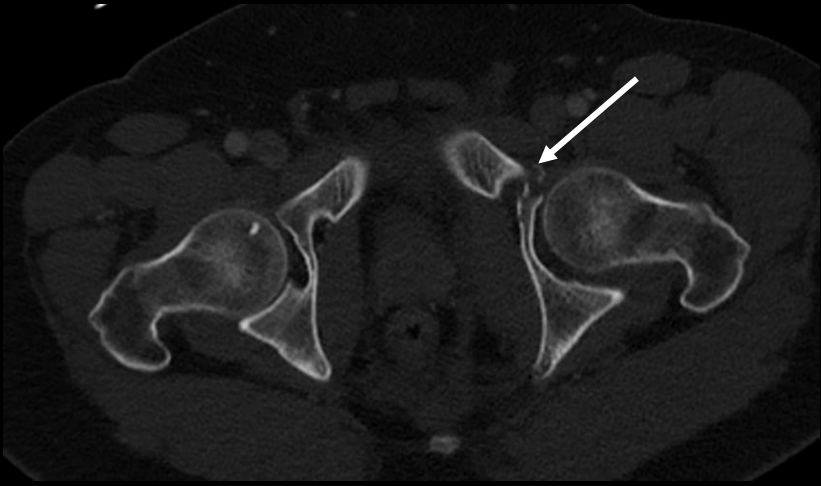


Left obturator foramen #. Obturator nerve damage & secondary muscle denervation



Left obturator foramen #. Obturator nerve damage & secondary muscle denervation

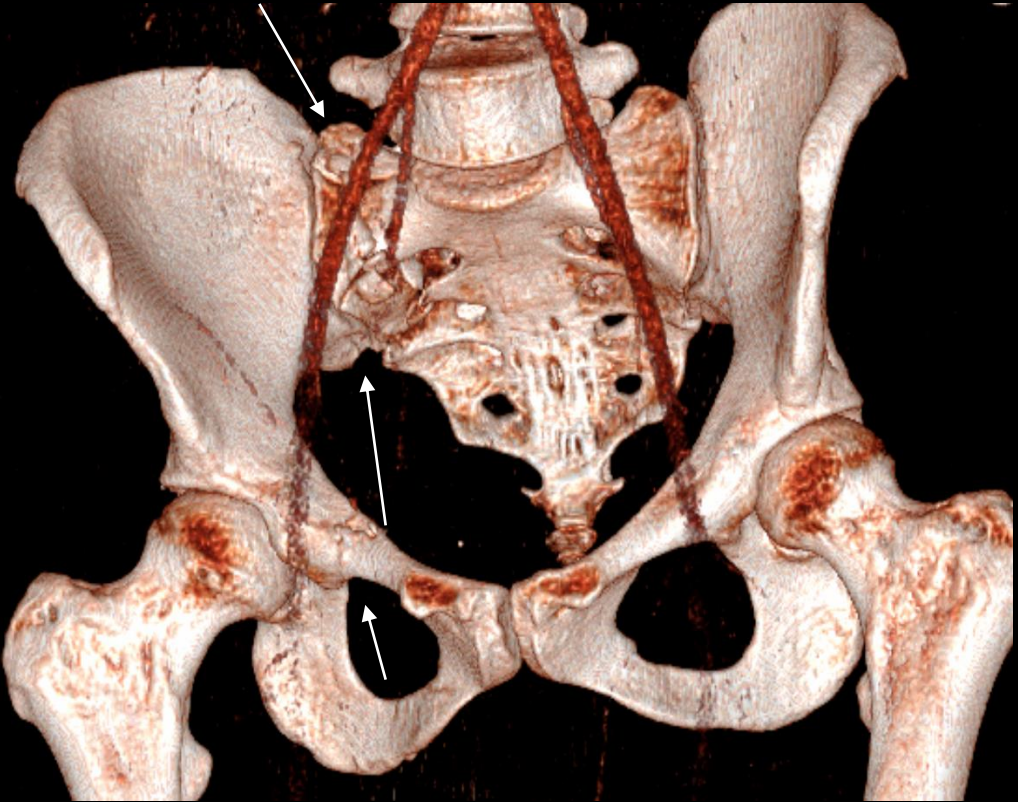
Gracilis, adductor longus, adductor magnus, obturator externus muscles = obturator nerve supply



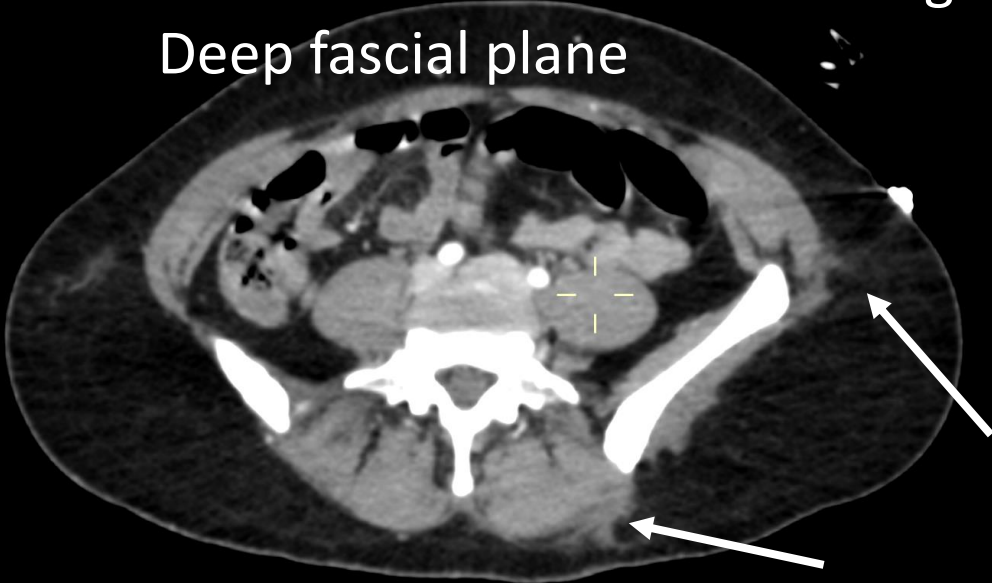
Checklist

1. Binder
2. Bleeding
 - Haematoma volume
 - Active bleeding
3. Anterior abdominal wall
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6. Anorectum
7. Nerves (lumbosacral plexus, sciatic nerve, obturator nerve)
8. External muscles and soft tissues

Undisplaced R sacral/pubis rami fracture (LC1, stable) DAY ZERO

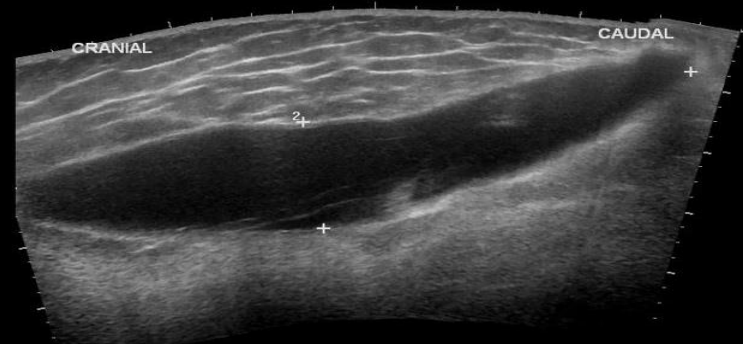
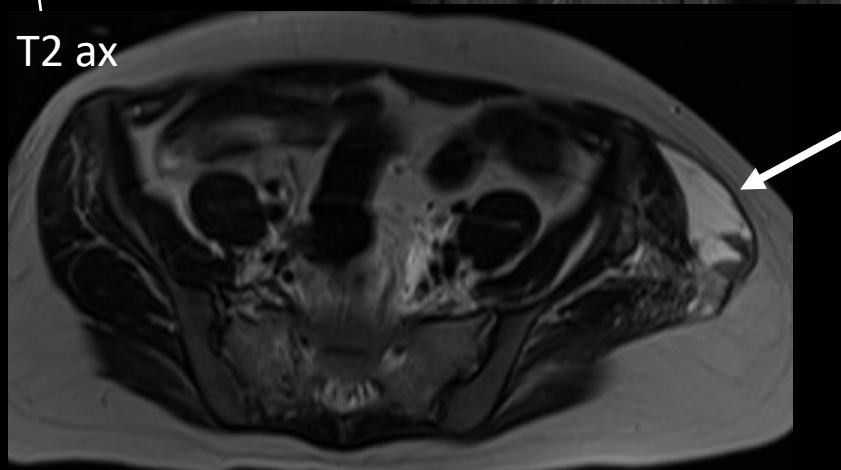
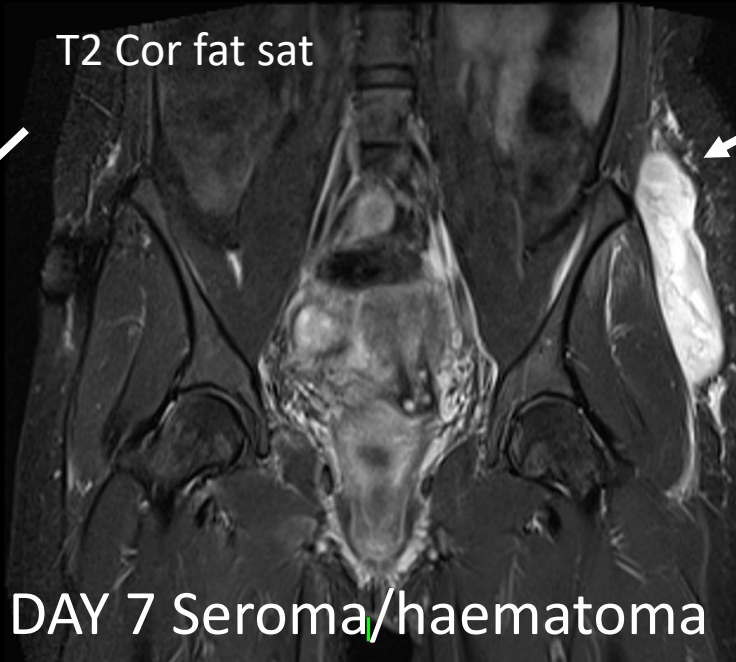


DAY ZERO Soft tissue stranding
Deep fascial plane



Undisplaced R sacral/pubis rami fracture (LC1, stable)

DEGLOVING/MOREL LAVALLE

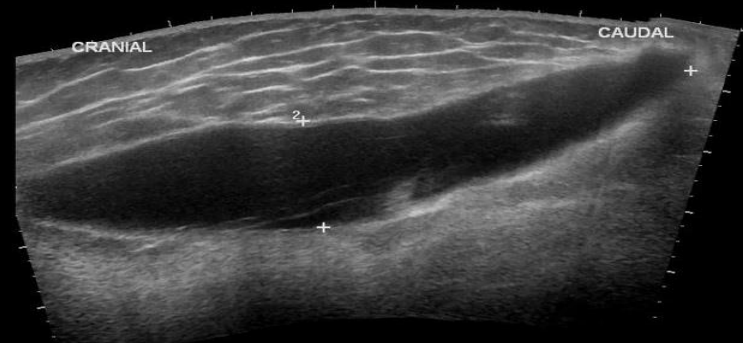
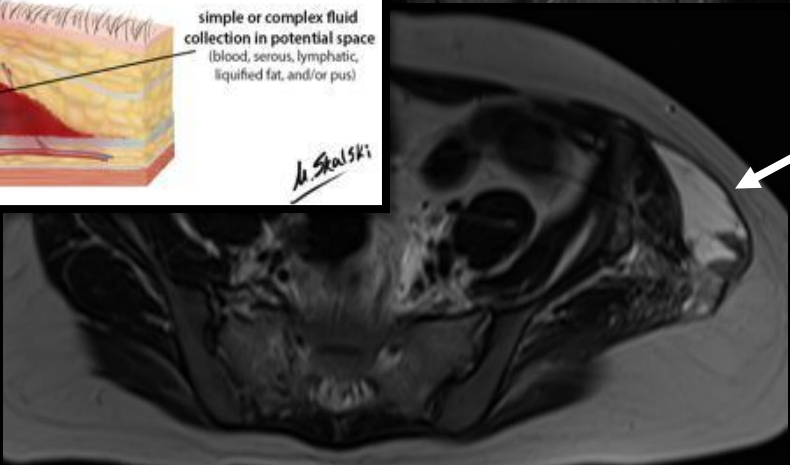
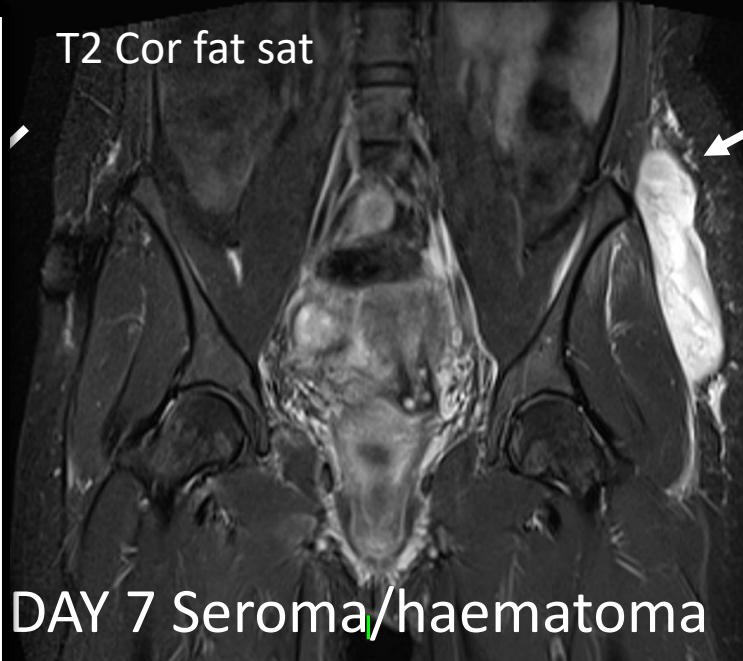
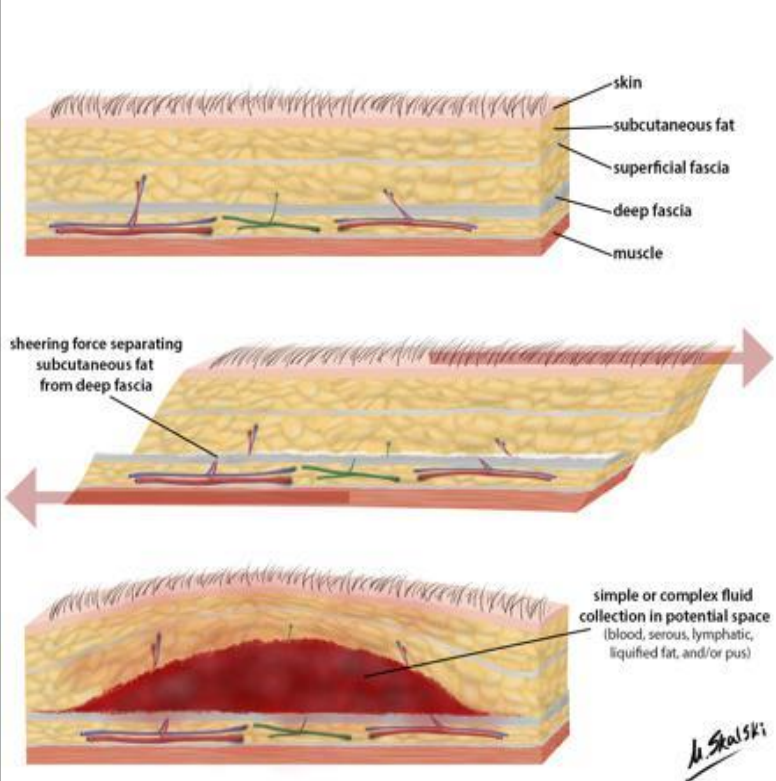


Thanks to Dra Marcela de la Hoz Polo

Undisplaced R sacral/pubis rami fracture (LC1, stable)

DEGLOVING/MOREL LAVALLE

Morel-Lavallée mechanism

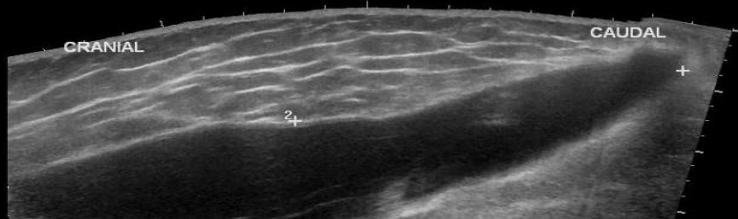
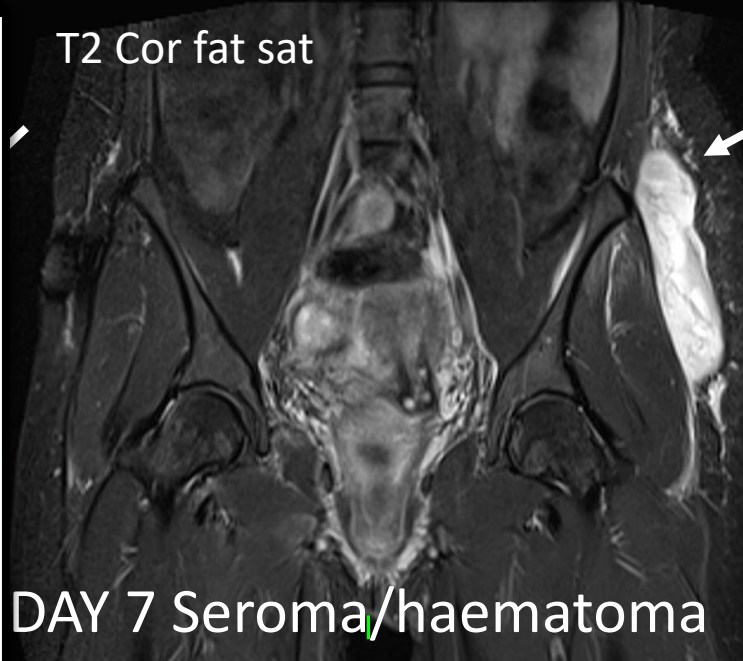
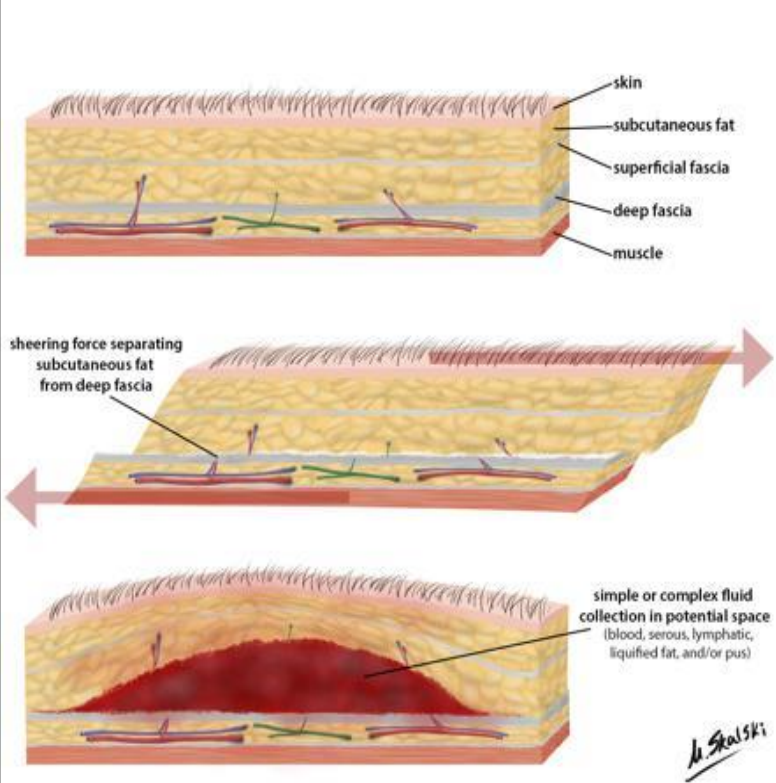


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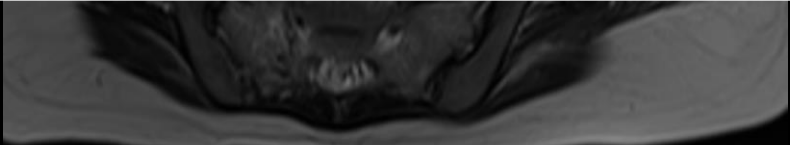
Undisplaced R sacral/pubis rami fracture (LC1, stable)

DEGLOVING/MOREL LAVALLE

Morel-Lavallée mechanism



Learning Point: Subtle stranding initially may develop over next week to large seroma



Learning Objectives

- Develop a checklist for soft tissue injuries in pelvic trauma
- Be able to alert the trauma team to critical findings
- Understand how radiological findings can predict increased risk of morbidity and mortality



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The banner features a photograph of the Valencia skyline, including the iconic Valencia City of Arts and Sciences buildings, set against a clear blue sky.



Thank you

Dr Sadie Syed

Dr Marcela delaHoz Polo

Dr Andreas Shekkeris

Dr John Curtis

Dr Nicola Batrick

Dr Elika Kashef

Mr Reza Mobasheri

Prof David Nott

Mr Chris Aylwin

Checklist

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 - Active bleeding
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