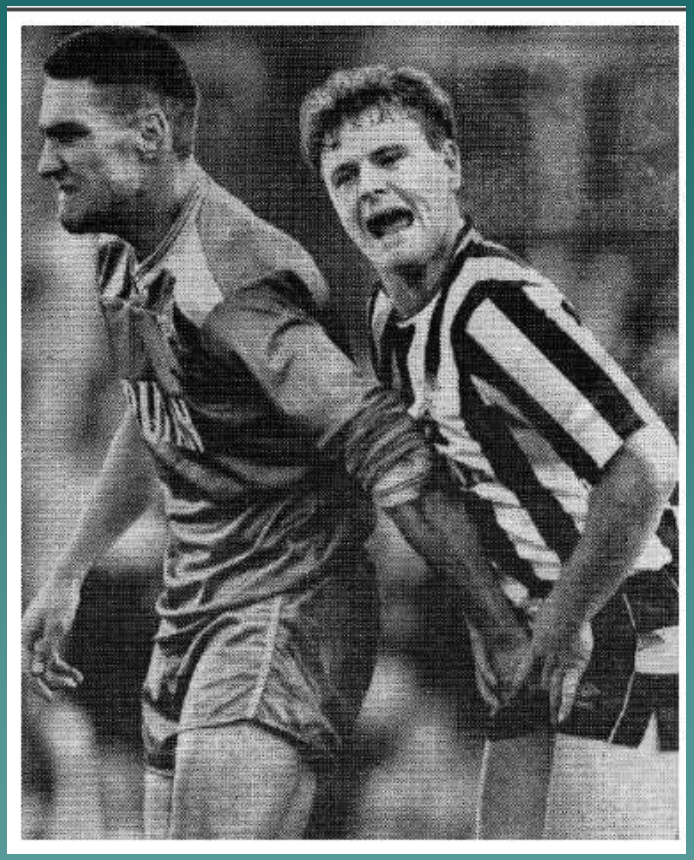
Groin pain in the athlete



Catherina Fu

February 18, 2010

Introduction

- PURPOSE: To help radiologists in evaluating imaging of persistent groin pain in athletes
- Review of regional anatomy of the pubic symphysis
- Causes of groin pain in the athlete and their imaging findings
  - Bony causes:
    - stress fracture
    - osteitis pubis
    - pubic symphysis degenerative change
    - apophyseal injury
  - Soft tissue causes
    - Inguinal ring insufficiency
    - Muscle strain
    - Enthesial injuries
    - Myofascial herniation
- Imaging tips for the pubic region

Groin pain in the Athlete

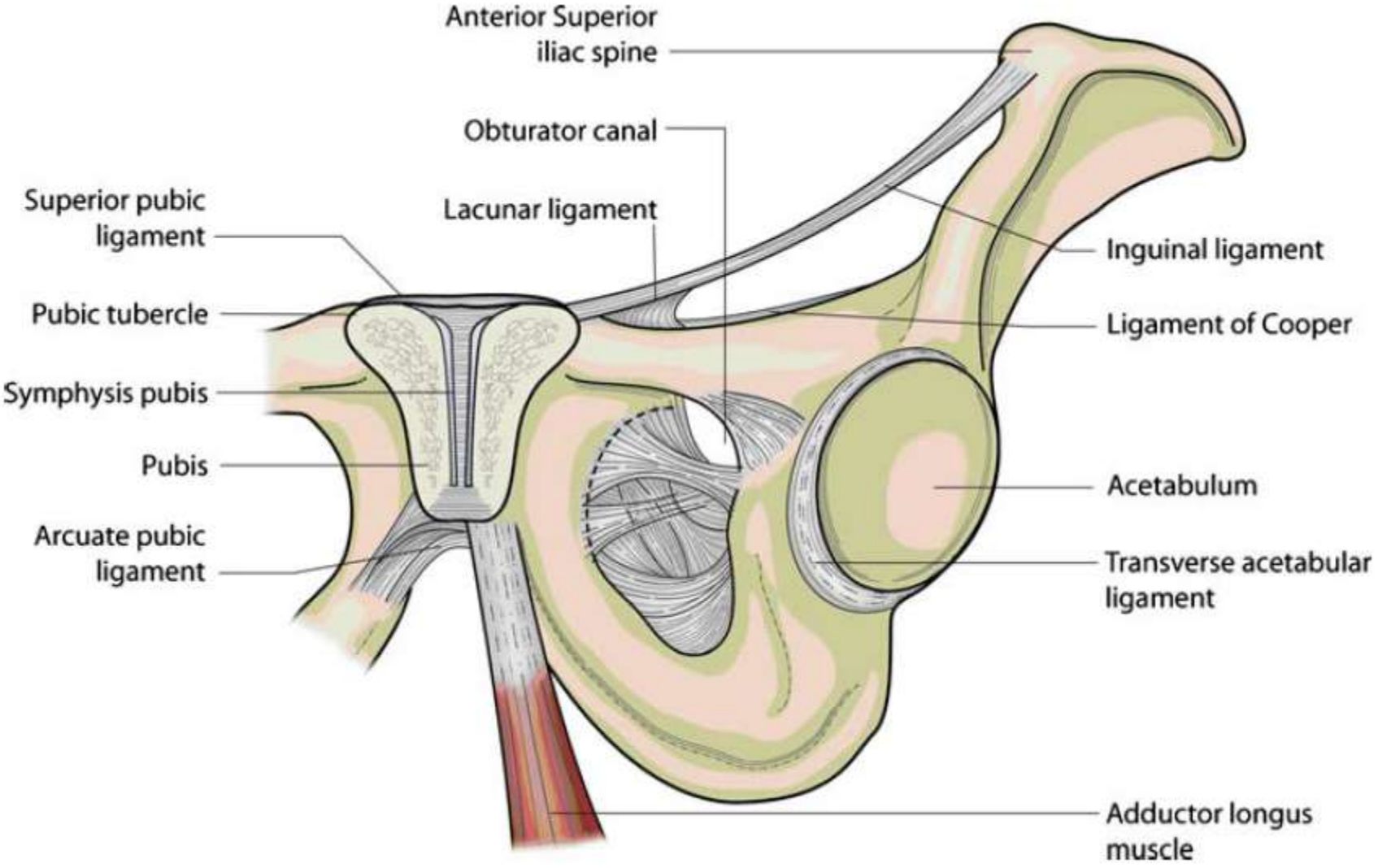
- Accounts for 2-5% of all sports injuries
- Common in sports involving repeated kicking, twisting at the waist, rapid change of direction, or side to side ambulation.
  - Commonly seen in tennis, rugby and increasingly, hockey and football. In these groups it rises to 5-7% of all injuries. In soccer players, it can account for up to 13% of injuries
- Clinical presentation
  - Pain in the inguinal region, radiating to the thigh or adductor area, or the scrotum and testicles.
  - Can be acute, but more commonly insidious.
  - Usually unilateral
  - More common in males than females

Groin pain in the athlete

- Can be caused by a single acute event, repetitive microtrauma, and often, a combination of both
- Due to the close interrelationships of the structures about the pubis, two or more of these entities may coexist.

Anatomy of the pubic symphysis

- Composed of paired pubic bones with a thin covering of hyaline cartilage and an intervening fibrocartilaginous articular disc.
  - The pubic symphysis stabilizes the anterior pelvis while allowing some motion during running and walking. Activities such as kicking put extra stress on the joint
  - The disc is important in dissipating axial and shear forces on the joint
- The joint is stabilized by multiple ligaments, including the superior, arcuate (or inferior), anterior, and posterior pubic ligaments
  - The arcuate ligament blends with the articular disc and merges inferiorly with the aponeuroses of the adductor longus and gracilis muscles
  - The anterior pubic ligament has a deep layer that merges with the articular disc and a superficial layer that blends with the aponeuroses of the external oblique and rectus abdominus muscles



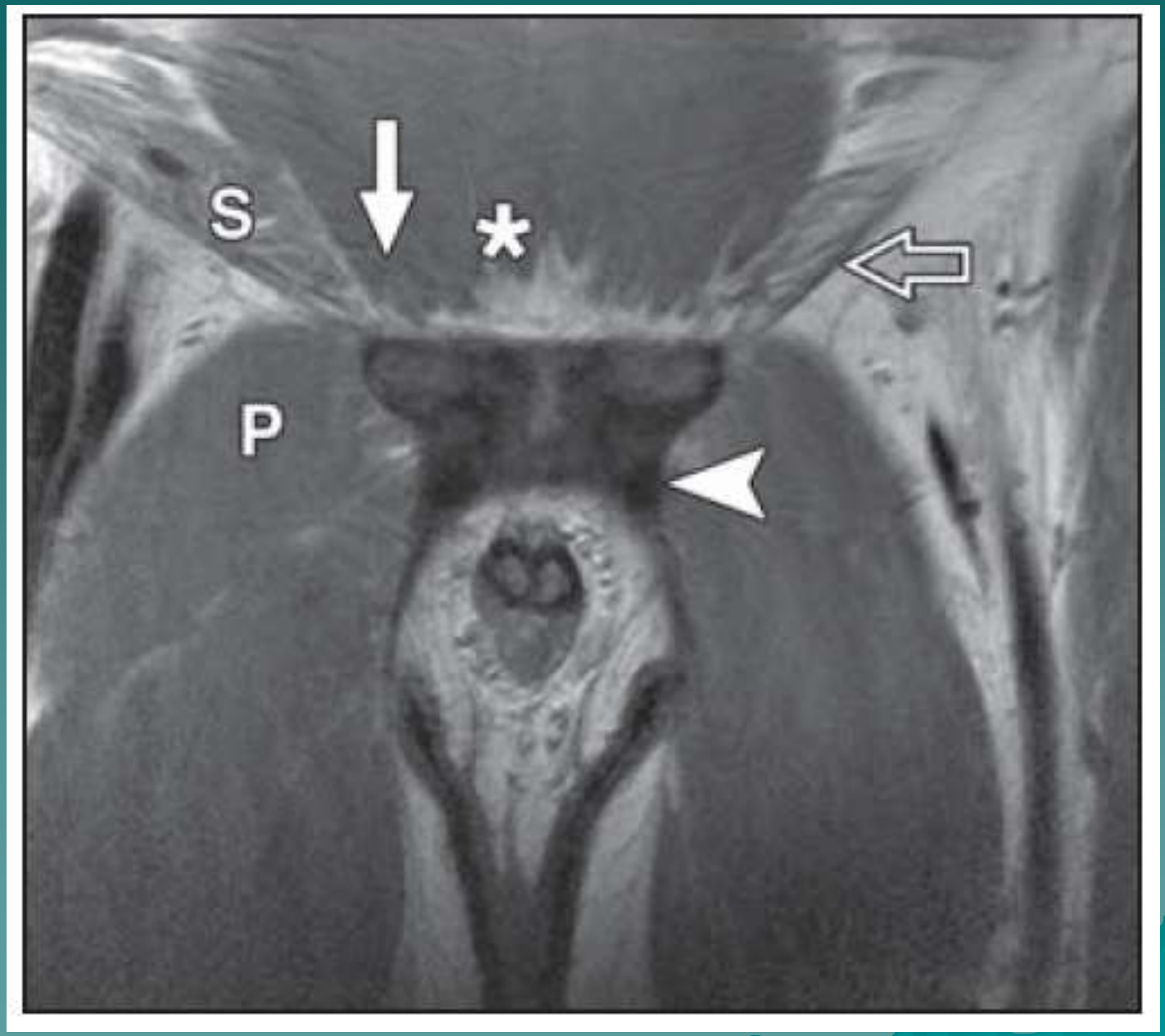
Skeletal radiology. 2009 Aug 27.

Rectus Abdominus

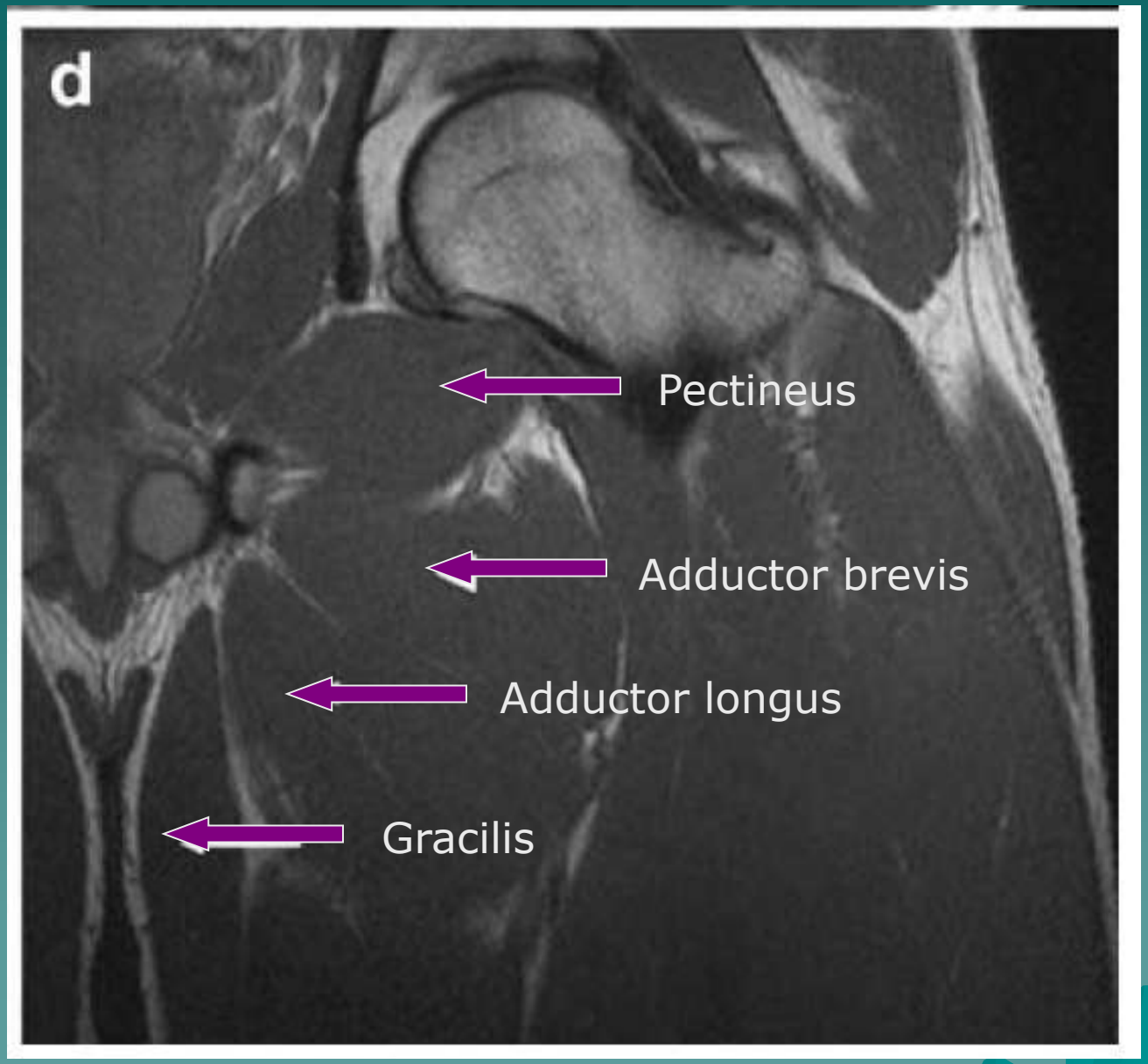
- Rectus abdominus – arises from the superior aspect of the pubic symphysis.
  - Can sometimes distinguish a medial and lateral head.
  - Inferiorly, the medial heads blend with one another. Superiorly, they are divided by the linea alba
  - Divided by 3 (or 4) intersections which blend with the anterior rectus sheath
  - Anterior rectus sheath attaches to the periosteum of the pubic bone

Adductor Muscles

- Gracilis – most medial adductor muscle. Attaches to the pubic body and inferior pubic ramus
- Adductor longus – attaches almost directly inferior to the rectus abdominus muscles
  - The adductor longus has a triangular shape on all imaging planes.
  - At the level of the pubic symphysis, both adductor longus tendons merge
- Adductor brevis – lies lateral and posterior to the adductor longus. Medial fibers of the adductor brevis also attach directly to the symphyseal capsule and pubic disk
- Pectineus – attaches to the superior pubic crest, just lateral to the rectus abdominus origin
  - The femoral neurovascular bundle travels anterior to it



◆*AJR*. 2008, 191:962-972.



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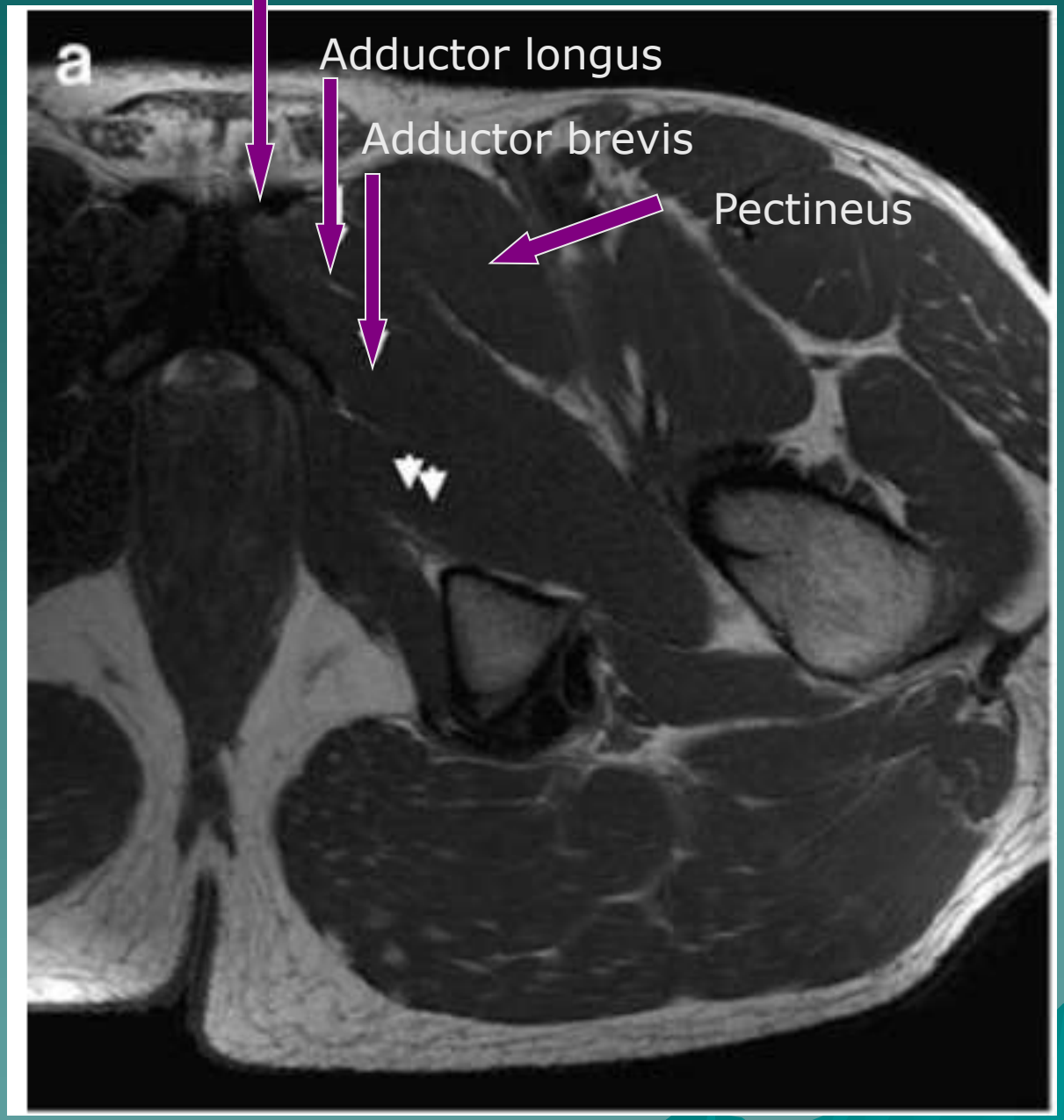
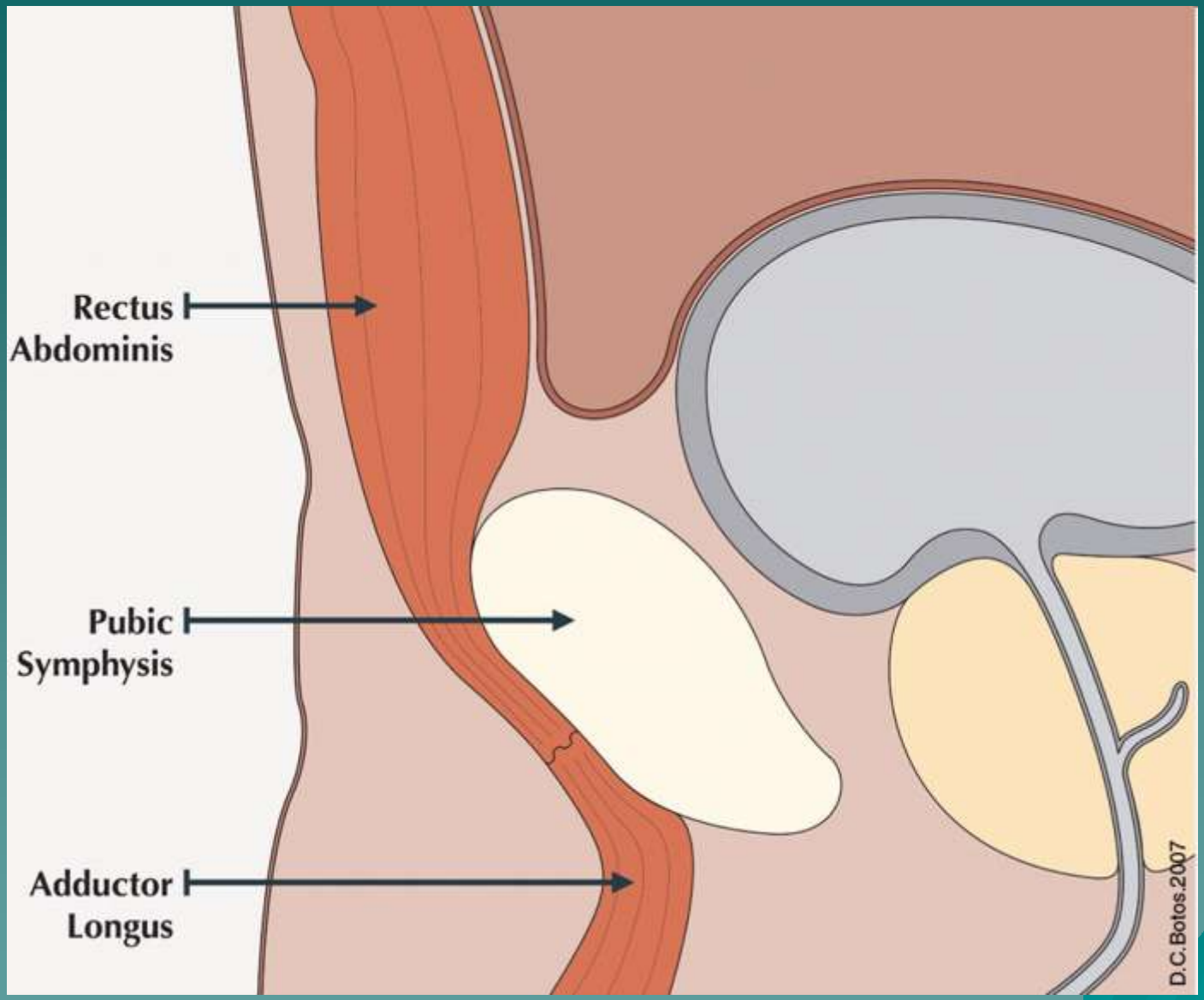
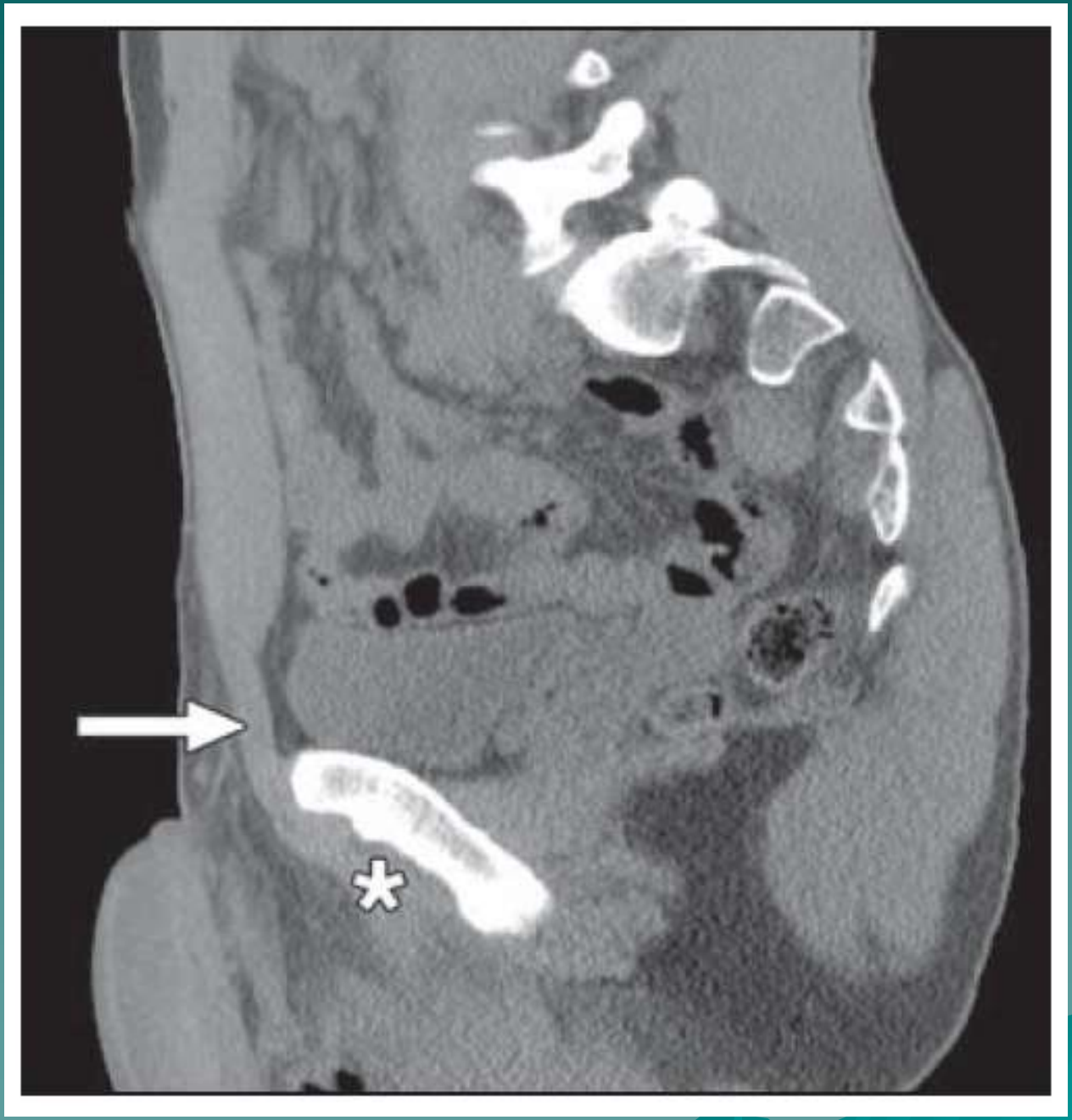

Gracilis
a
Adductor longus
Adductor brevis
Pectineus

Rectus abdominus-adductor longus Aponeurosis

- The rectus abdominis and adductor longus muscles are relative antagonists of one another during rotation and extension from the waist and form a common aponeurosis that attaches to the periosteum of the anterior aspect of the pubic body and that merges with the anterior and arcuate pubic ligaments and pubic disk



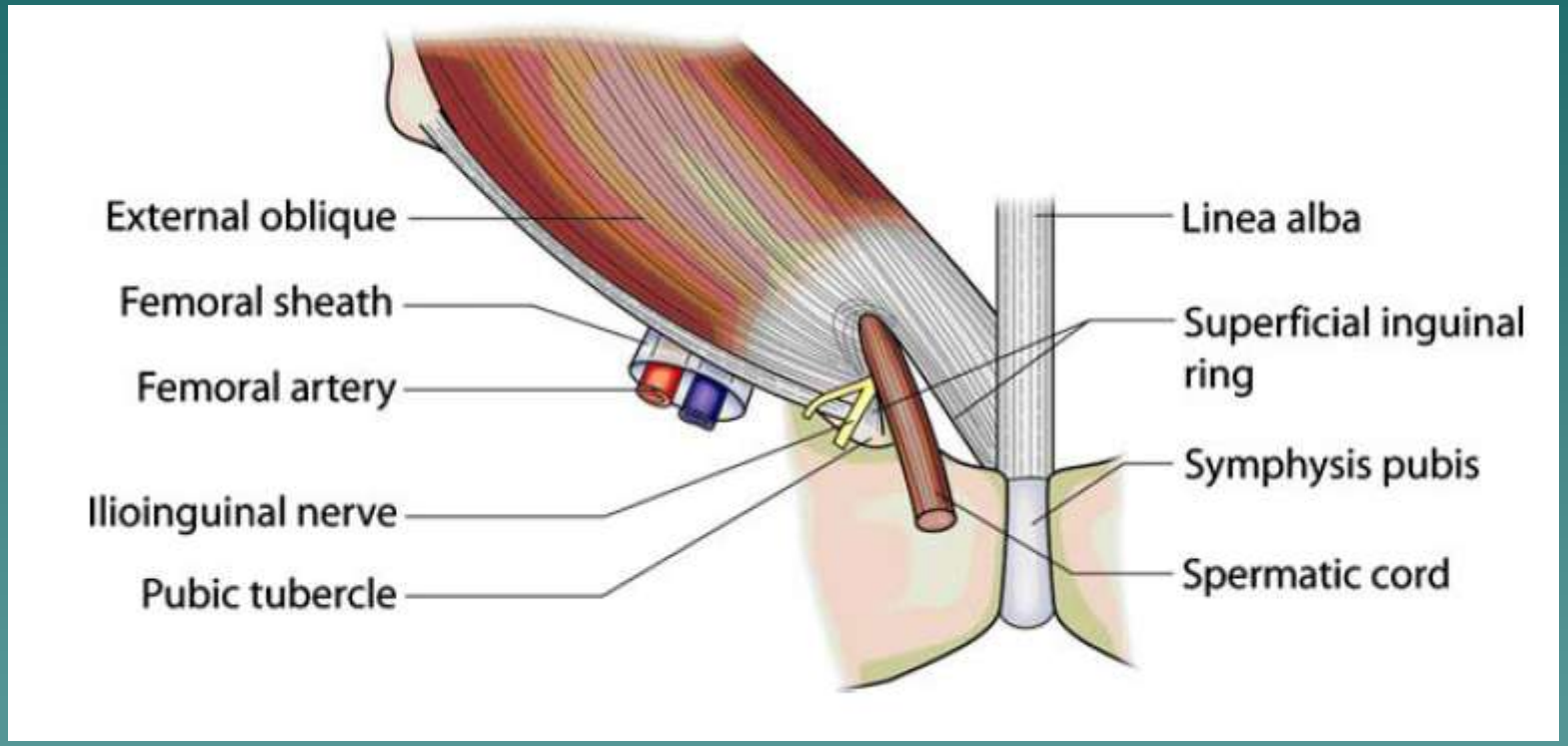
Radio Graphics. 2009; 28(5):1415-38



AJR. 2008, 191:962-972.

The Inguinal Canal

- Superficial inguinal ring – formed by a V-shaped gap in the lower border of the external oblique aponeurosis
- Inguinal ligament – formed by the rolled up inferior border of the external oblique aponeurosis. Extends medially to the anterior pubic symphysis capsular tissues and anterior rectus sheath



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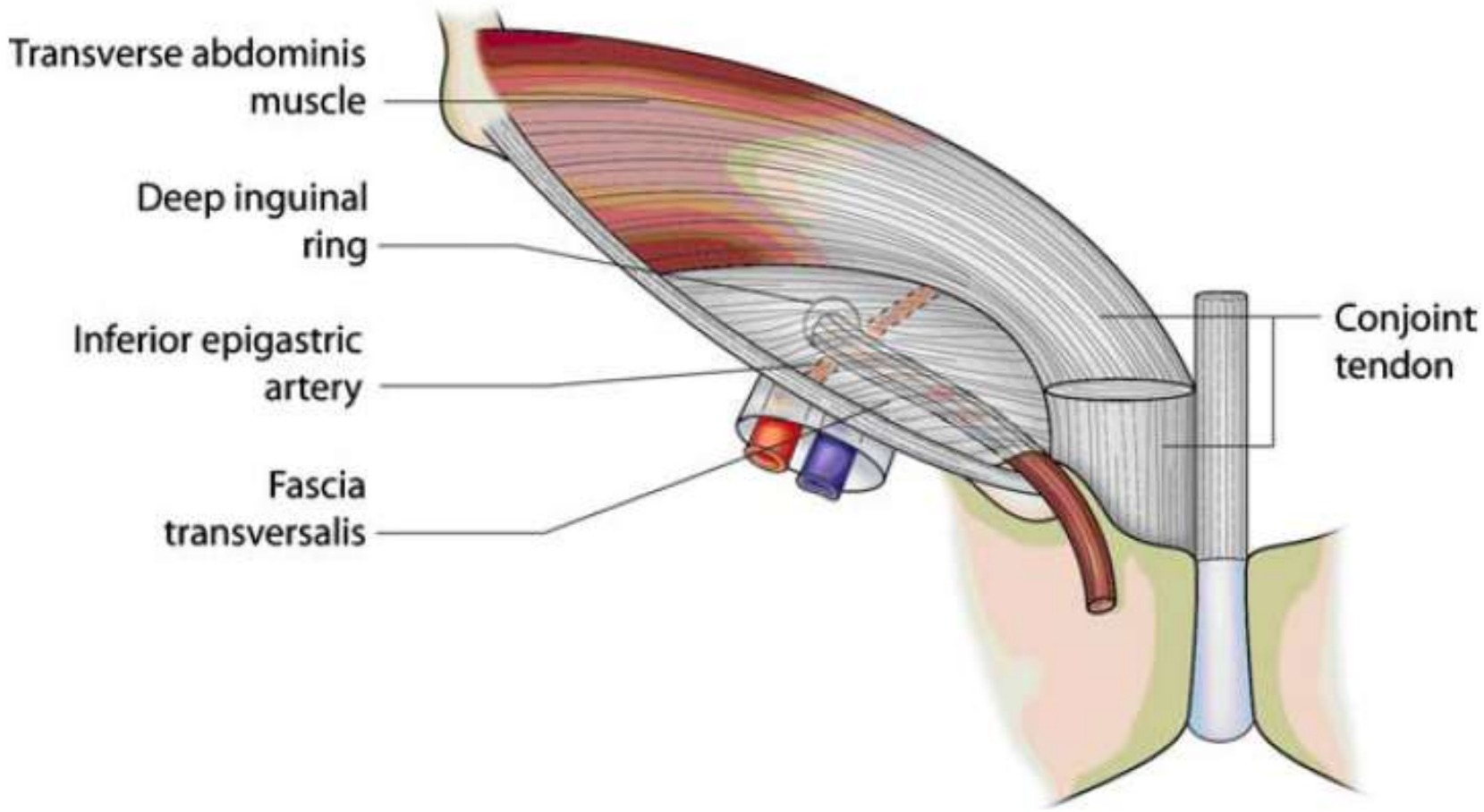
Deep Inguinal Ring

- The internal oblique and transversus abdominus join medially to form the conjoint tendon (though some sources say the two structure remain separate), which forms the roof and posterior wall of the inguinal canal
- The tranversalis fascia is deep to the conjoint tendon, which forms the deep inguinal ring. The spermatic cord exits the abdomen through the deep inguinal ring



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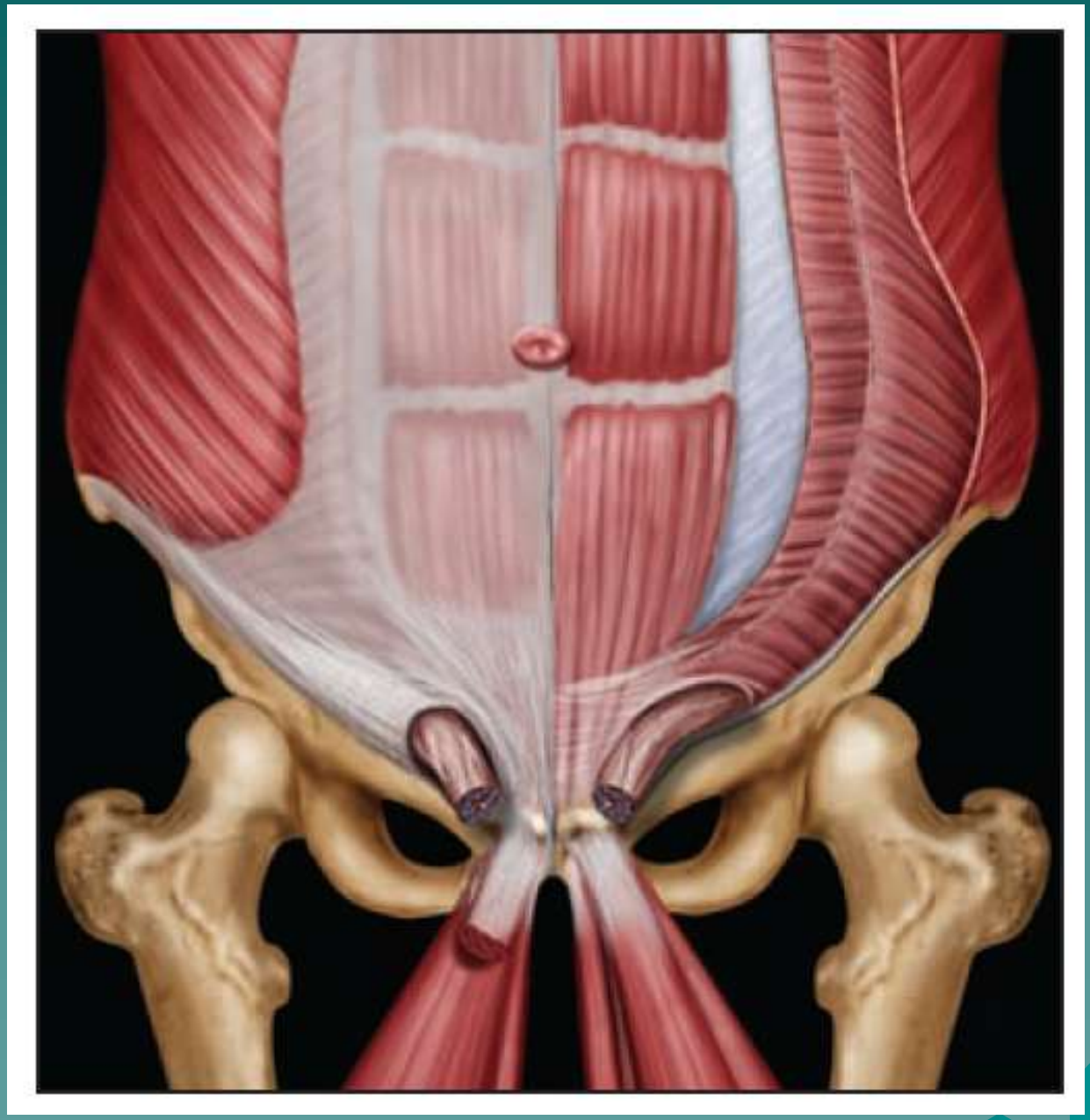

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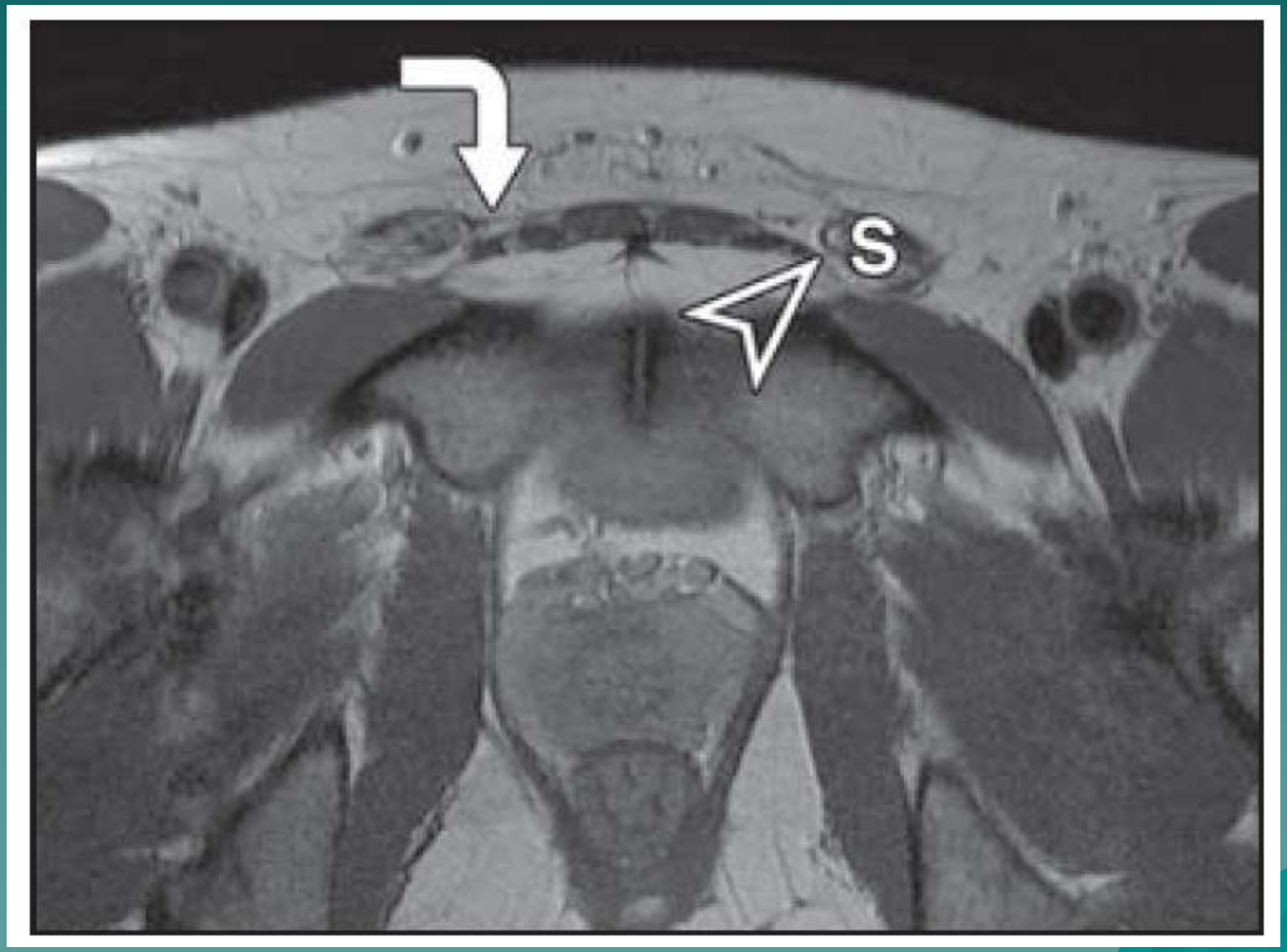


AJR. 2008, 191:962-972.

Pelvic stress fractures

- In the athletic population, most common in long distance runners
- Despite the "ring structure" of the pelvis, usually only affects one site
- Two types are recognized: fatigue fractures and insufficiency fractures.
- Fatigue fracture: due to abnormal stress or torque on a normal bone.
  - Common in military recruits and endurance athletes
  - Most common spot in the pelvis are inferior and superior pubic rami.
    - The femoral neck is a more common spot and can mimic groin pain.
    - Parasymphyseal stress fractures are less common, but can be associated with fragmentation, osteolysis, and sacral stress fractures

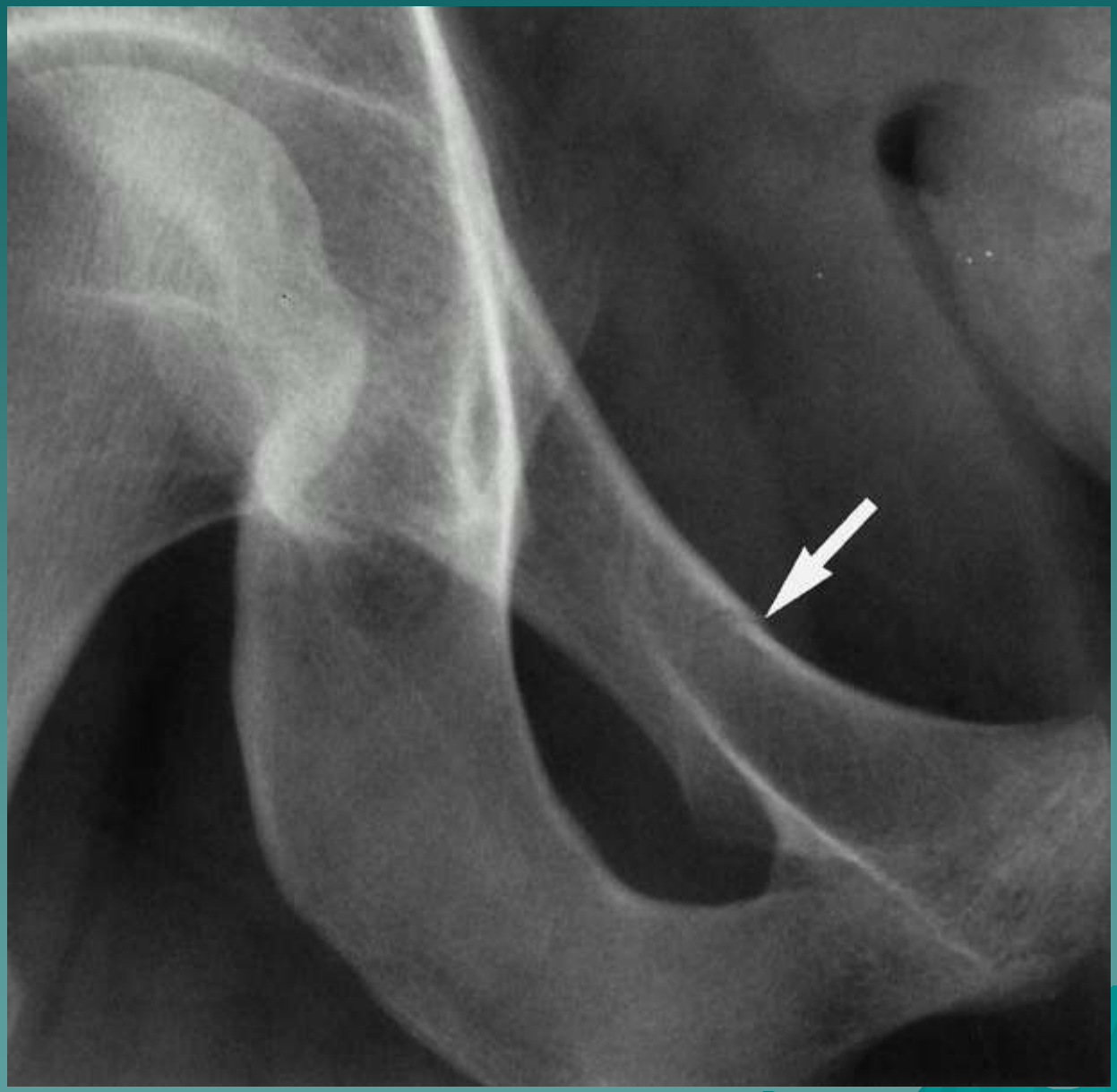
Pelvic stress fractures

- Insufficiency fracture: normal stress placed on abnormal bone.
  - In an athletic population, this can be seen in young females. The "female athlete triad": eating disorder, amenorrhea, and osteoporosis
  - Most common in superior and inferior pubic rami and iliac blades.
- The soft tissues and muscle of the pelvis protect against stress fractures in general
- Treatment:
  - Conservative Therapy: 6-10 weeks of rest, followed by behavior modifications to avoid recurrence
  - Up to 7% go on to non-union requiring surgery or ECSW therapy

Imaging findings: X-ray

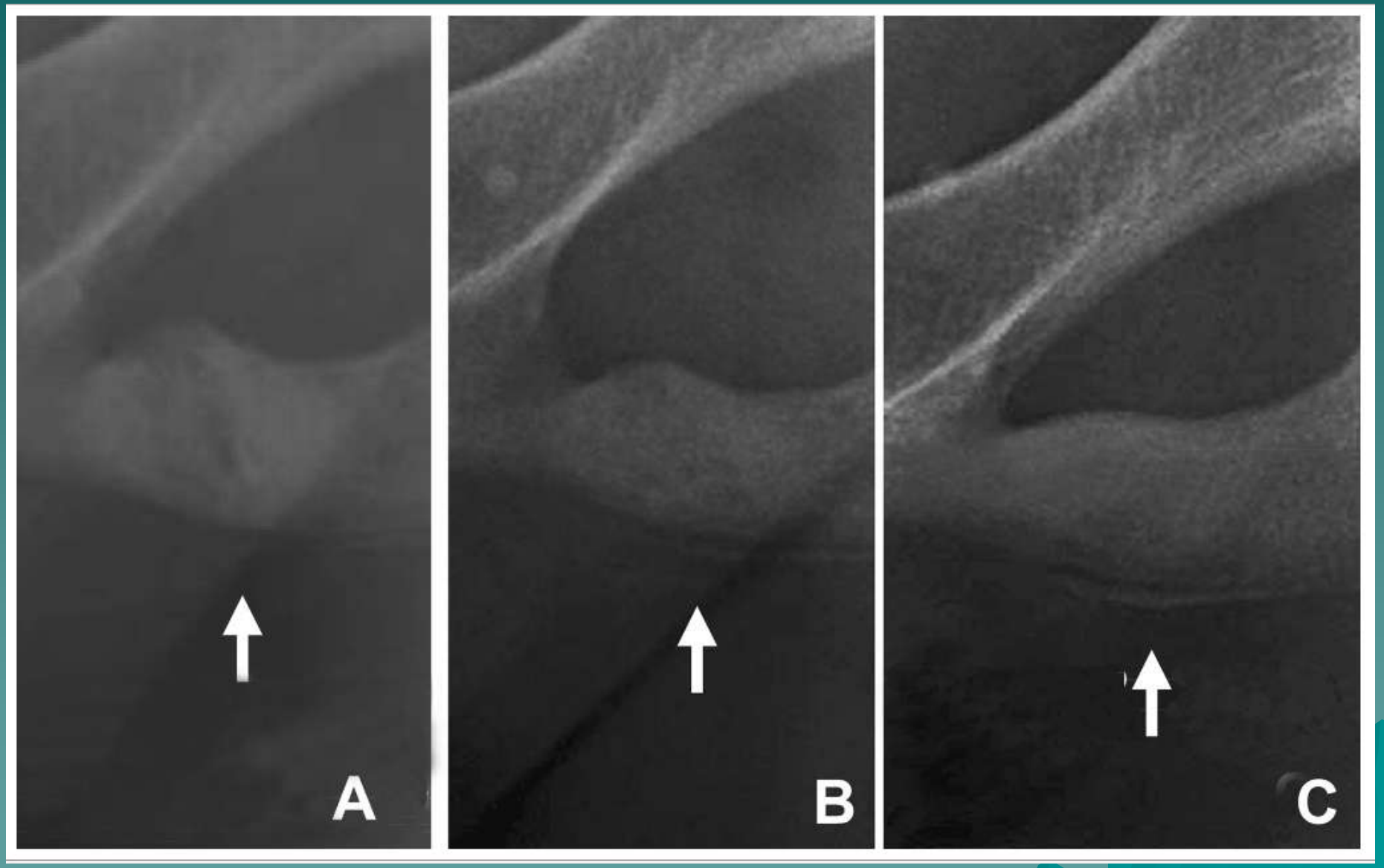
- Conventional radiographs: Sensitivity of 37-50%.
  - Early stress fractures that may be seen on other modalities will not have a correlate on conventional radiographs.
  - In the acute phase, they can be subtle and non-displaced

Superior pubic ramus stress fracture in a jogger



Am J Sports Med July 2007 vol. 35 no. 7 1188-1192

22 yo F runner with non-union at 1 year, after ECSW therapy



Am J Sports Med July 2007 vol. 35 no. 7 1188-1192

Imaging findings: Scintigraphy

- Bone scan: sensitive, but not specific. Poor resolution.
  - False positives are present in up to 30% of cases
  - Abnormal uptake persists for 8-10 months, but becomes less intense after 3-6 months

Am J Sports Med. 2001 Jan-Feb;29(1):100-11

Imaging findings: MRI

- MRI: Considered the best choice
  - First 3 weeks: edema and hemorrhage
  - After 3 weeks: resolving edema, may get hypointense signal. It is important to have a non-fat sat T1 so this finding is not missed.
  - After 3 months: fluid sensitive sequences return to normal signal intensity

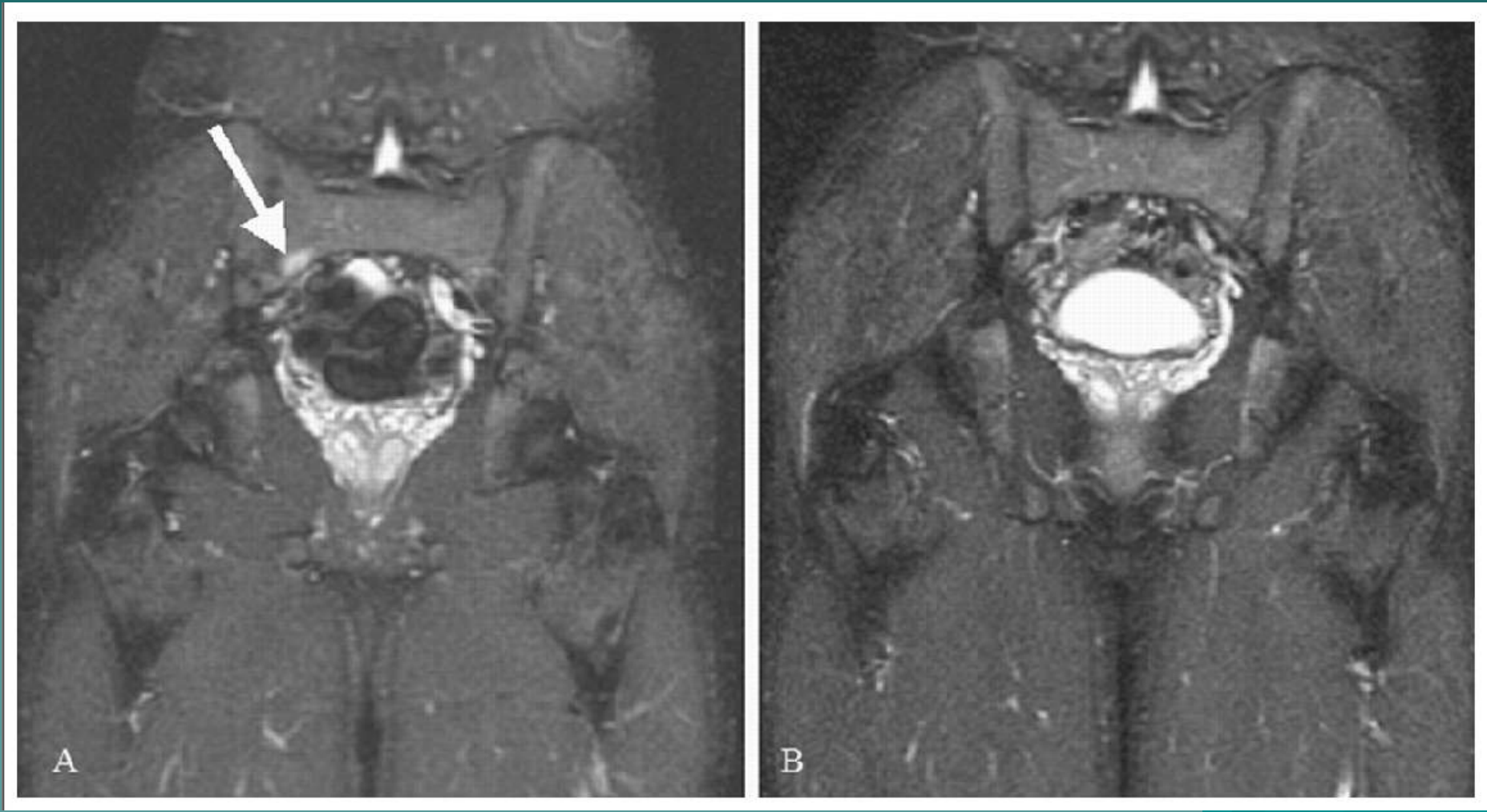
Grading stress fractures by MRI

- Grade 1: endosteal marrow edema
- Grade 2: endosteal and periosteal marrow edema
- Grade 3: endosteal and periosteal marrow edema, T1 weighted marrow change or edema in the surrounding muscle
- Grade 4: fracture line
- Grade 5: callus in cortical bone

Asymptomatic stress changes

- In asymptomatic athletes and military recruits, Grade 1, 2, and 3 changes may be seen
  - One study of 21 military recruits demonstrated that asymptomatic Grade 1 injuries all spontaneously resolved or did not progress, even with continued rigorous training
  - It is recommended that when asymptomatic, these regions can be monitored clinically for pain

Grade I stress changes in a 20 year old military recruit with spontaneous resolution at 5 months



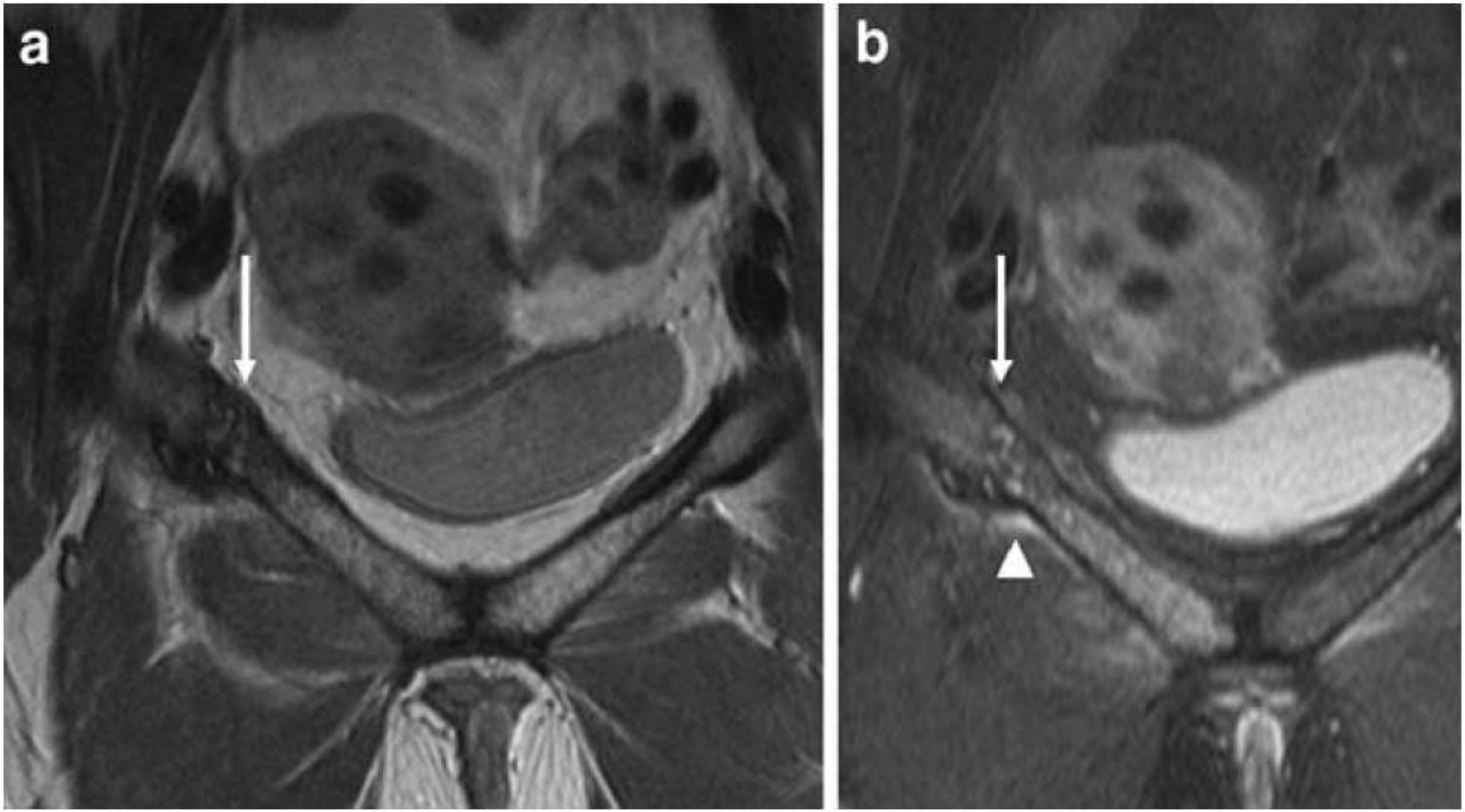
Am J Sports Med. 2005 vol. 33 no. 2 272-276

Grade 2 Stress Fracture

Eur. Radiol. 2003 Mar;13(3):605-11.

Grade 4 stress fracture, plain film was normal

Grade 5 Stress Fracture



Skeletal radiology. 2009 Aug 27.

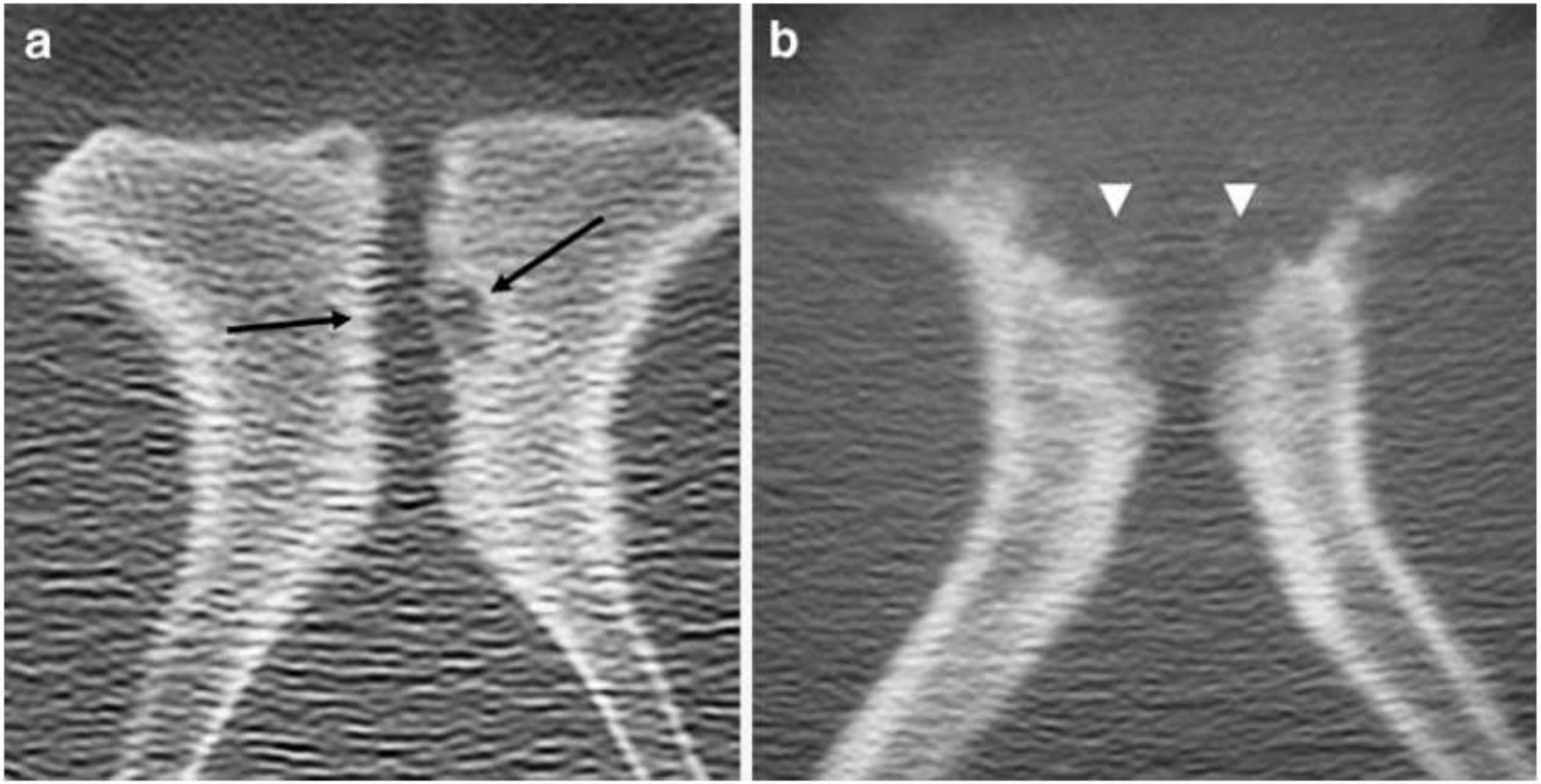
Osteitis Pubis

- A painful inflammatory condition of the symphysis pubis and surrounding muscle fascia
- Proposed to be secondary to traction microtrauma, possibly due to muscle imbalance between the abdominal and adductor muscles
- The patient develops an inflammatory response, with resulting osteitis and periostitis. When the microtrauma occurs faster than the rate at which tissue can repair, the result is tissue degeneration

Imaging Findings: X-ray and CT

- Conventional radiographs and CT: irregular cortical margin, fragmentation, widened symphysis (greater than 7 mm), and subchondral resorption.
  - Chronic cases can show subchondral cysts, sclerosis and bridging osteophytes.
  - Findings are non-specific, always consider the clinical status of the patient

Radiographic findings of osteitis pubis



Skeletal radiology. 2009 Aug 27.

Radiographs for assessment of instability

- To assess for instability at the pubic symphysis in osteitis pubis, “flamingo” views can be obtained with one leg raised
- Greater than 2 mm of vertical off-set is diagnostic

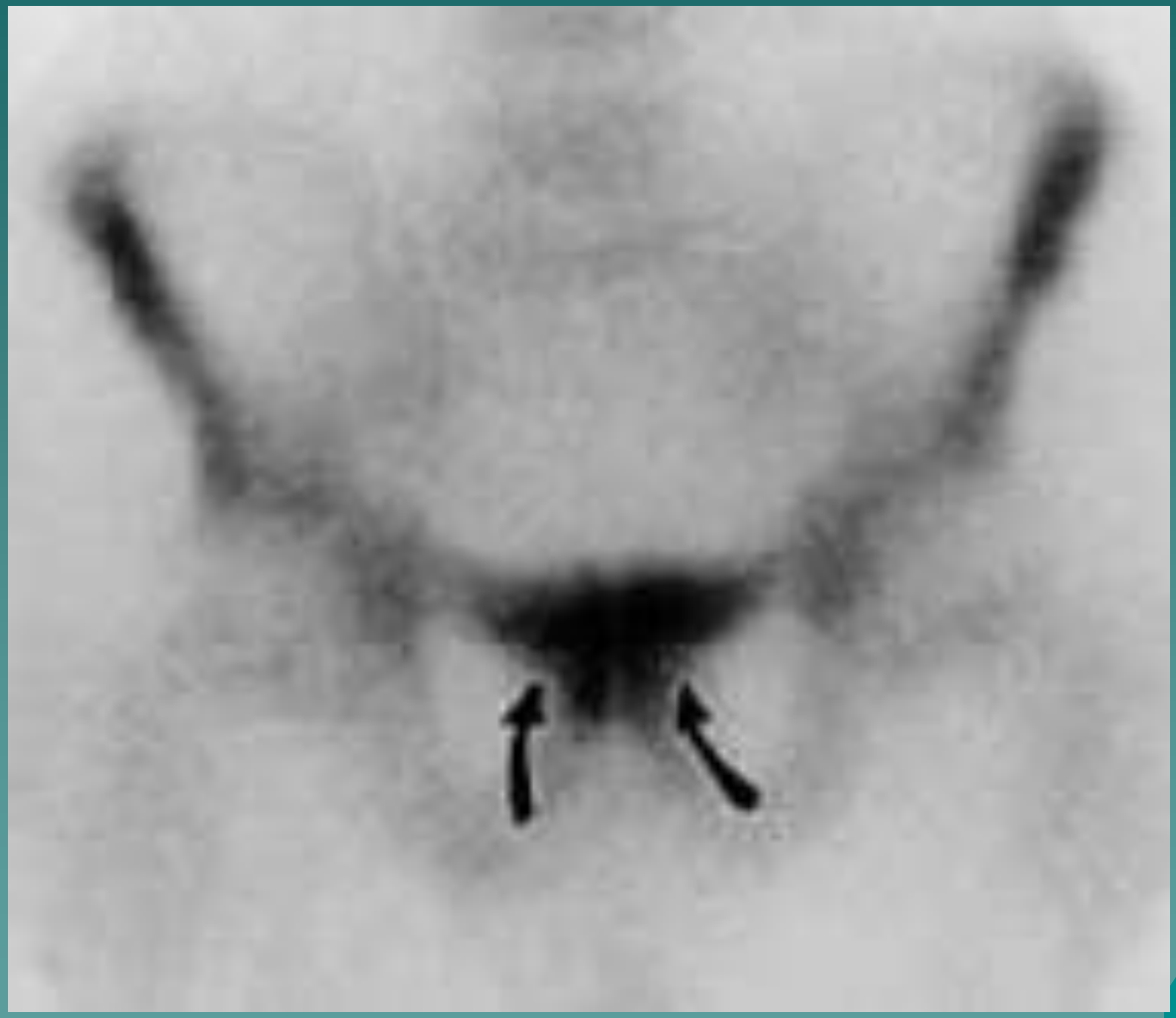
Vertical instability in a patient with osteitis pubis, elicited when standing on left leg

Am J Sports Med. 2000 vol. 28 no. 3 350-355

Imaging Findings: Scintigraphy

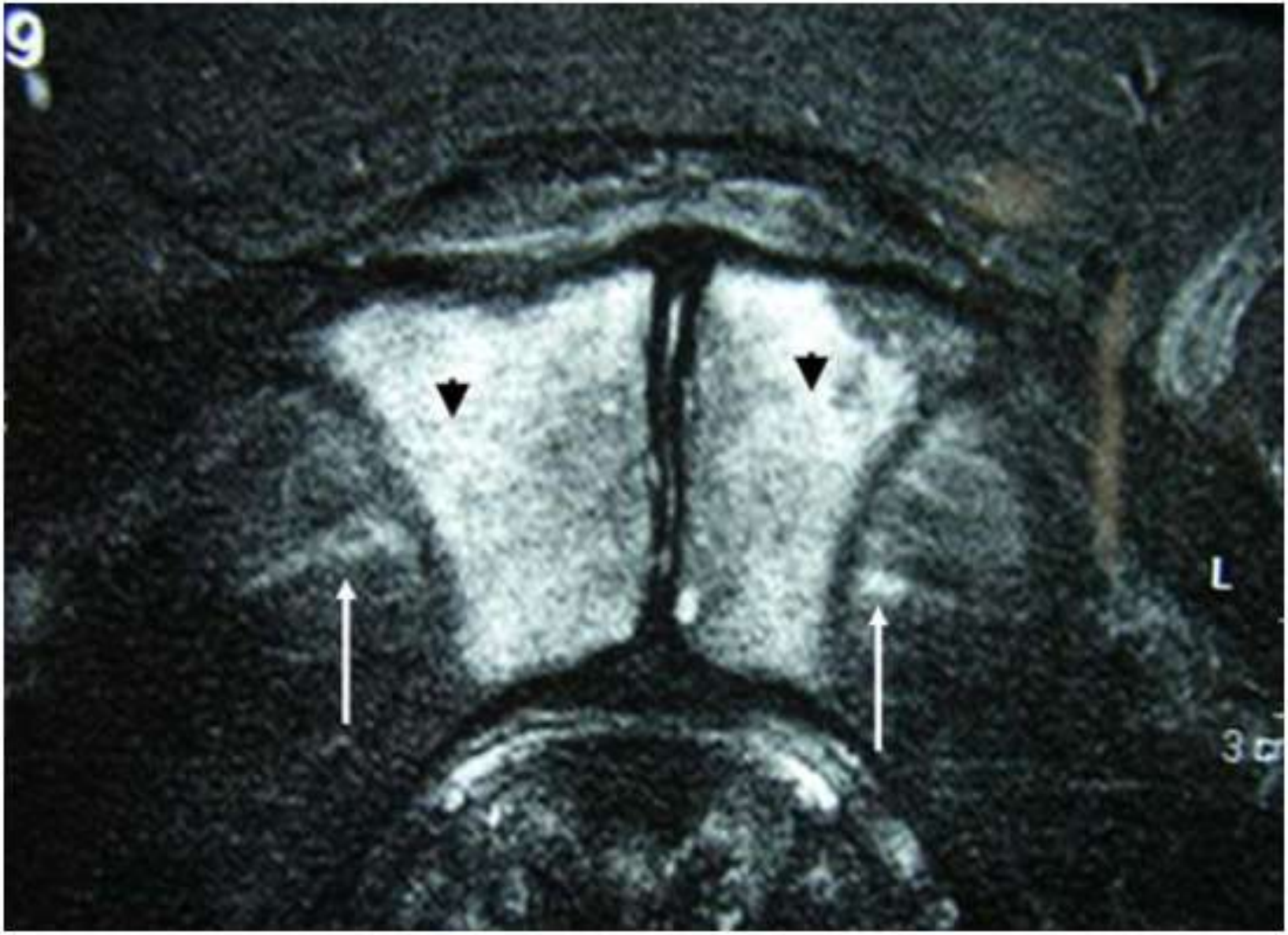
- Bone scan: increased uptake at the pubic symphysis, but again, scintigraphy is not very sensitive or specific

Positive bone scans for osteitis pubis



Imaging Findings: MRI

- MR: study of choice.
  - Acute: Edema in symphysis, symphyseal fluid, peripubic soft tissue edema, +/- adjacent muscles. The edema enhances with contrast
  - Chronic (>6 months of disease): Subchondral cysts, sclerosis, osteophytes, incongruent joint
- Most studies have found a good correlation between these findings and symptoms, but edema can also be seen in asymptomatic patients, particularly in junior athletes.

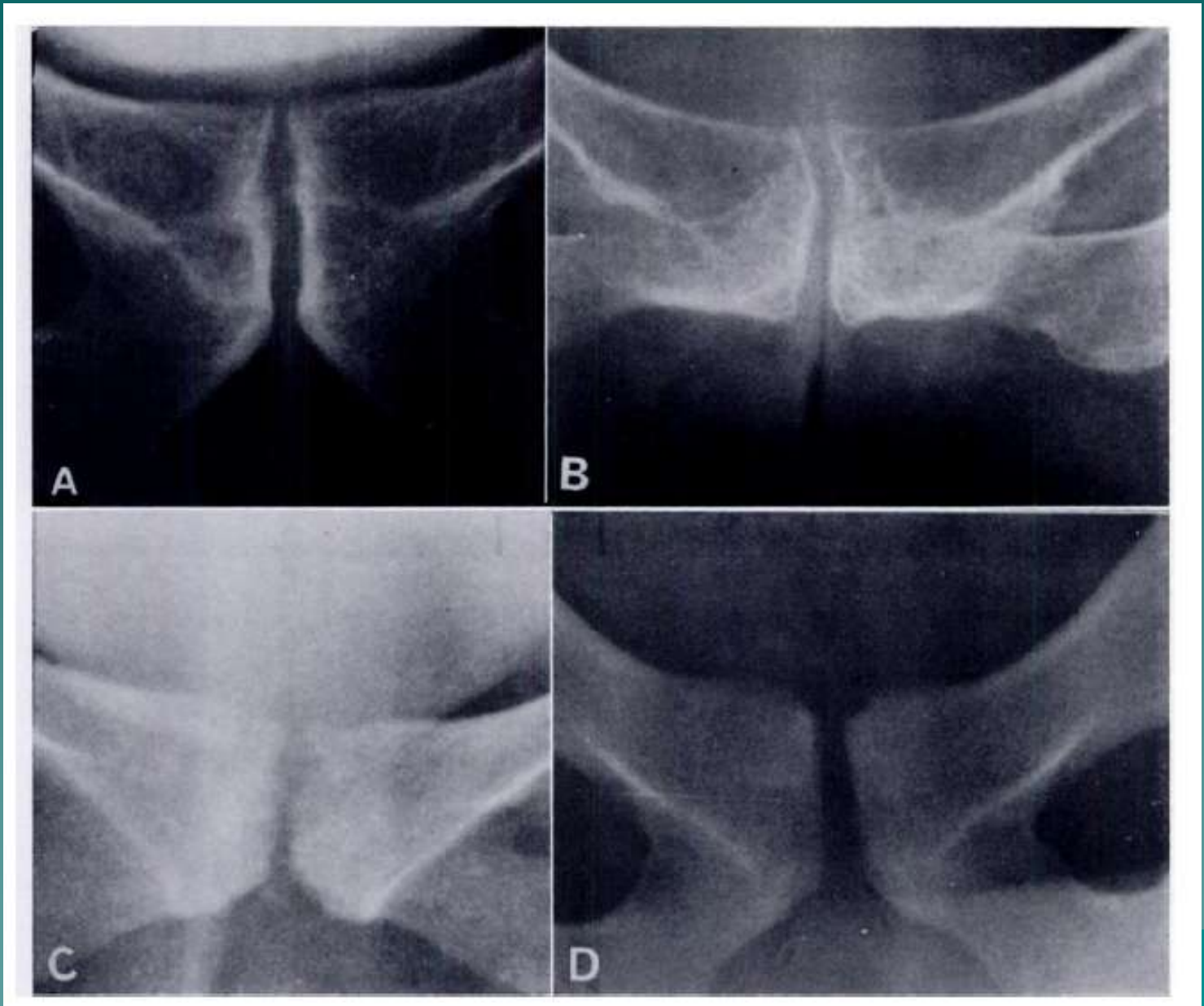


Skeletal radiology. 2009 Aug 27.

Skeletal radiology. 2009 Aug 27.

Caveats to diagnosis of Osteitis Pubis

- Should not be diagnosed radiologically in non-symptomatic patients due to the array of normal variation



AJR. 1971:112: 517-524

Osteitis pubis in females

- Osteitis pubis can also be seen in pregnant and post-partum women
- Years after the pregnancy, the pubic symphysis can show residual irregularity, so be mindful of this in a woman with prior pregnancies who has developed new-onset groin pain

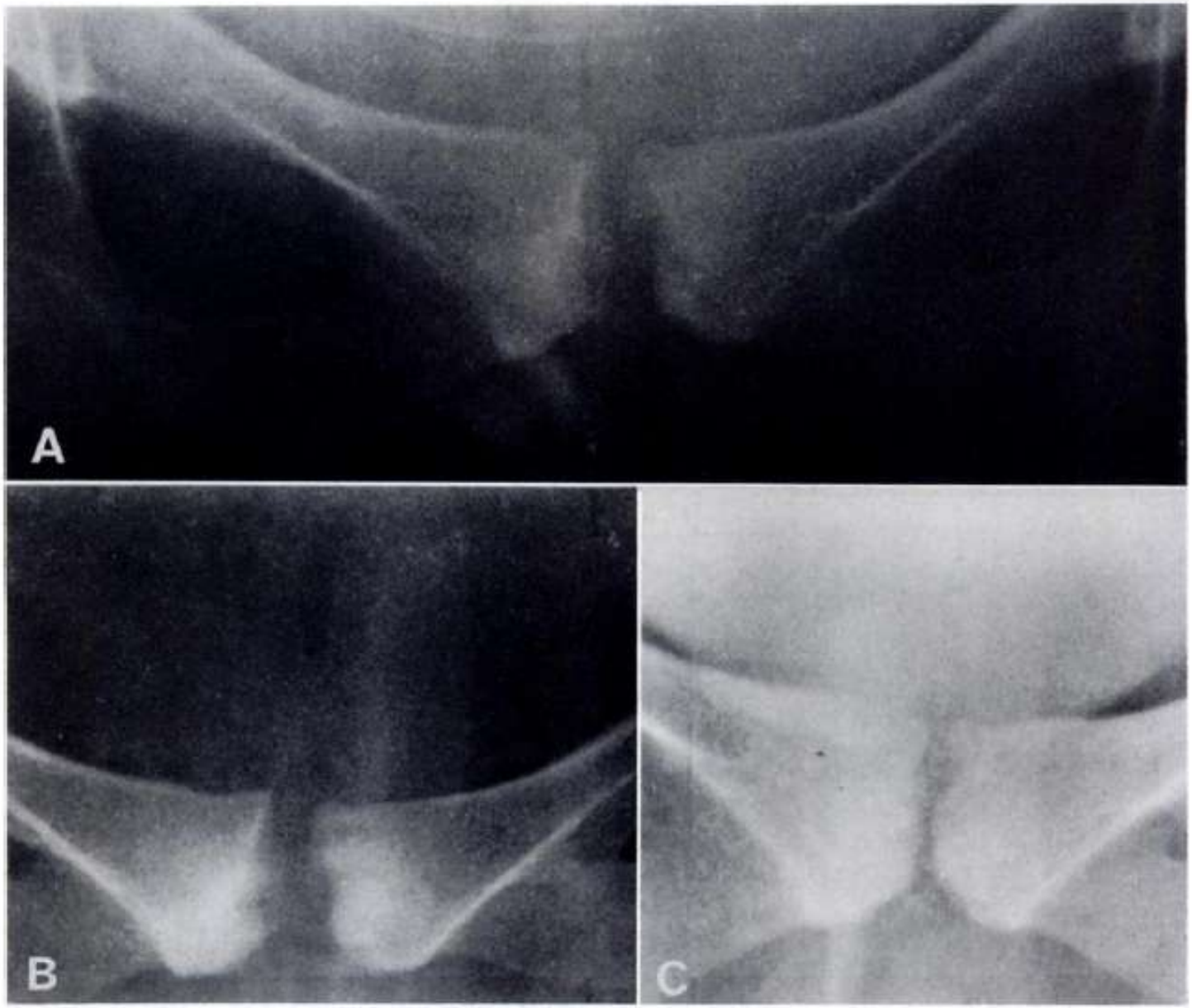
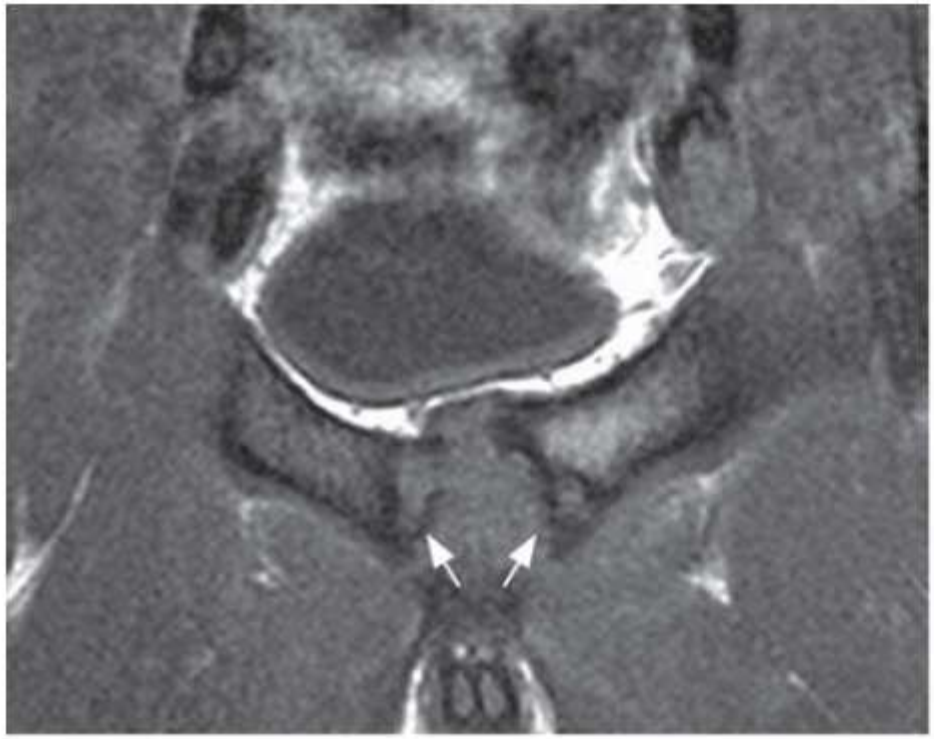


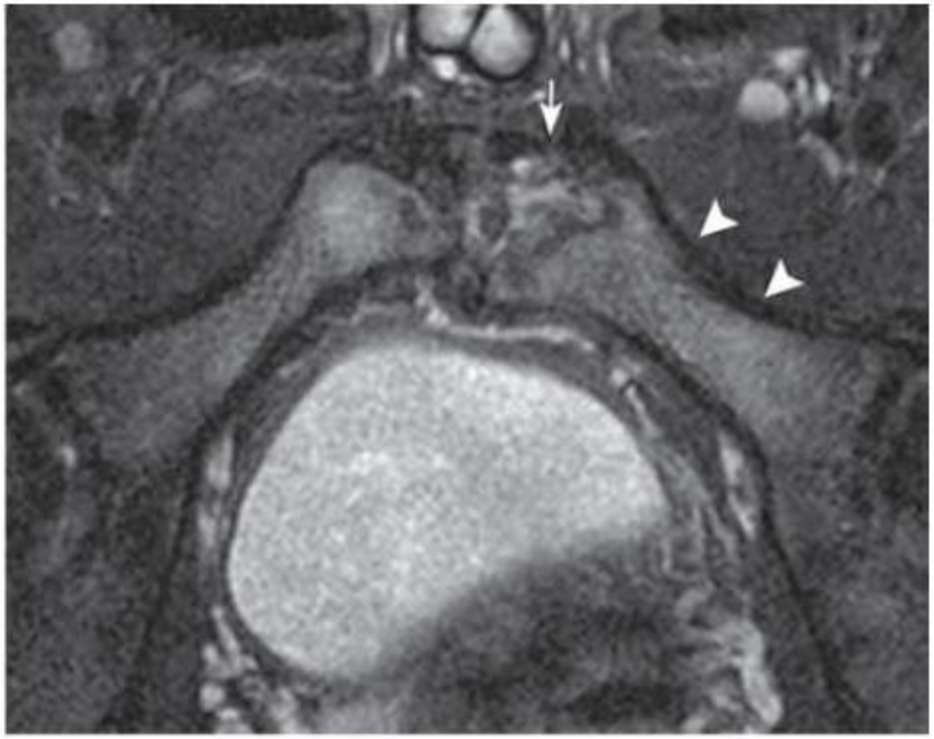
FIG. 5. (*A*) Symphysis erosion during pregnancy. (*B*) Same patient 6 weeks post partum. (*C*) Same patient 4 years later shows irregular sclerotic bone.

Osteitis pubis vs. Osteomyletis/ Septic Arthritis

- When aggressive, osteitis pubis can be radiologically indistinguishable from septic arthritis/osteomyelitis.
- Clinical picture can be helpful. OM/SA common in post-partum women, patients with direct instrumentation, and pelvis tumor.
- In the athletic patient without these risk factors, OM/SA is much less likely, but has been reported.

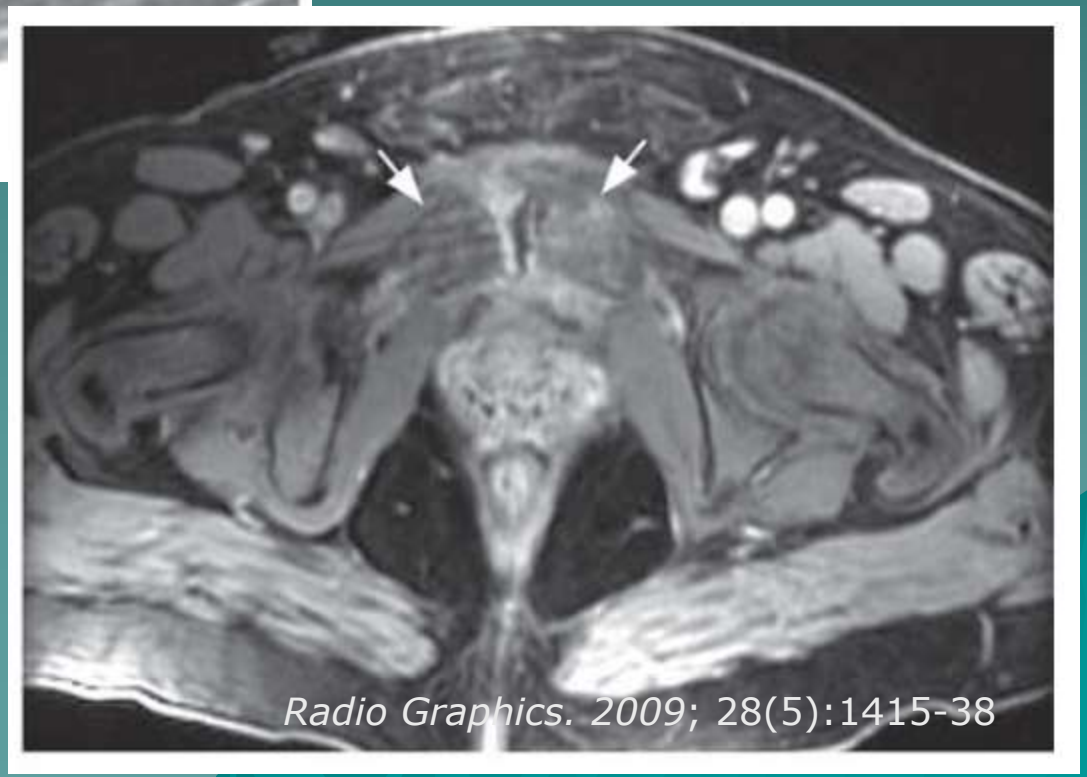
19 yo M soccer player with advanced osteitis pubis





Radio Graphics. 2009; 28(5):1415-38

Septic athritis and osteomyelitis in a 43 yo F



Treatment of osteitis pubis

- Conservative management: rest, NSAIDs, theraputic modalities (such as US, cryomassage, or electric stimulation), and a rehabilitative regimen to strengthen the surrounding muscles.
  - Direct image-guided steroid injection and local anesthetic has been reported to speed recovery
- Surgical management: curettage and in cases of instability, arthrodesis
  - Wedge resection has also been performed, but can result in instability
- Medical: recently, some athletes have been treated with bisphosponates

Degenerative Changes of the Pubic Symphysis

- With advancing age, the fibrocartilage of the symphysis pubis liquefies and develops a small central cleft.
- Like intervertebral discs, the symphyseal disc can extrude with herniation, usually inferiorly or posteriorly.
- Also see: osteophytes, ligamentous thickening, joint space narrowing, and sometimes, degenerative ankylosis
- Appearance may overlap with the appearance of osteitis pubis, but joint space widening and bone marrow edema should not be a prominent features of degenerative change
- Commonly seen in elite athletes, may be asymptomatic

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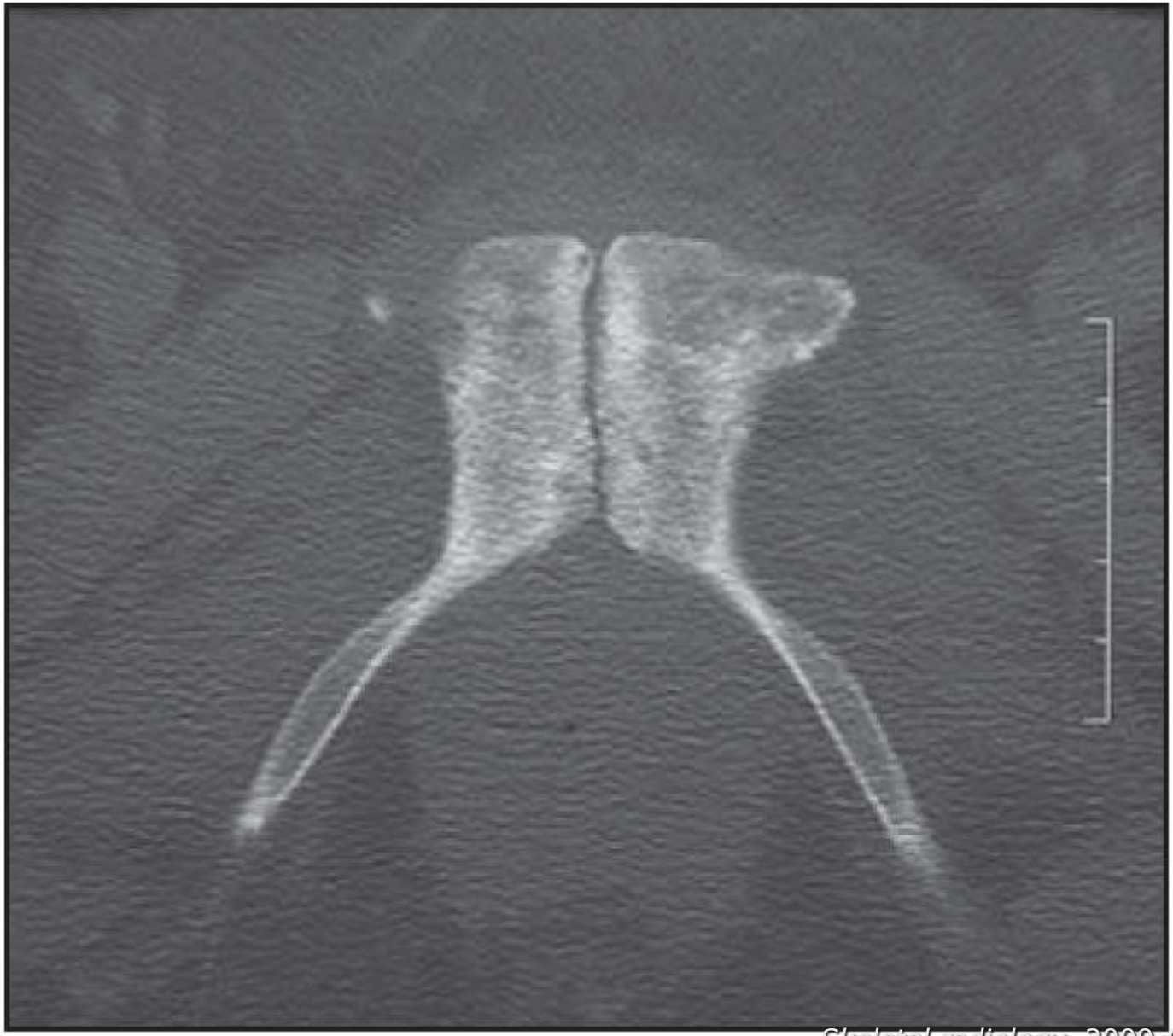


Skeletal radiology. 2009 Aug 27.

Soft tissue causes of groin pain: Sportsman's Hernia

- Probably an overuse injury, not well understood but usually far more commonly in men, possibly due to the stronger generation of forces around the pubis in male athletes.
- Controversial clinical area; some say it is the most common cause of groin injury (up to 85%), some say it is quite rare.
- The use of this term was not consistent in the literature. In the orthopedic/sports medicine literature, the definition is generally any persistent, unilateral pain that is NOT associated with a hernia.

A groin pain by any name: the Sportsman's Hernia

- Originally described as weakening of the posterior inguinal wall; a precursor to a hernia (another term for the sportsman's hernia is the pre-hernia complex).
- Also used to describe insufficiency of the anterior inguinal canal. Other names for this include Gilmore groin and hockey groin syndrome.
- Some articles in the orthopedic literature also include injury to the rectus abdominus muscles

Athletic pubalgia

- Several articles in Sports Medicine literature have proposed using of the term *athletic pubalgia* rather than *sports hernia* to refer to a group of musculoskeletal processes that occur in and around the pubic symphysis and that share similar mechanisms of injury and common clinical manifestations
  - Anterior inguinal ring insufficiency
  - Posterior inguinal ring insufficiency
  - Rectus Abdominus-Adductor Longus aponeurosis dysfunction

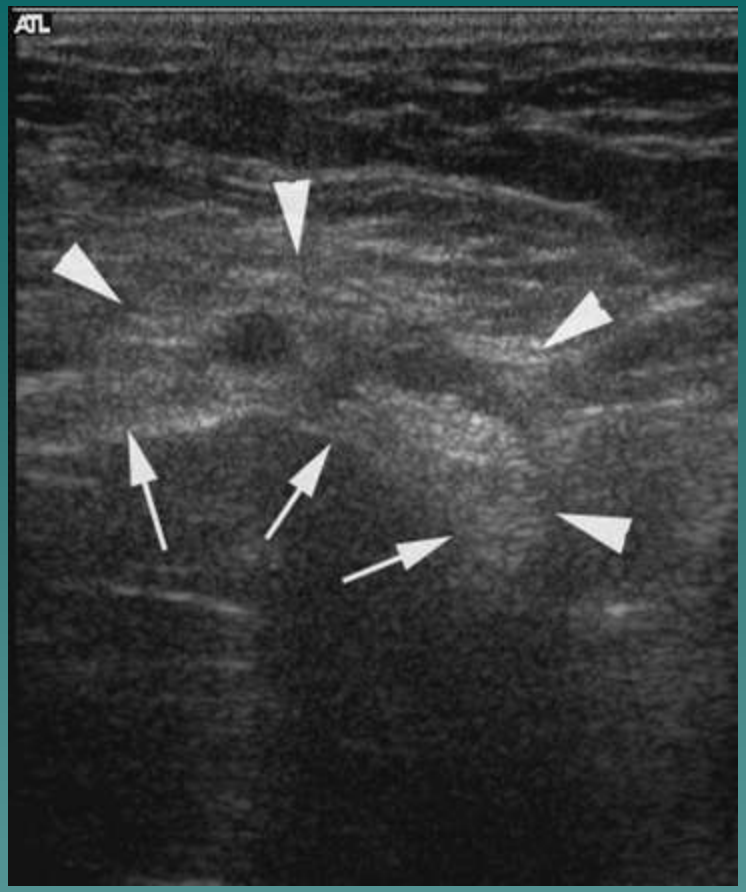
Anterior inguinal wall insufficiency

- Involves tears in the medial aspect of the external oblique aponeurosis, leading to dilation of the external inguinal ring
- Imaging: Most often, this is a clinical diagnosis, and imaging findings are rare. Imaging can rule out other pathologies
- Treatment: Conservative for 6-8 weeks, then surgery, though there is no consensus on surgical technique
  - Some authors have proposed nerve entrapment, particularly of the cutaneous branches of the ilioinguinal nerve and the genital branch of the genitofemoral nerve, as the reason for pain in sports hernias. This may be a reason surgery can be helpful

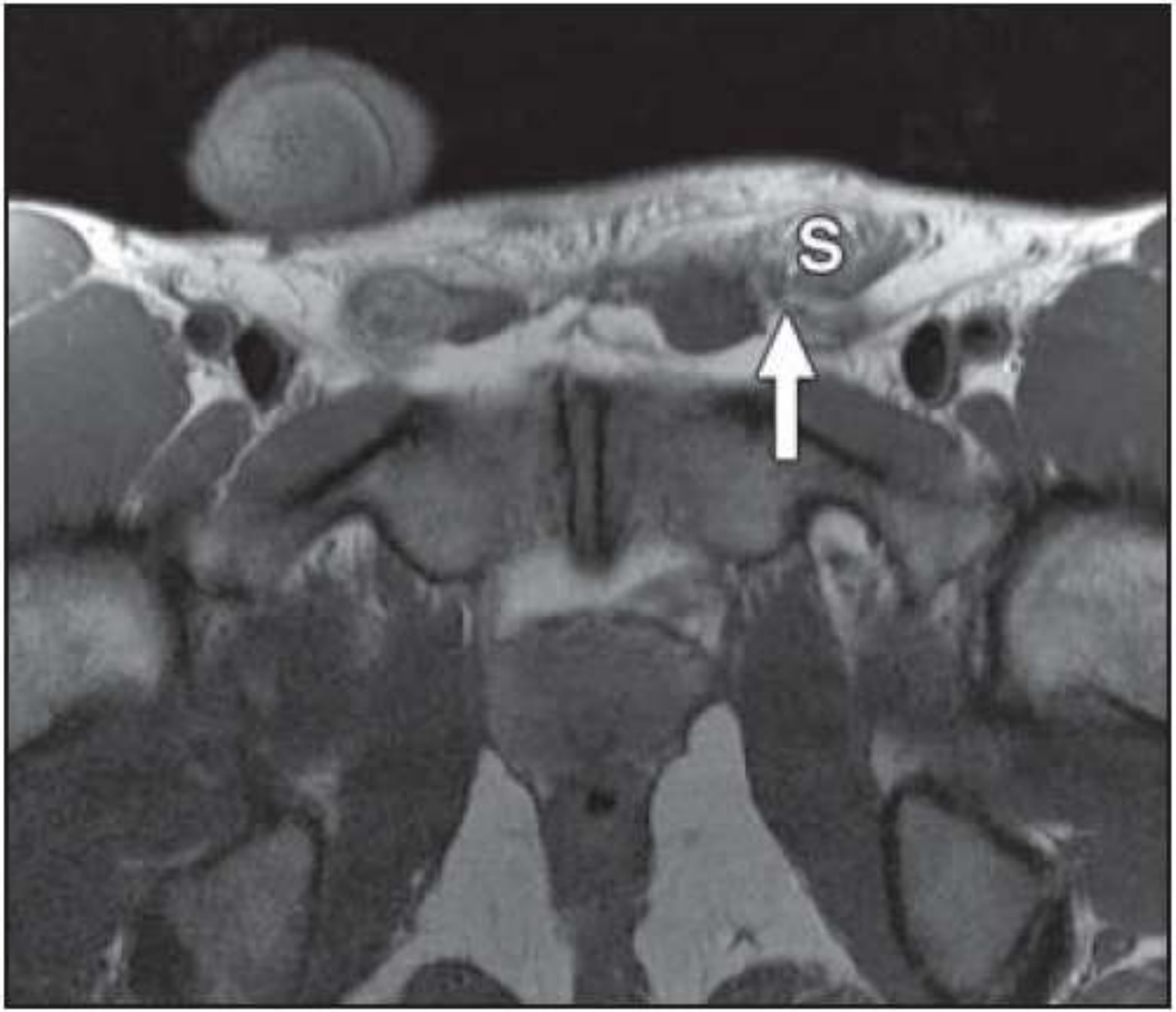
28 yo M Aussie-rules football player with acute disruption of the anterior inguinal wall

Posterior inguinal wall insufficiency

- Weakening or tearing of the conjoint tendon and transversalis fascia at their attachment sites
- May be related to traumatic injury to common adductor-rectus abdominus origin. Injury to this structure may disrupt the attachment of the posterior wall of the inguinal canal onto the rectus sheath.
- Imaging: Some authors believe this is a clinical diagnosis; the use of imaging is debated in the sports medicine literature.
  - Ultrasound in real-time can show loss of the valve-like function of the posterior inguinal ring. However, this finding is not necessarily sensitive or specific and can be seen in asymptomatic patients.
  - Dynamic MRI is being considered explored
- Treatment: Conservative for 6-8 weeks, then surgery, though there is no consensus on surgical technique



Demonstration of normal left posterior inguinal wall bulging on dynamic ultrasound of a patient asymptomatic in this region, showing “ballooning” of the posterior wall



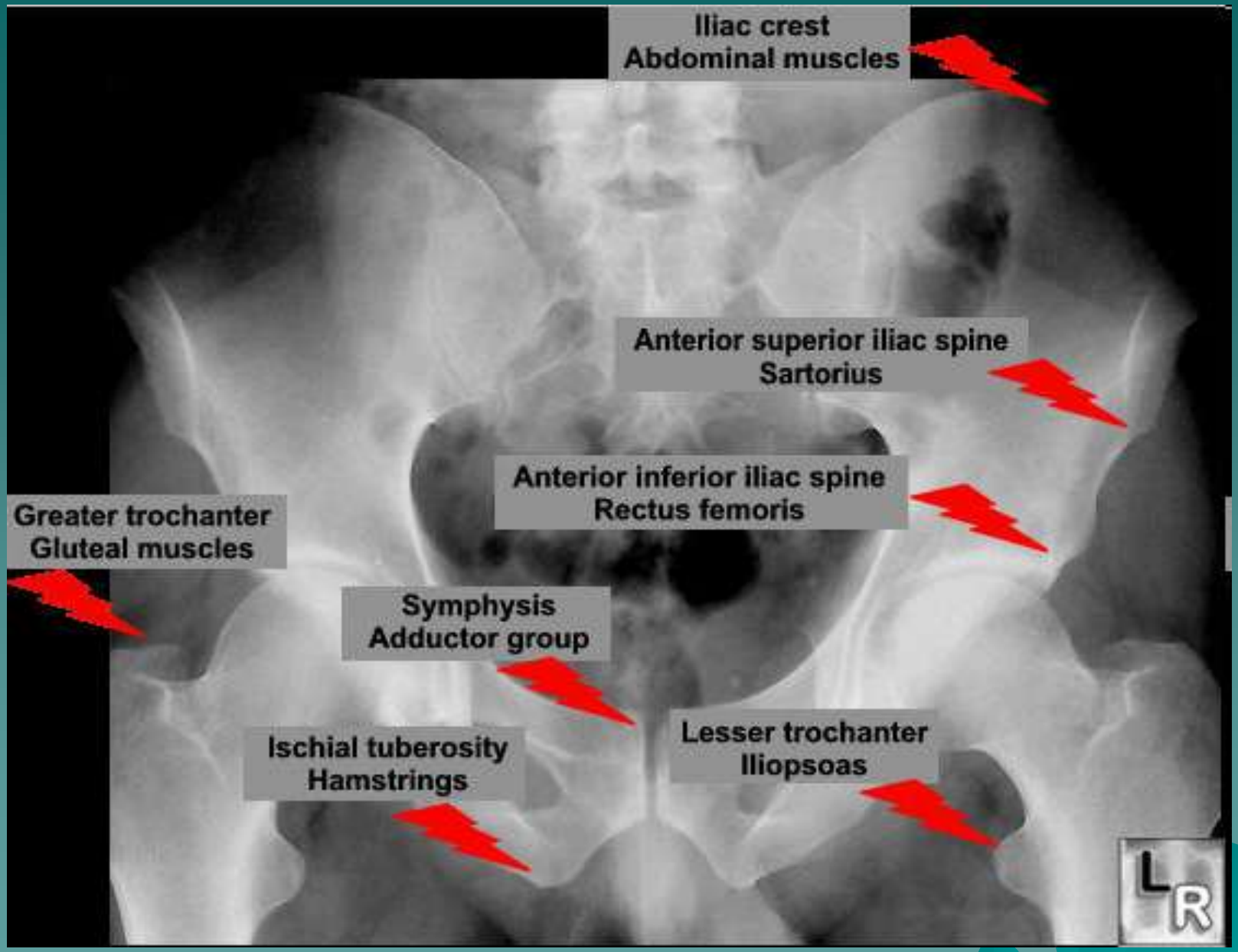
- *AJR*. 2008, 191:962-972.

Muscle, Tendon, and Apophyseal Injury

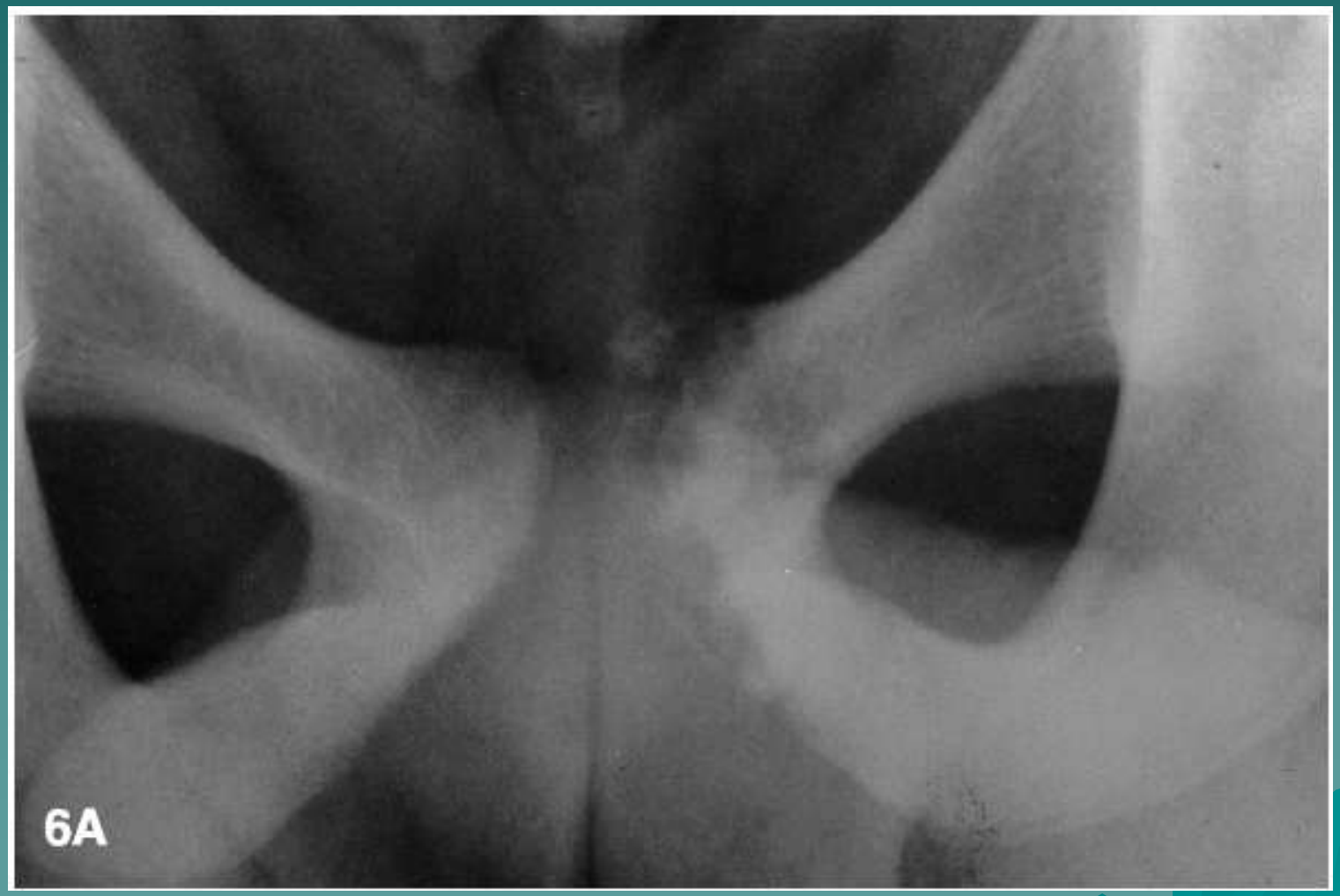
- Manifestations depend on the skeletal maturity of the patient
  - Skeletally immature: site of failure is at the bone, resulting in an apophyseal avulsion or aphophysitis
  - Young, skeletally mature: sites of weakness are the myotendinous junction (muscle strain) and at the enthesis
  - Older, skeletally mature: the degenerated tendon itself may tear

Avulsion fractures

- Occurs in the skeletally immature population, prior to apophyseal fusion
- More common in males, because females fuse earlier
- Clinical presentation mimics muscular pain, can be accompanied by loss of muscular function
- Imaging: Apparent on plain flim.
  - Can be accompanied by osteolysis particularly in the pubic symphysis, mimicking a more aggressive process
  - In the healing phase, can have a mass-like appearance which should not be mistaken for a tumor
  - Approximately 1/3 of patients have more than one avulsion site, which can be a clue to avoid misdiagnosis


Iliac crest
Abdominal muscles
Anterior superior iliac spine
Sartorius
Anterior inferior iliac spine
Rectus femoris
Greater trochanter
Gluteal muscles
Symphysis
Adductor group
Ischial tuberosity
Hamstrings
Lesser trochanter
Iliopsoas
L
R

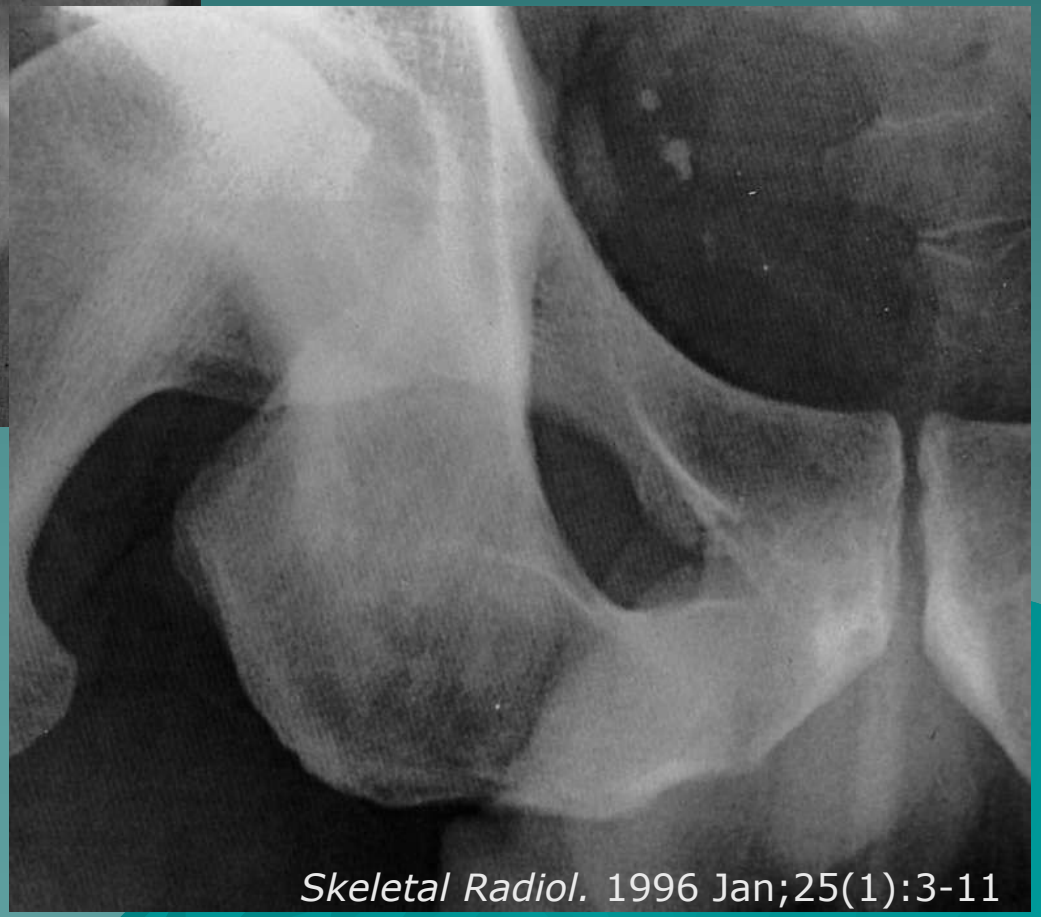
13 year old soccer player with left sided, chronic groin pain



Skeletal Radiol. 1996 Jan;25(1):3-11

Left: Chronic avulsion in a 22 yo athlete

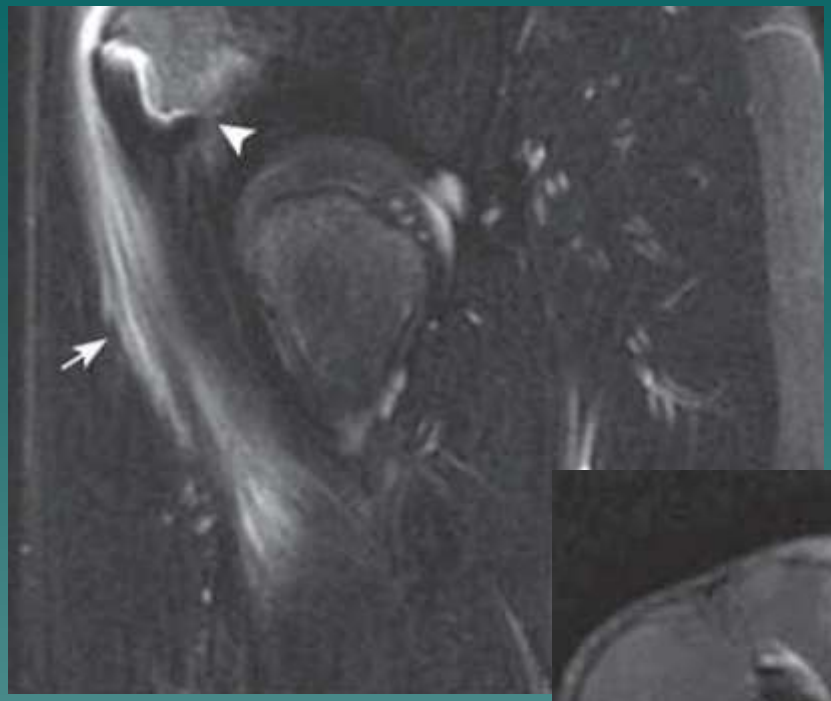
Right: Residual deformity in a 41 yo former high school track athlete



Skeletal Radiol. 1996 Jan;25(1):3-11

Apophysitis

- Same population as apophyseal avulsions
- Repetitive injury
- Imaging: Will not be detected by conventional radiographs. MRI is the study of choice to delineate the inflammatory changes at the apophysis



15 yo M with edema of the right anterior inferior iliac spine with rectus femoris edema

Radio Graphics. 2009; 28(5):1415-38

Muscle Strain vs. Enthesial Injury

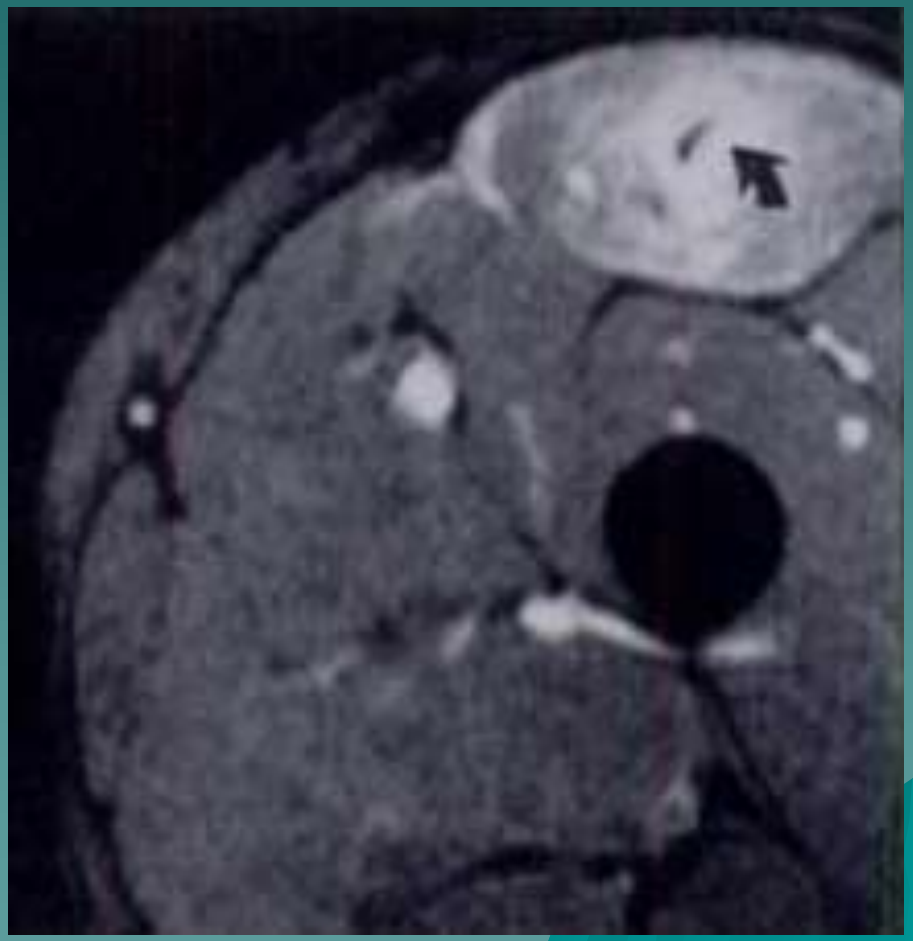
- In general the injury can either be at the myotendinous junction (muscle strain) or at the enthesis.
- The clinical outcome for these entities is very different
  - Chronic myotendinous strain, in the absence of enthesis tears, has a better outcome
  - Enthesial pathology can lead to resistant, chronic groin pain.

Myotendinous Strain

- Most common in muscles that cross two joints
- Grade I: Muscle stretch. Edema at MTJ spreading into adjacent muscle; has a "feathery" appearance. No weakness. Can resolve completely
- Grade II: Partial tear. Edema and hematoma at the MTJ. Associated muscle weakness. May have long term impairment
- Grade III: Complete rupture. Clinically obvious with muscle retraction, loss of muscle function.
- On follow-up imaging: atrophy, fibrosis, and calcium deposition

"Feathery" edema in a Grade I muscle strain

Second degree muscle strain in a 15 yo M with acute onset pain while playing soccer



RadioGraphics, 2000: 20, S295-S315

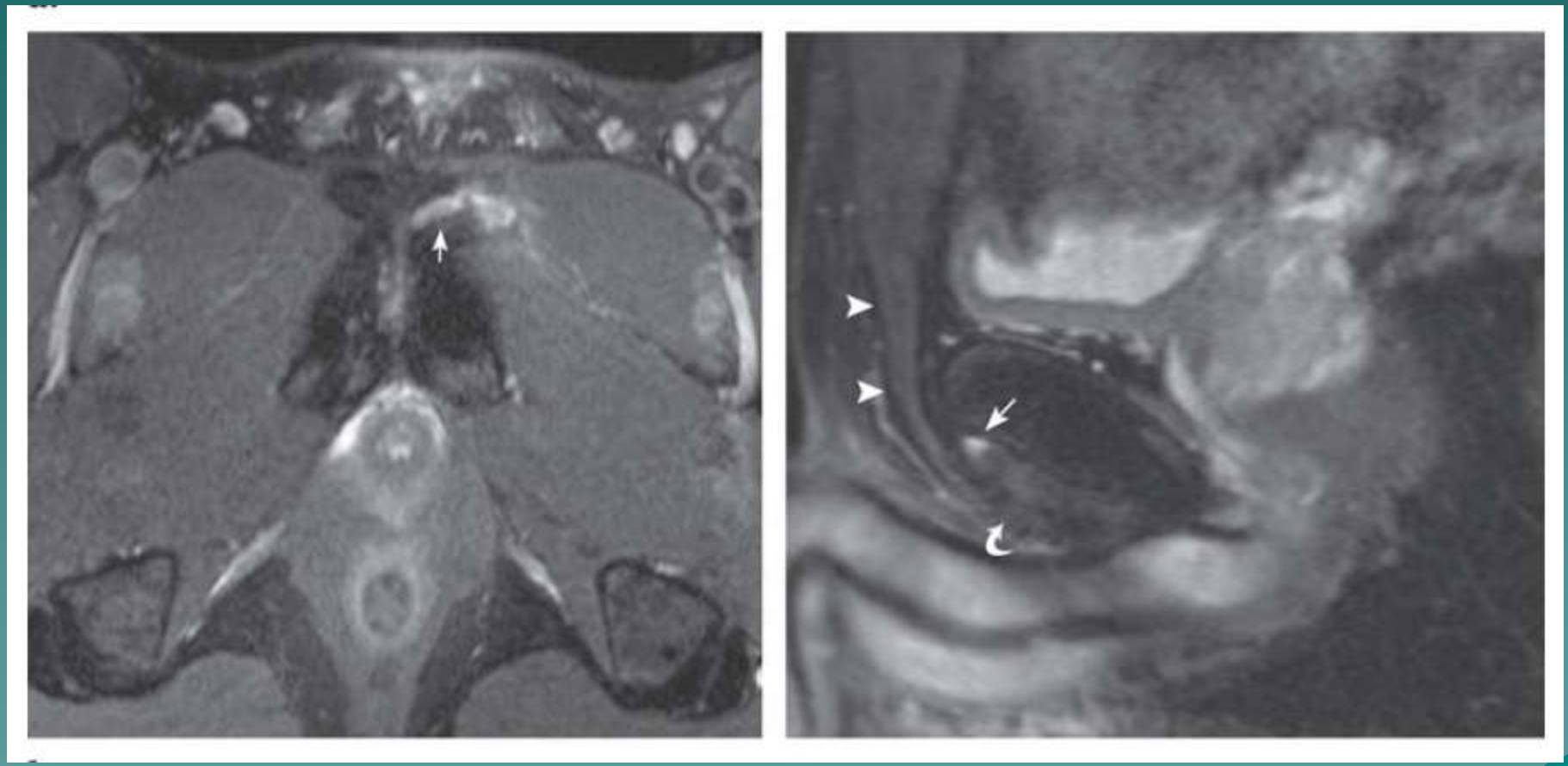
Enthesial Injury

- MRI: study of choice. Abnormal high signal at the muscle attachment or detachment
  - Chronic enthesial injury can result in muscle atrophy

Enthesial injury: common aponeurosis of the rectus abdominus and adductor longus

- Injury to one of these tendons predisposes the opposing tendon to injury by altering the biomechanics and disrupting the anatomic contiguity of the tenoperiosteal origins.
- This leads to instability of the pubic symphysis, which can in turn, worsen pubic symphysis degeneration

Common Adductor-Rectus Abdominus Apponeurosis Injury



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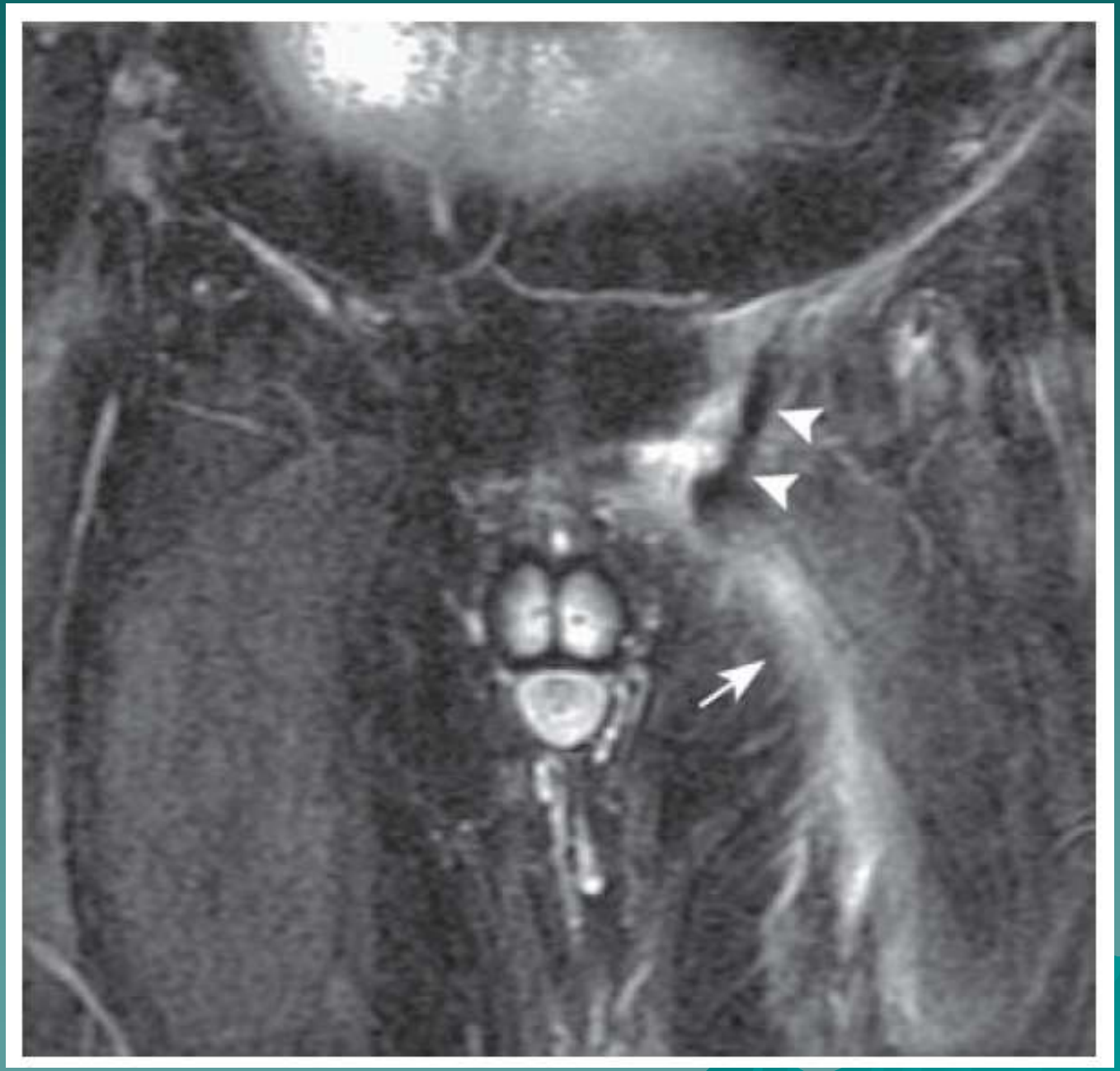
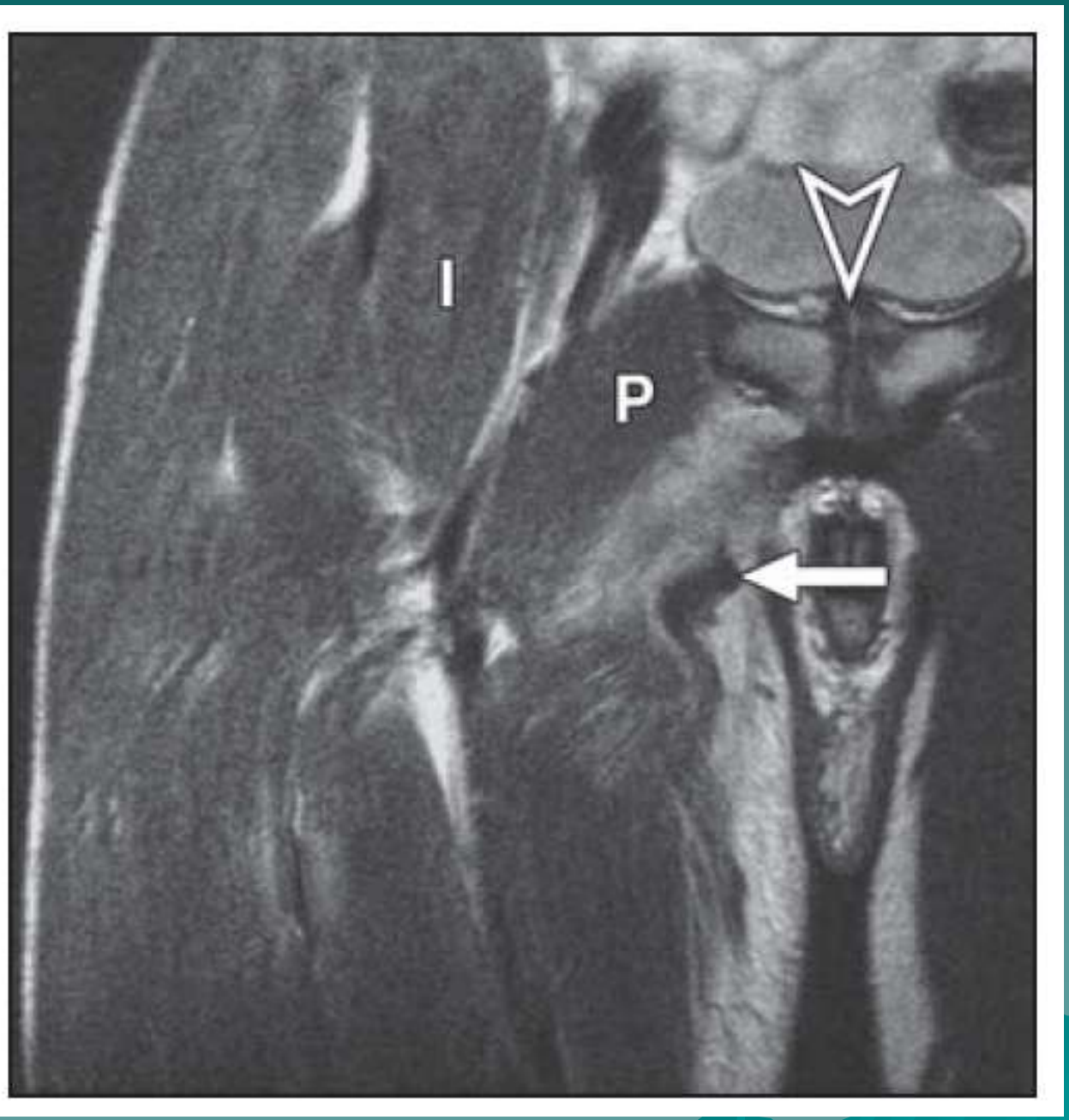
Enthesial Injury: Adductor Longus

- Of the muscles of the groin, the adductor longus is the most frequently injured.
- The adductor longus originates from periosteum free bone. The tendon fibers must pass through poorly vascularized, but richly innervated, transitional zone of calcified cartilage. It is hypothesized that this predisposes the adductor longus to injury.



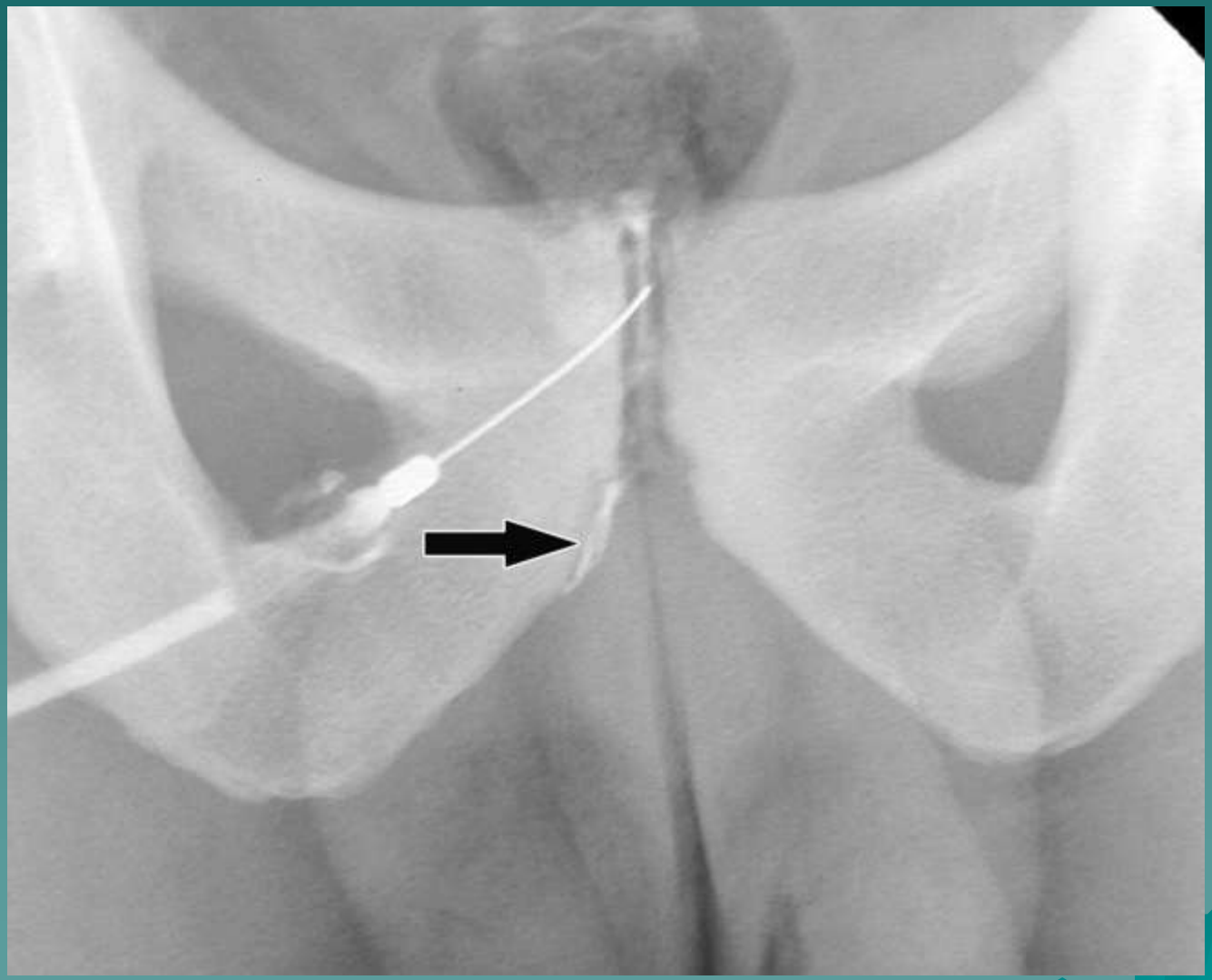


◆*AJR*. 2008, 191:962-972.

Secondary Cleft

- The secondary cleft sign, which appears on the side ipsilateral to the side of groin pain, is thought to be a microtear in the origin of the adductor longus tendon.
- Seen in the setting of symphyseal degeneration. Extrusion of the fibrocartilaginous disc exacerbates the situation by undermining the arcuate ligament complex
- It was initially described at arthrography of the pubic symphysis, but the secondary cleft sign can also be seen on fluid-sensitive MR images

27-year-old male soccer player with long-standing bilateral groin pain that was worse on right side.



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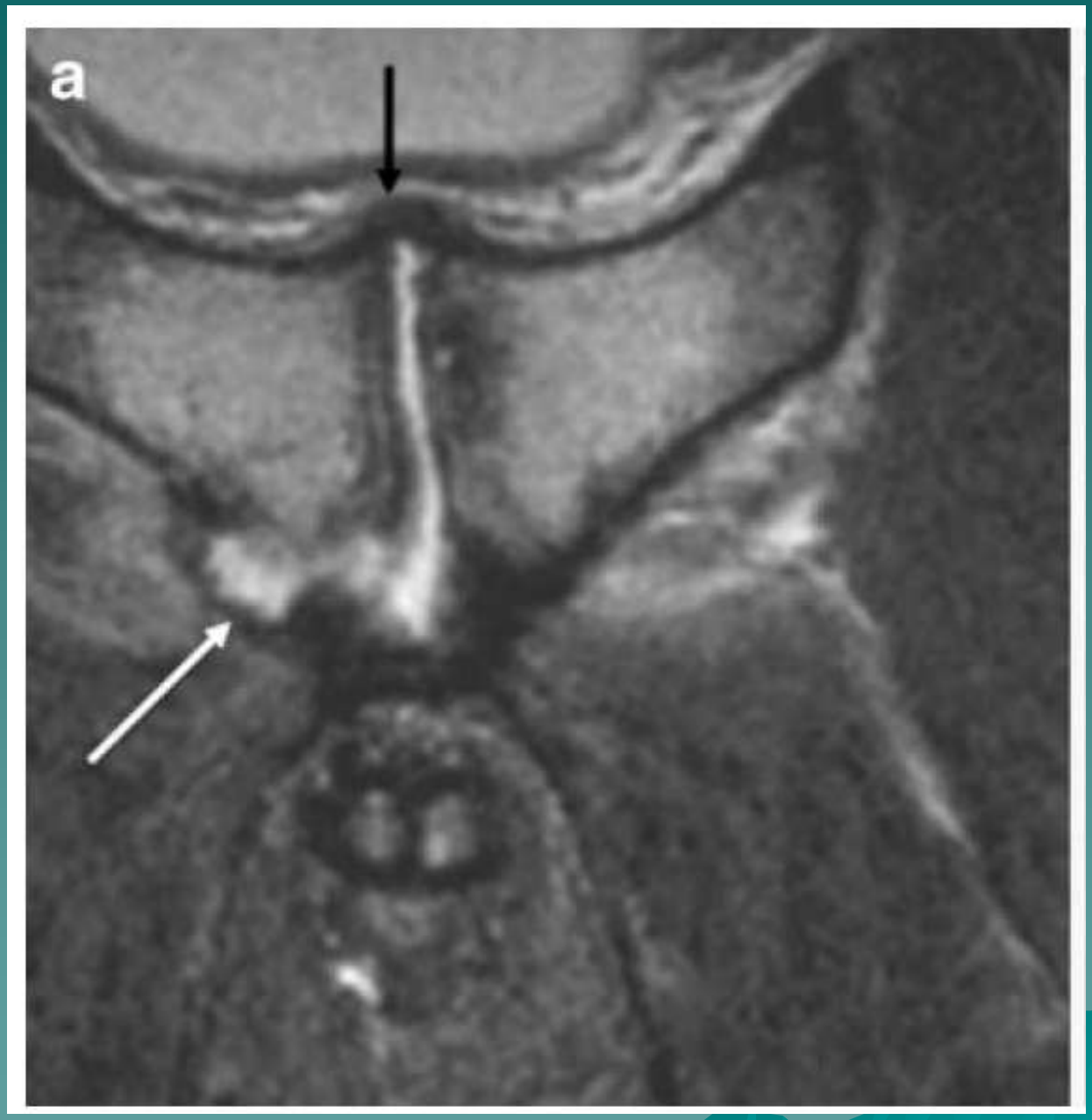
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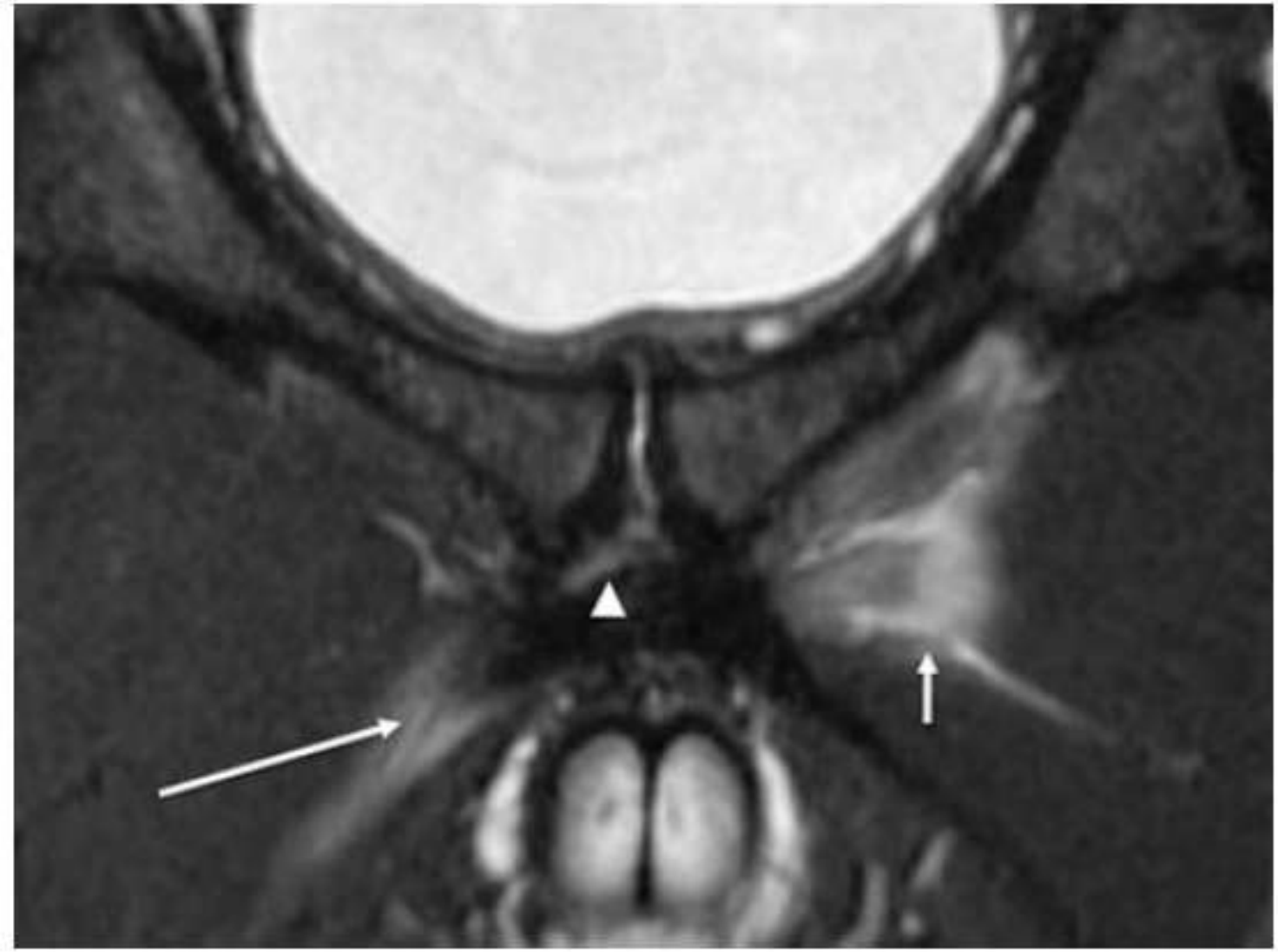
Secondary cleft with edema in the right adductor longus, left adductor brevis.



Rectus Abdominus Enthesial Injury

- Less common; isolated rectus abdominus tears are seen in 27% of cases
- More common in tennis players

- *AJR*. 2008, 191:962-972.

Right rectus abdominus atrophy in a chronic tear

AJR. 2008, 191:962-972.

Rectus Abdominus-Adductor Longus injury in women

- Less common in women, but tend to be more severe in women
- In male patients, the injury is usually unilateral, whereas in females, the injuries usually start at midline and propagate bilaterally

30 yo F runner with a broad based tear of the adductor longus attachments

Treatment of rectus adbominus-adductor longus enthesial injury

- Conservative – rest, ice, NSAIDS, followed by a rehabilitative strengthening program
- Surgical treatment – rare. Reserved for resistant pain
  - Repair of the injured structures: variable success; improvements may be due to ensuing fibrosis which bring stability to the region
  - Mesh stabilization of adjacent inguinal ring: thought to perhaps add stability
  - Adductor tenotomy - may be helpful to some patients, but does not improve stability of the pelvis

Hockey Goalie/Baseball Pitcher Syndrome

- Results from a myofascial herniation of the adductor longus muscle several centimeters from the site of pubic attachment
- Clinical Findings: acute onset pain which is persistent or intermittent. May feel a "mass." Pain localizes distal to the symphysis and the diagnosis is usually clinical
- Imaging Findings: May be normal, but most diagnostic finding is a focal muscle bulge with edema centered on the defect. If suspected, US or dynamic MRI which engages the muscle in question is helpful
- Treatment: Surgical epimysiotomy and debridement

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Other Etiologies of Pain Referred to the Groin

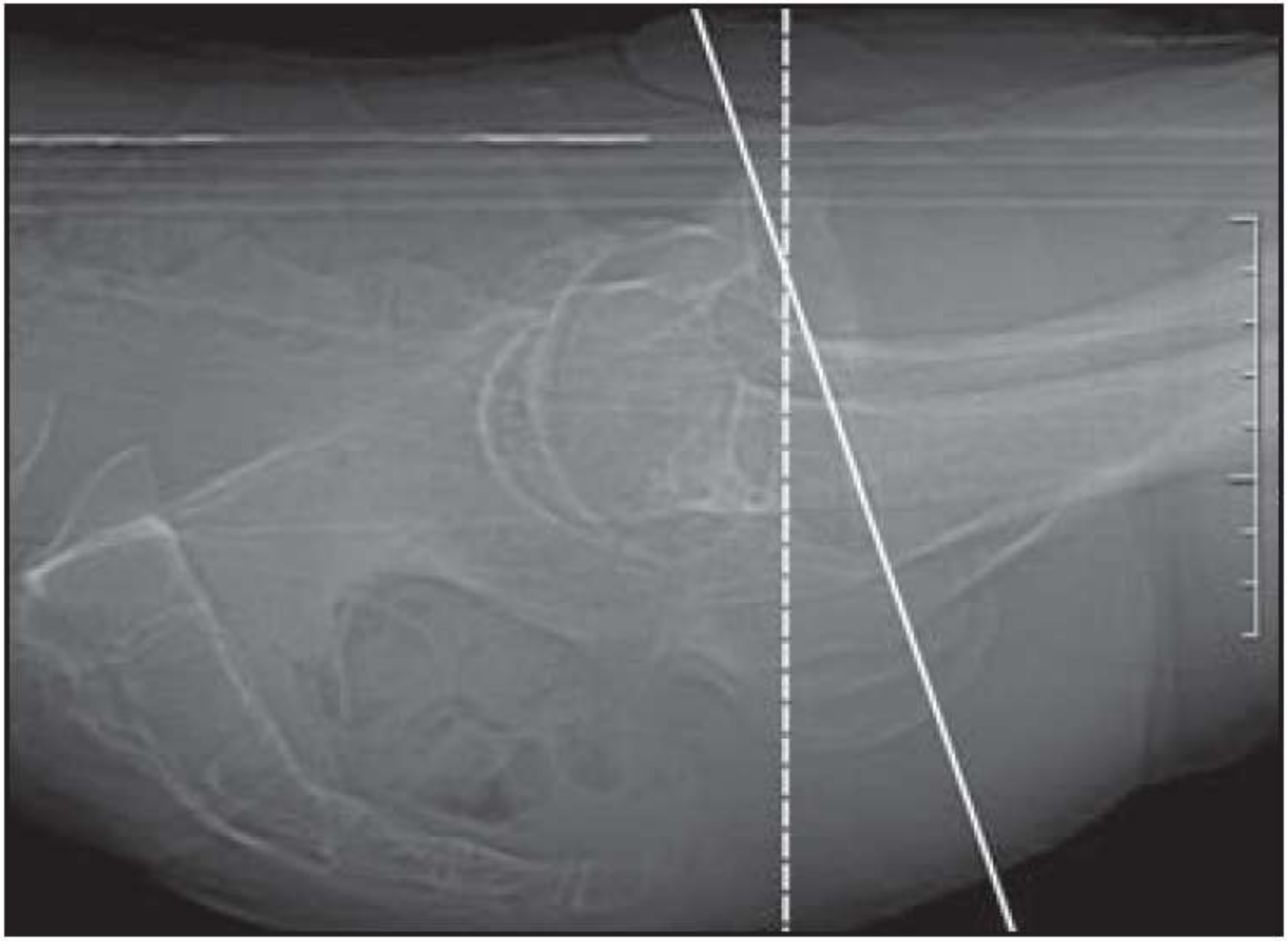
- Bony
  - Osteoid Osteoma
  - Femoral acetabular impingement syndrome
- Soft tissue
  - Labral tear
  - Inguinal hernia
  - Bursitis
  - Nerve entrapment
  - Female athletes: ovarian or uterine pathology

Imaging tips

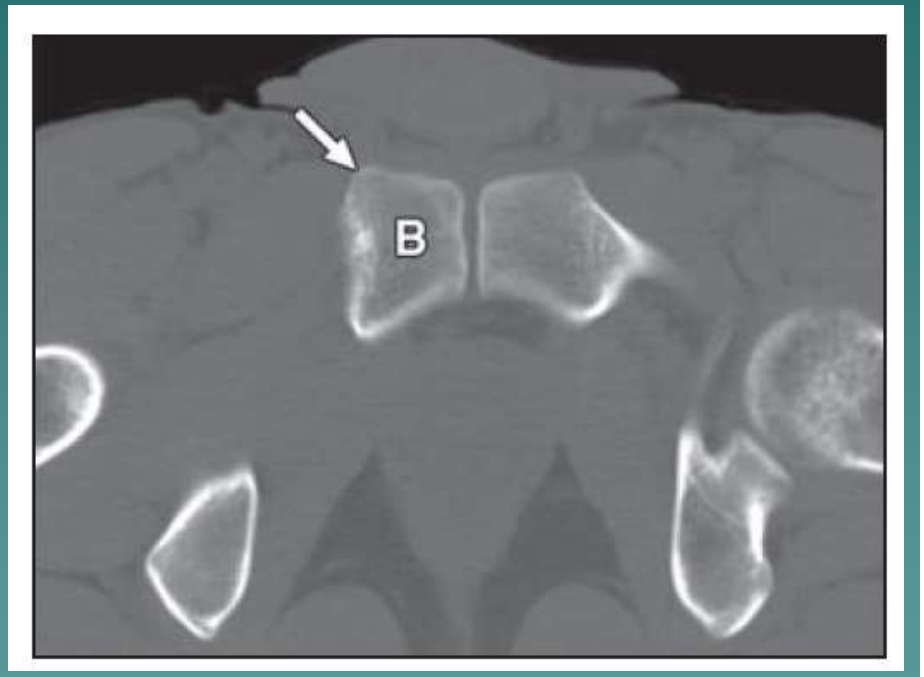
- Some authors advocate performing large FOV images as a screening tool to initiate further imaging, either by ruling out or increasing suspicion for certain pathology, then ordering more specific, high resolution, small FOV imaging
- Others recommend including at least large FOV coronal T1 and fluid sensitive images along with a more targeted study instead of doing two separate studies

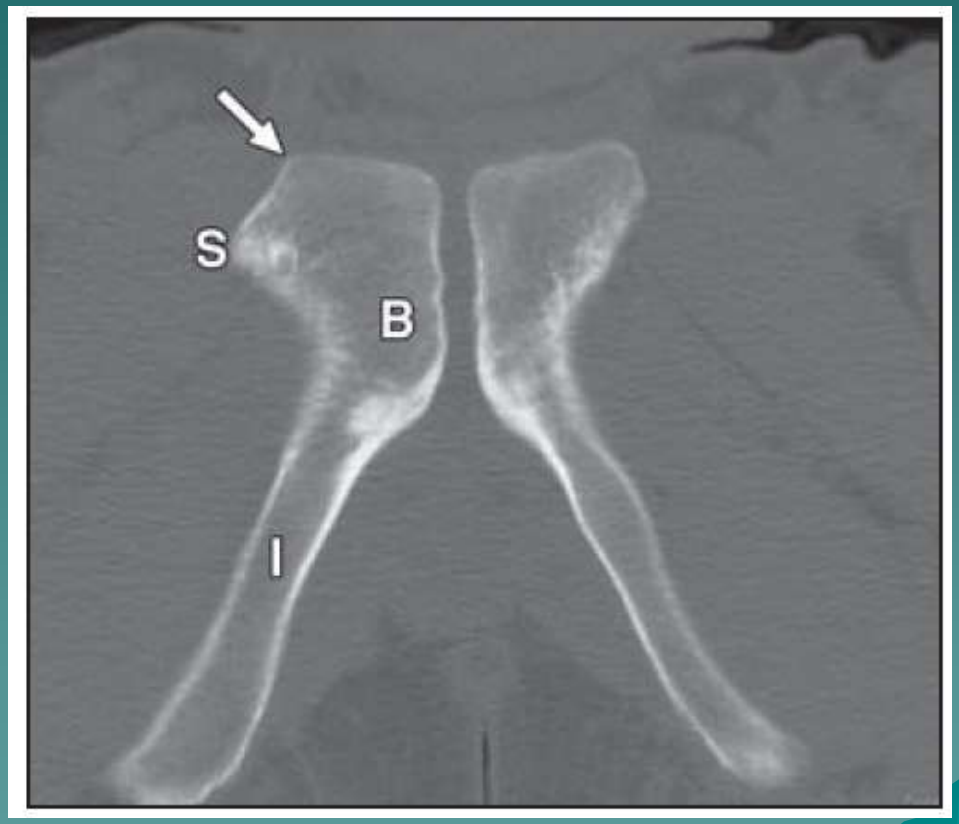
Imaging of pubic symphysis: CT and MRI

- Use a surface coil to improve signal-to-noise ratio, placed in the midline
- Authors recommend an 18 to 20 cm FOV
- Include axial and coronal obliques. Some authors recommend imaging along the plane of the pubic symphysis by reformatting images along an axial oblique plane
  - On CT, this produces better imaging of the subchondral bone plate
  - On MRI, provides better evaluation of the muscles and tendinous attachments



Skeletal radiology. 2009 Aug 27.

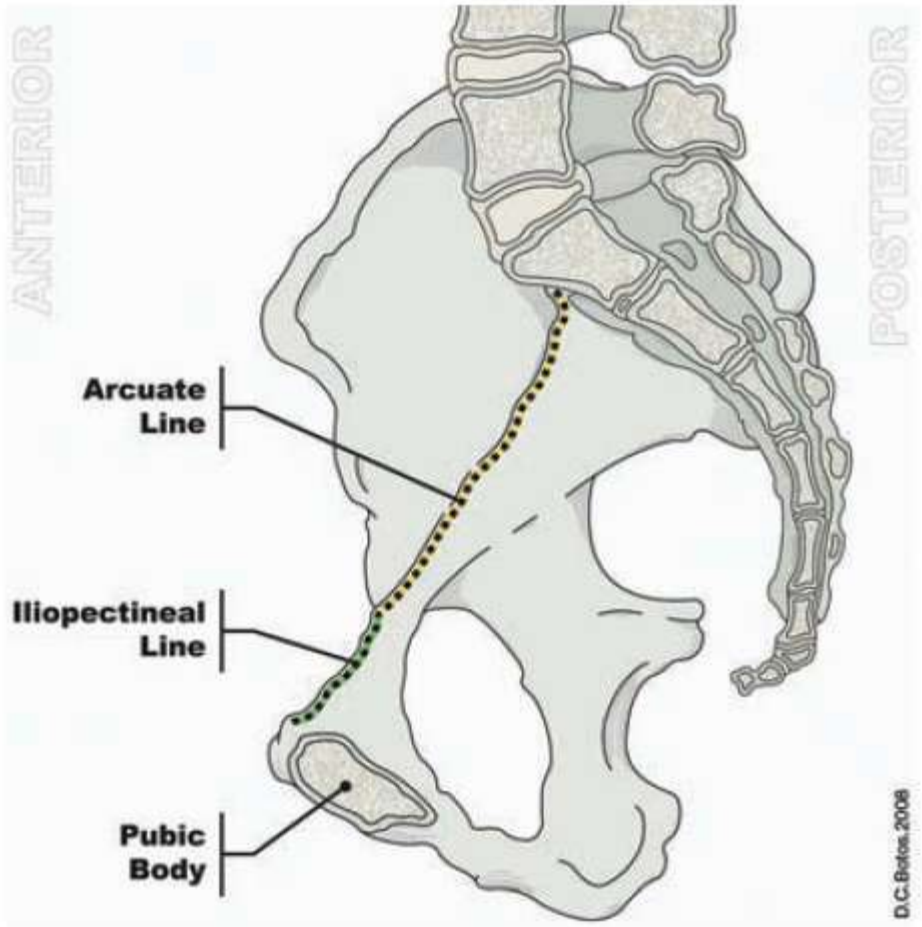


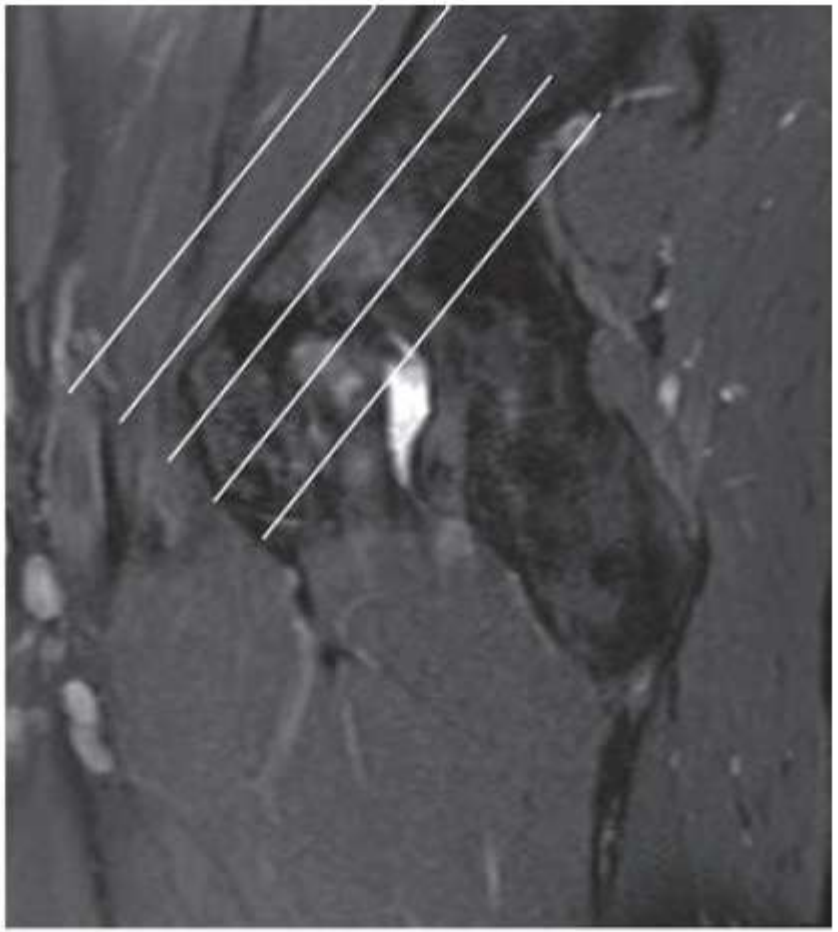


Skeletal radiology. 2009 Aug 27.

Imaging of pubic symphysis: CT and MRI

- Others recommend orienting the axial oblique images along the arcuate line.





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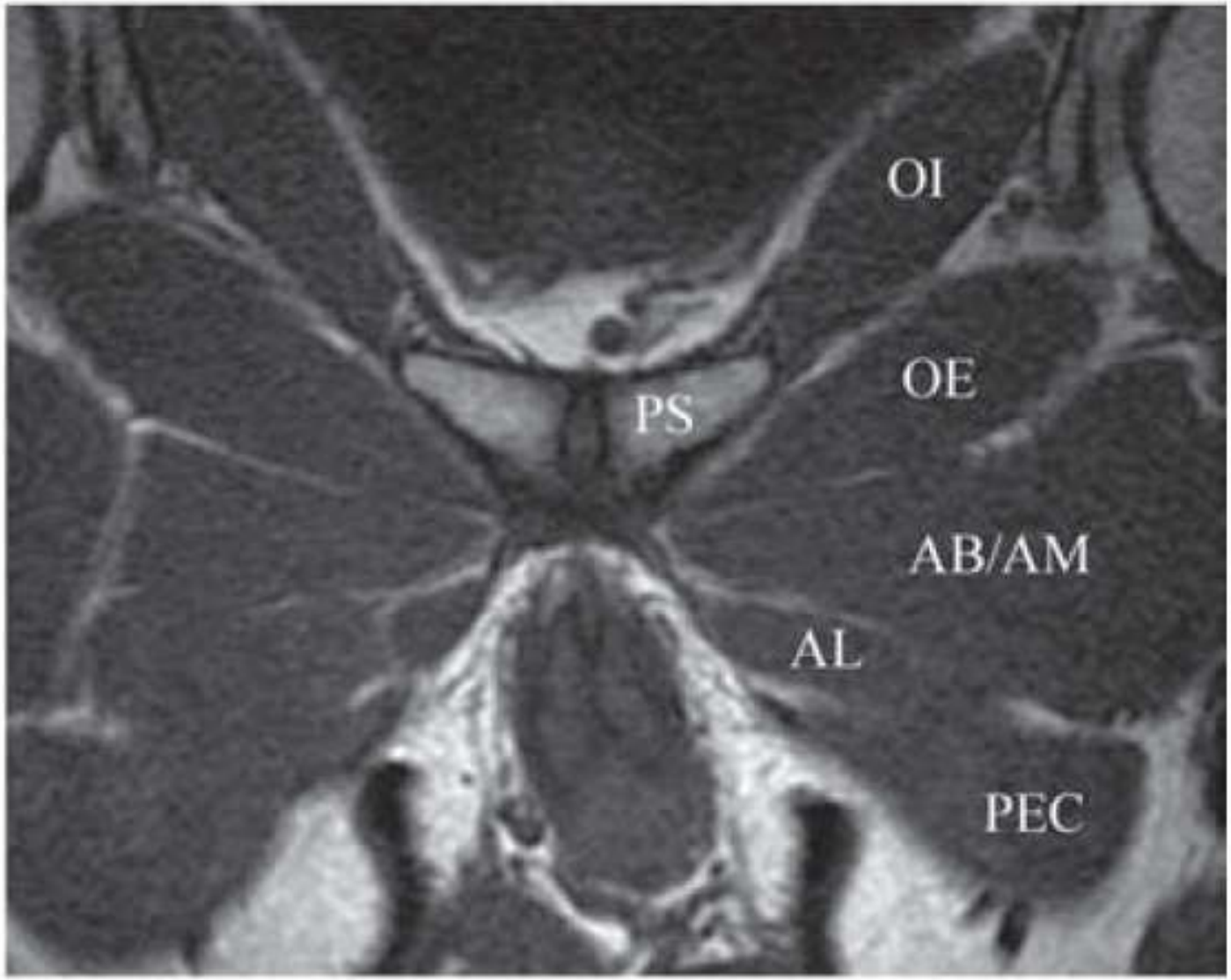

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Conclusions

- Due to the variety of causes of groin pain in the athlete, knowing the anatomy of the pubic region is important for understanding the underlying cause.
- Familiarity with the various bony and soft tissue causes of groin pain will help improve detection of the pathology.
- Always consider the clinical picture, given the wide range of radiographically apparent but clinically insignificant findings.
- The clinical terms describing the pathologies about the pubis are confusing, and often defined differently by clinicians and radiologists. If possible, try to give the most specific diagnosis and avoid confusing terms
- If the indication for the exam is groin pain in the athlete, tailoring the imaging towards the likely causes may improve evaluation of structures around the symphysis.

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