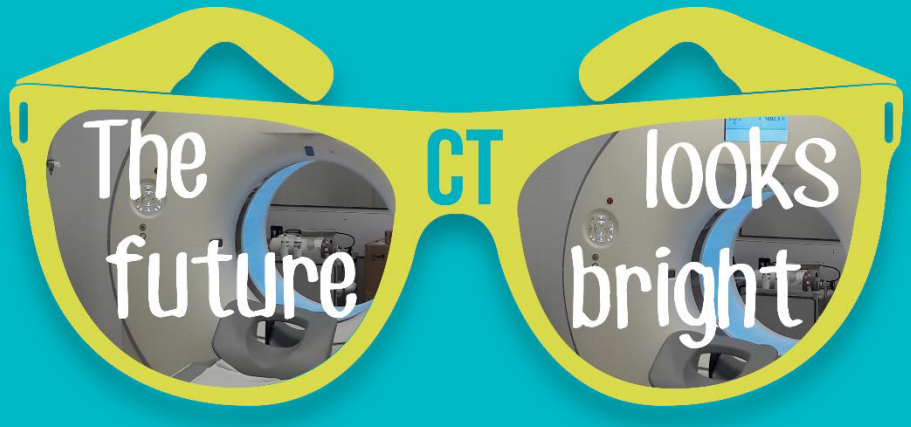

Waarvoor liever geen CT?

Endry Willems

Medische Beeldvorming ZOL

CT relative contra-indications

- Young age
- Pregnancy
- Contrast allergy
- Weight/girth

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Guidelines

RADIA®

Referring Physician Ordering Guide: What to Order When

The radiologists at Radia have developed the following scanning guidelines for our referring providers to assist you in selecting the most effective imaging modality for your patient's clinical presentation. This booklet is intended only as a guideline. To schedule a study or consult with a radiologist, please call 877-997-2342.

NEURORADIOLOGY ORDERING GUIDELINES

BRAIN

Indication	Preferred Study
Headache	CT head without contrast for acute ("worst headache of life"). MRI without contrast
Trauma	CT head without contrast (acute). Concussion/TBI: MRI without and with contrast with DTI
Suspected intracranial hemorrhage	CT head without contrast
Acute neurological changes	CT head without contrast (only if concern for ICH) Subsequent study: MRI with and without contrast
Acute stroke/TIA	CT head without contrast (if candidate for thrombolysis) Subsequent studies: MRI brain with /without contrast (with MR perfusion), MRA brain and MRA neck without and with contrast as indicated
Hydrocephalus	If concern for shunt malfunction CT head without contrast. Alternative for more acute processes: MRI with and without contrast
Seizure	First (New Onset) seizures: MRI Brain with and without contrast (CT Head if patient unstable / concern for ICH).
Temporal lobe epilepsy	MRI without and with contrast with hippocampal volumes. Brain SPECT as needed
Dementia / Memory loss	MRI brain with & without contrast (Hippocampal volumetrics (Alzheimer's disease), perfusion, aqueductal stroke volume measurement (NPH)). PET can also be considered for Alzheimer's diagnosis

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2017 MAGELLAN[1] CLINICAL GUIDELINES FOR MEDICAL NECESSITY REVIEW

Version: 3
Effective: January 2017

: "National Imaging Associates, Inc. is a subsidiary of Magellan Healthcare, Inc."

Magellan HEALTHCARE

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POORMD.COM
...appears to be a possible, borderline, indeterminate, equivocol, suspected pixel, probably of questionable significance. Clinical correlation needed... maybe...
M

Headache

- First Presentation
- Worst headache of my life / thunderclap headache
- Primary vs secondary cause of headache
- …..

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Headache

The sensitivity for CT-based diagnosis of subarachnoid haemorrhage was 92.9%, the specificity was **100%**. When the CT was acquired within 6 h of disease onset, sensitivity was increased to **100%**.

Perry JJ. Et al., Sensitivity of computed tomography performed within six hours of onset of headache for diagnosis of subarachnoid haemorrhage: prospective cohort study, BMJ. 2011 Jul 18: 343:d4277

Headache

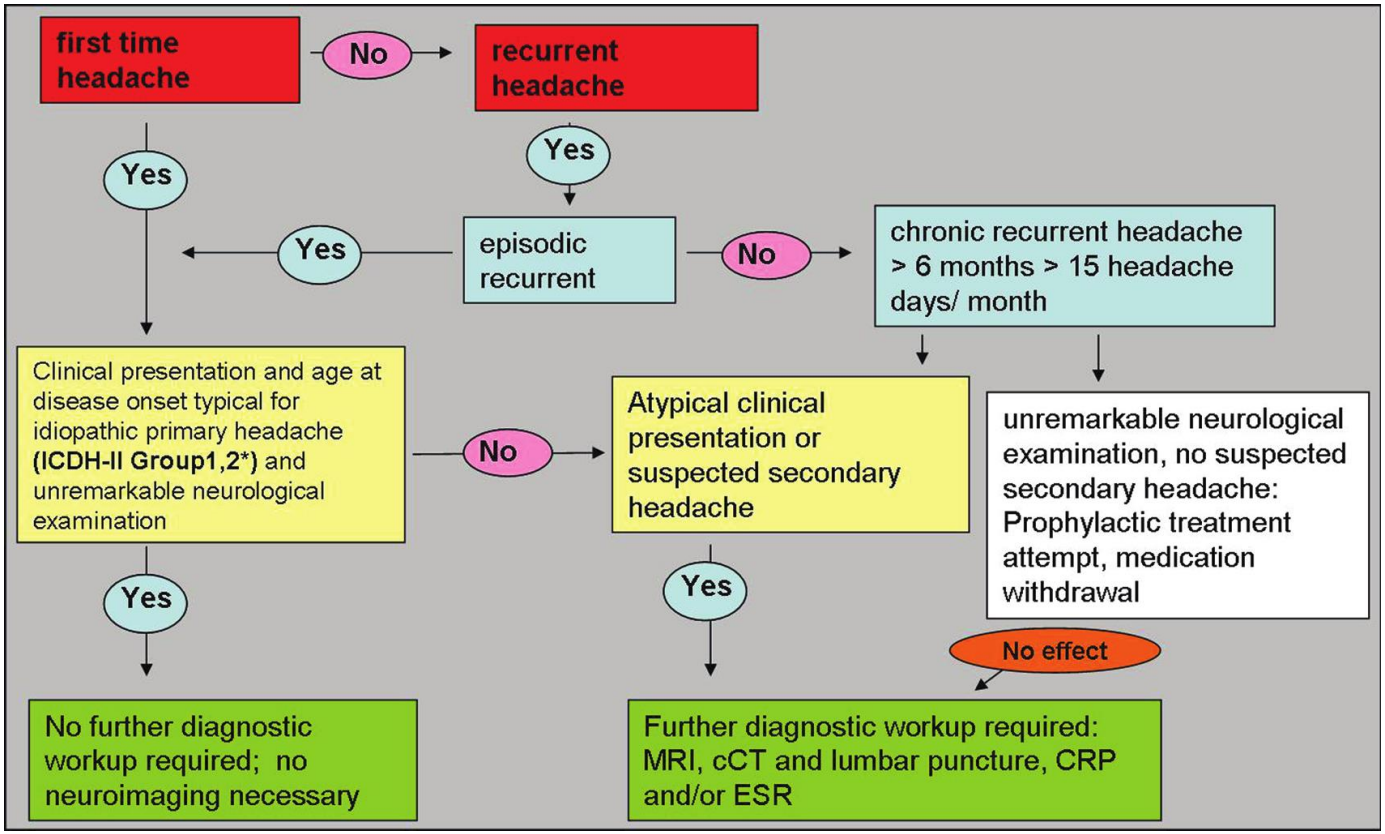

Figure 1. Decision tree for neuroimaging in headache.
*ICHD-II Group 1: migraine; Group 2: tension-type headache. CRP, C-reactive protein; cCT, cerebral computed tomography; ESR, erythrocyte sedimentation rate; ICHD, International Classification of Headache Disorders; MRI, magnetic resonance imaging.

Holle D. et al., the role of neuro-imaging in the diagnosis of headache disorders, ther adv neurol disord. 2013 Nov; 6 (6): 369-374

Headache

Which neuroimaging should be performed in non acute headache?

Data are insufficient regarding the relative sensitivity of MRI compared with CT in nonacute headaches. However, MRI offers a greater resolution and discrimination and might therefore be the preferred method of choice in nonacute headache. In addition, radiation due to CT scanning may be avoided.

Holle D. et al., the role of neuro-imaging in the diagnosis of headache disorders, ther adv neurol disord. 2013 Nov; 6 (6): 369-374

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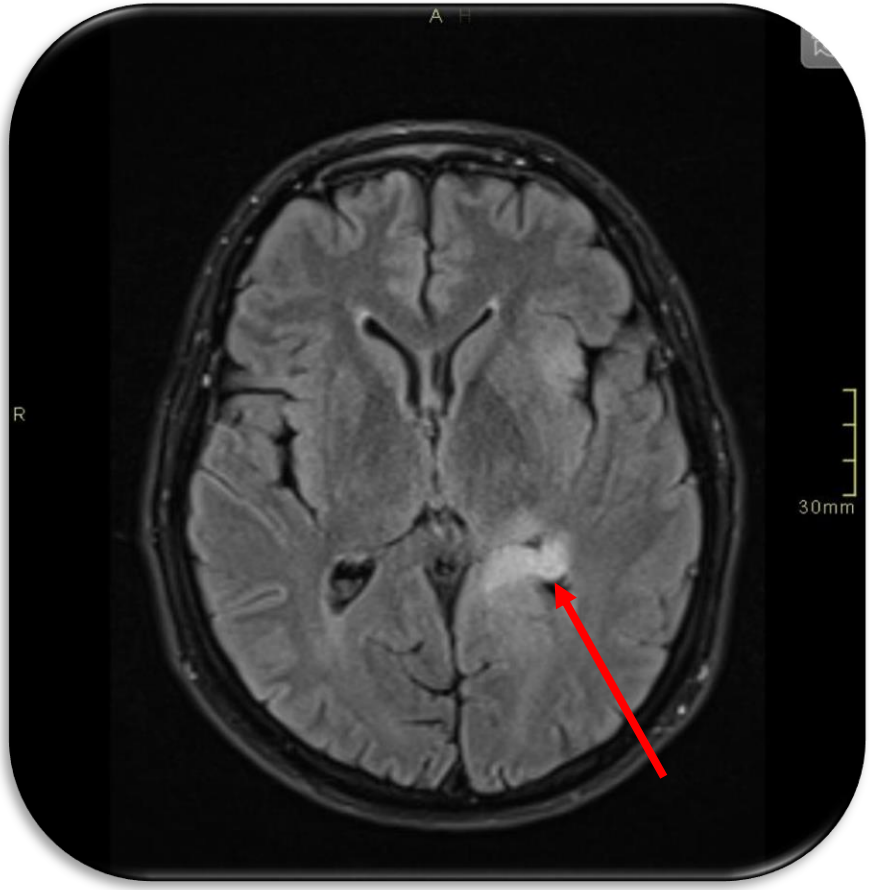
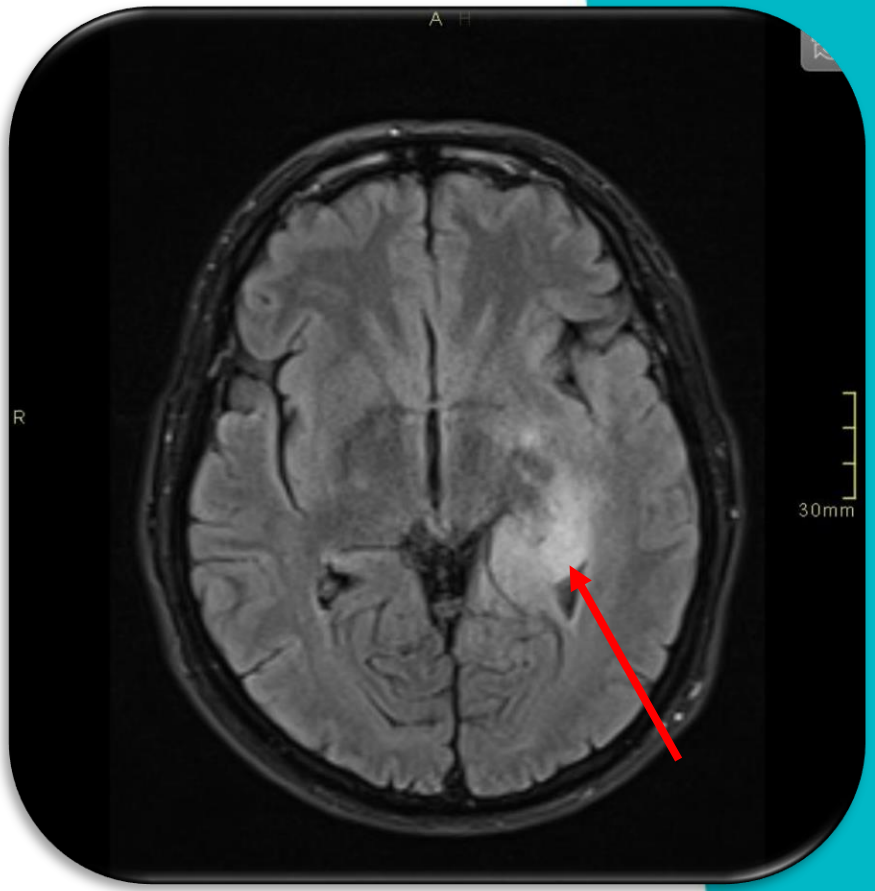
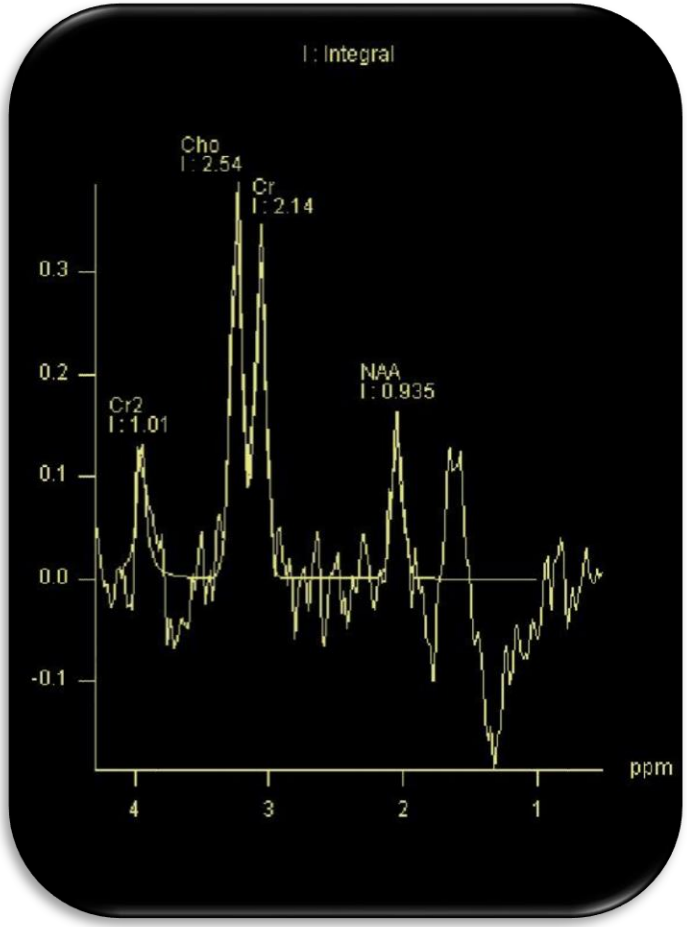
Headache

Headache





Headache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Headache

Indications for CT?

- To rule out intracranial haemorraghe
- Ventricular size
- Fracture
- ……

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Vertigo - Dizziness

Peripheral causes

- Acute labyrinthitis
- Acute vestibular neuronitis (vestibular neuritis)
- Benign positional paroxysmal vertigo (benign positional vertigo)
- Cholesteatoma
- Herpes zoster oticus (Ramsay Hunt syndrome)
- Ménière's disease (Ménière's syndrome, endolymphatic hydrops)
- Otosclerosis
- Perilymphatic fistula

Vertigo - Dizziness

Central causes

- Neoplastic lesions
- Schwannoma (acoustic neuroma) meningioma
- Arachnoid cyst
- Epidermoid cyst
- Leptomeningeal neoplastic seeding lipoma
- Hemangioma
- Non-neoplastic lesions
- Sarcoidosis
- Meningitis
- Vascular loop
- Siderosis
- Intra-axial auditory pathways
- Ischemic lesions
- Neoplastic lesions
- Traumatic lesions
- Demyelinating lesions

Vertigo - Dizziness

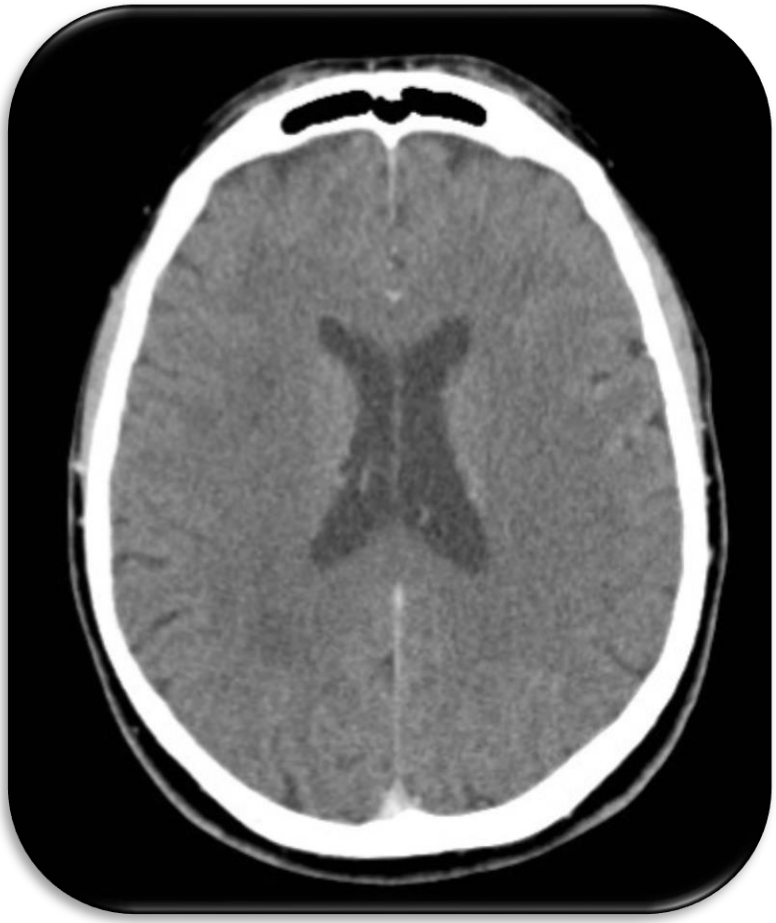
Table 1: Rating of techniques: Clinical condition—vertigo and hearing loss*

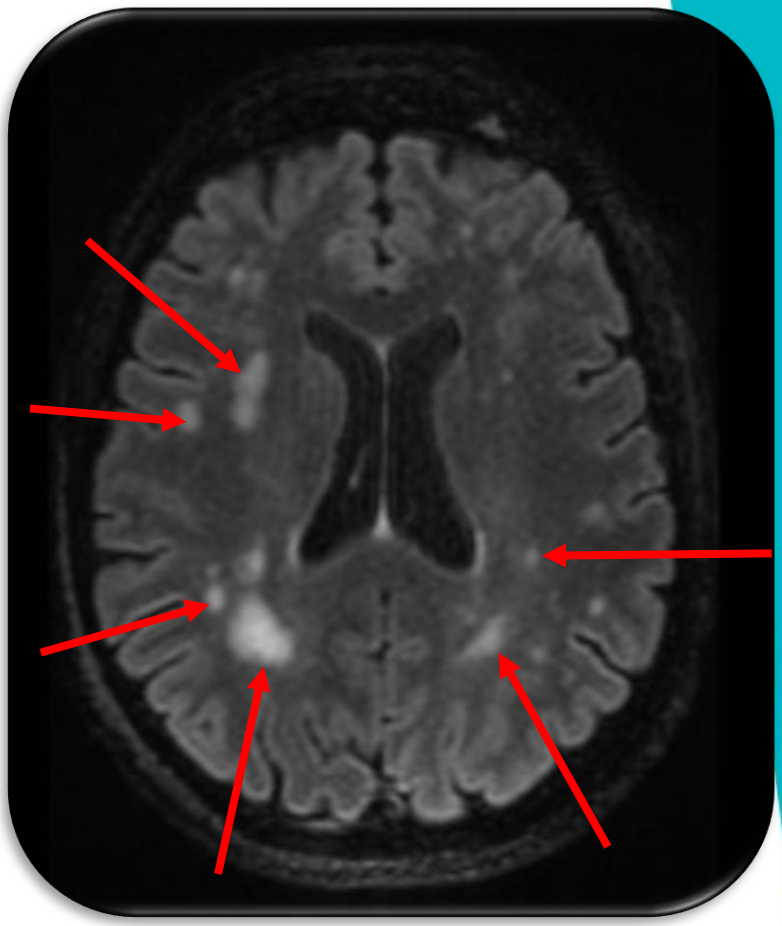
	MRI head and internal auditory canal without and with contrast	*MRI head and internal auditory canal without contrast*	*CT temporal bone without contrast*	*CT head without and with contrast*	*MRA head with or without contrast*	*CTA head*
Sensorineural hearing loss, acute and intermittent vertigo	8	7	6†	3	N/A	N/A
Sensorineural hearing loss, no vertigo	8	7	5	4	N/A	N/A
Conductive hearing loss, rule out petrous bone abnormality	3	3‡	8	3	N/A	N/A
Total deafness, cochlear implant candidate, surgical planning	5	5	9	3	N/A	N/A
Fluctuating hearing loss, history of meningitis or to rule out congenital anomaly	7	7	8	4	N/A	N/A
Episodic vertigo, new onset (hours to days)	7	6	4	5	6	5
Vertigo, no hearing loss, normal findings on neurologic examination	8	7	5	4	N/A	N/A

Note: MRI: Magnetic resonance imaging; MRA: MR angiography; CTA: CT angiography; N/A: Not rated; *Appropriateness criteria scale from 1 to 9; 1 indicates least appropriate; **Most appropriate; †For possible cholesteatoma with labyrinthine fistula; ‡MR imaging is superior to CT for the detection of dural invasion and extradural extension

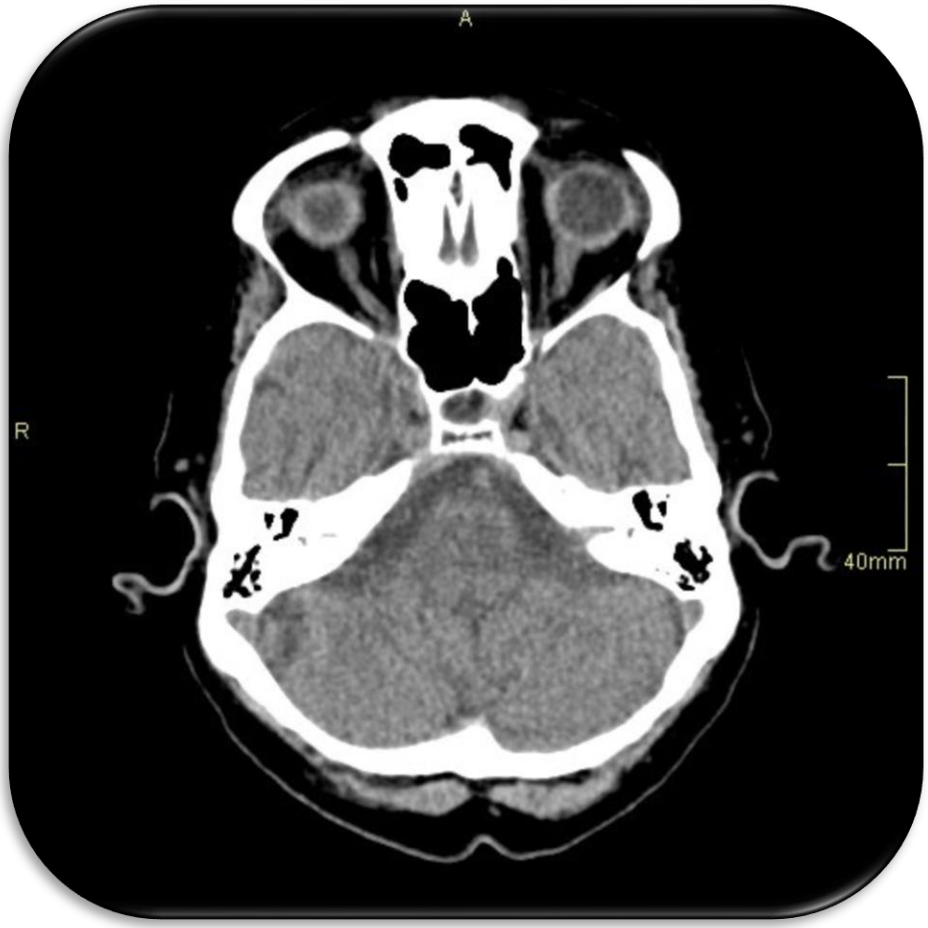
Patkar D. et al., Radiology in Vertigo and Dizziness, Otorhinolaryngol Clin. Int. J. 2012; 4(2): 86-92

Vertigo - Dizziness

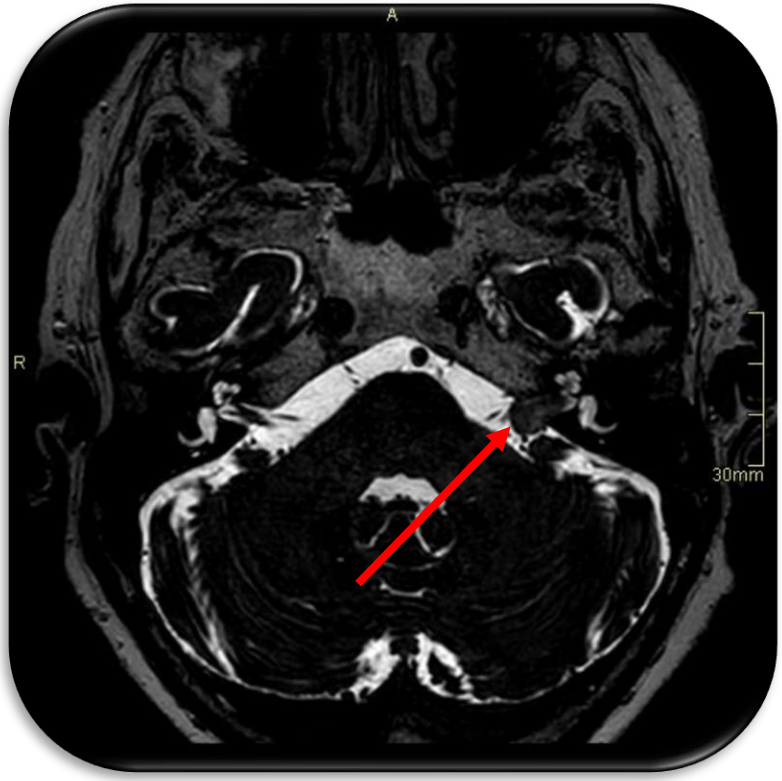


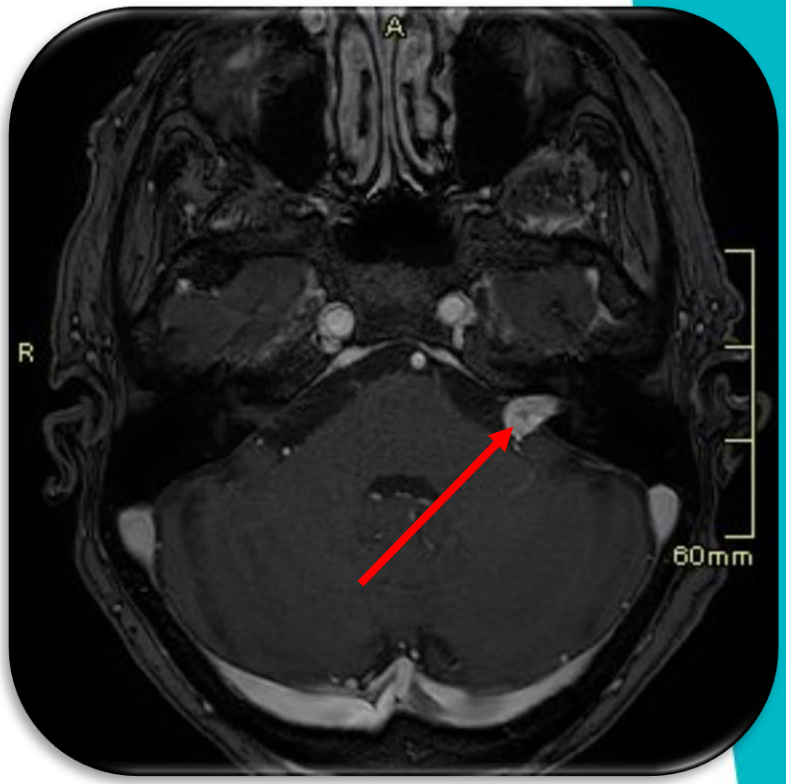


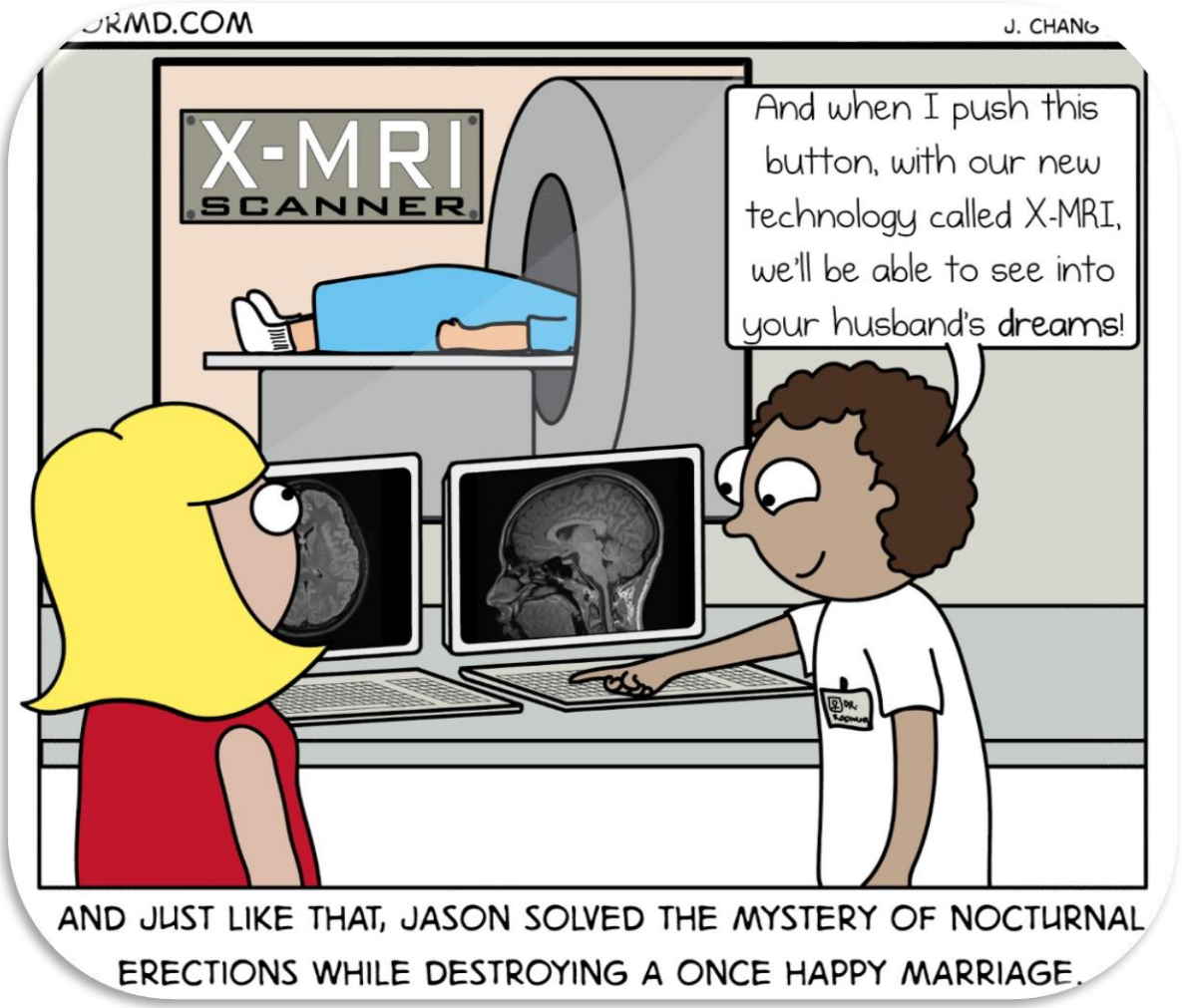
Vertigo - Dizziness



Vertigo - Dizziness



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J. CHANG
X-MRI
SCANNER
And when I push this button, with our new technology called X-MRI, we'll be able to see into your husband's dreams!
AND JUST LIKE THAT, JASON SOLVED THE MYSTERY OF NOCTURNAL ERECTIONS WHILE DESTROYING A ONCE HAPPY MARRIAGE.

Right upper quadrant pain

Causes of right upper quadrant (RUQ) abdominal pain

RUQ	Clinical features	Comments
Biliary		
Biliary colic	Intense, dull discomfort located in the RUQ or epigastrium. Associated with nausea, vomiting, and diaphoresis. Generally lasts at least 30 minutes, plateauing within 1 hour. Benign abdominal examination.	Patients are generally well-appearing.
Acute cholecystitis	Prolonged (>4 to 6 hours) RUQ or epigastric pain, fever. Patients will have abdominal guarding and Murphy's sign.	
Acute cholangitis	Fever, jaundice, RUQ pain.	May have atypical presentation in older adults or immunosuppressed patients.
Sphincter of Oddi dysfunction	RUQ pain similar to other biliary pain.	Biliary type pain without other apparent causes.
Hepatic		
Acute hepatitis	RUQ pain with fatigue, malaise, nausea, vomiting, and anorexia. Patients may also have jaundice, dark urine, and light-colored stools.	Variety of etiologies include hepatitis A, alcohol, and drug-induced.
Perihepatitis (Fitz-Hugh-Curtis syndrome)	RUQ pain with a pleuritic component, pain is sometimes referred to the right shoulder.	Aminotransferases are usually normal or only slightly elevated.
Liver abscess	Fever and abdominal pain are the most common symptoms.	Risk factors include diabetes, underlying hepatobiliary or pancreatic disease, or liver transplant.
Budd-Chiari syndrome	Symptoms include fever, abdominal pain, abdominal distention (from ascites), lower extremity edema, jaundice, gastrointestinal bleeding, and/or hepatic encephalopathy.	Variety of causes.
Portal vein thrombosis	Symptoms include abdominal pain, dyspepsia, or gastrointestinal bleeding.	Clinical manifestations depend on extent of obstruction and speed of development. Most commonly associated with cirrhosis.

Penner R. et al. Up To Date

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Right upper quadrant pain

- Acute cholecystitis (AC) is the **primary diagnostic concern** in the setting of acute right upper quadrant pain. It may be life threatening, so correct, timely diagnosis is essential for proper treatment.
- **Ultrasound** for AC: sensitivity of 88% and specificity of 80%,
- **MRI** can be the **next best** imaging modality when AC is excluded, and it is considered the best modality for evaluating hepatic and biliary abnormalities that are not characterized by ultrasound.
- CT can confirm or refute the diagnosis of AC in equivocal cases and reveal such **complications** as gangrene, gas formation, intraluminal hemorrhage, and perforation

Yarmish G. et al. ACR Appropriateness Criteria Right Upper Quadrant Pain. J Am Coll Radiol. 2014 Mar; 11(3):316-322

Right upper quadrant pain

Gallstones

- Cholesterol (10%)

  >50% cholesterol contents; form with supersaturation of bile, nucleation and stone growth

- Mixed (80%)

  20-50% cholesterol content

- Pigment stones (10%)

  <20% cholesterol content; high bilirubin content and occur when there is supersaturation of unconjugated bilirubin

Bortoff G. et al. Galbladder stones: imaging and intervention. RadioGraphics 2000; 20:751–766
Chuang S-C, Hsi E, Lee K-T. Genetics of gallstone disease. Adv. Clin. Chem. [Internet]. 2013 Jan [cited 2013 Nov 12];60:143–85.

Right upper quadrant pain

- Gallstones occur in ~10% of the population with a predominance in women (F:M = 2:1). The prevalence increases with age in both sexes.
- Approximately **15%–20%** of gallstones contain enough calcium to be **visible on plain radiographs**.
- **Ultrasound** remains the **method of choice** for detection of gallstones, offering several advantages: high sensitivity and accuracy (>95%), noninvasiveness, the option of performing a bedside examination, lack of ionizing radiation and relatively low cost.

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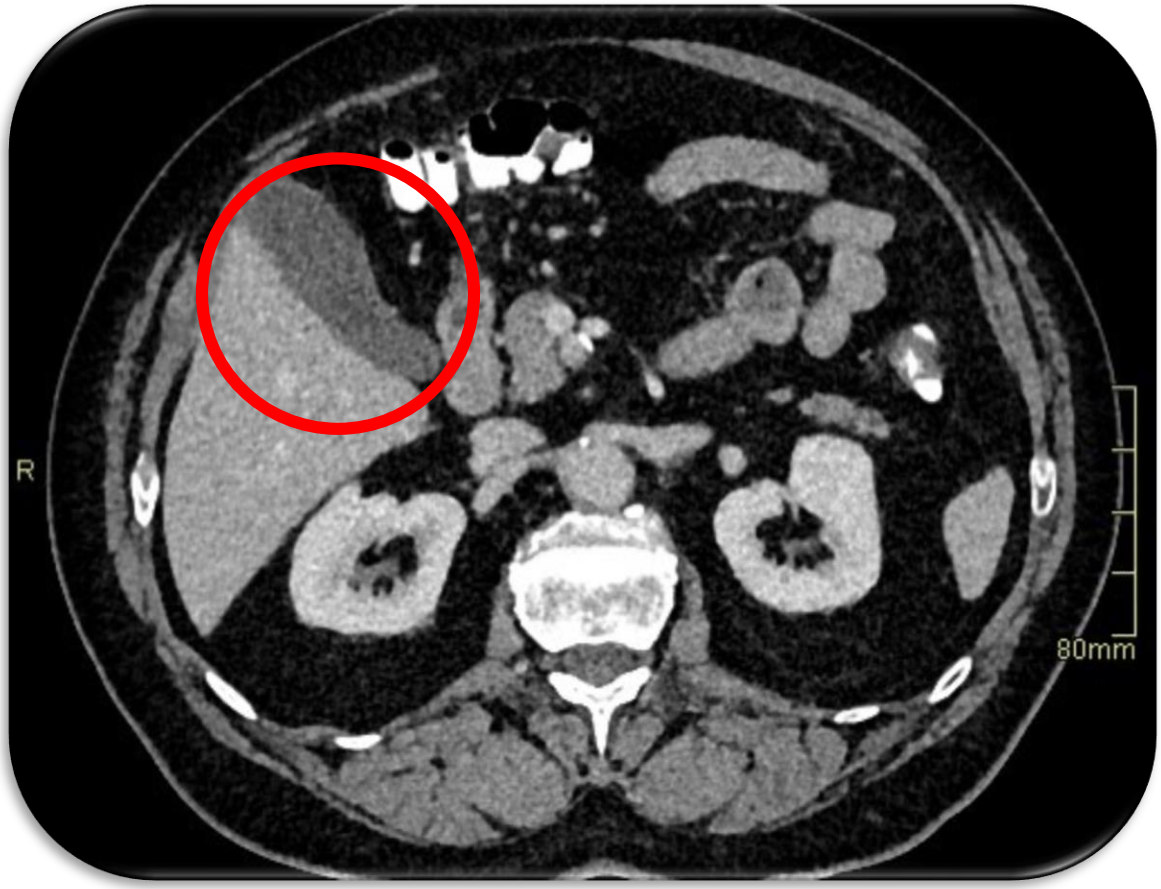
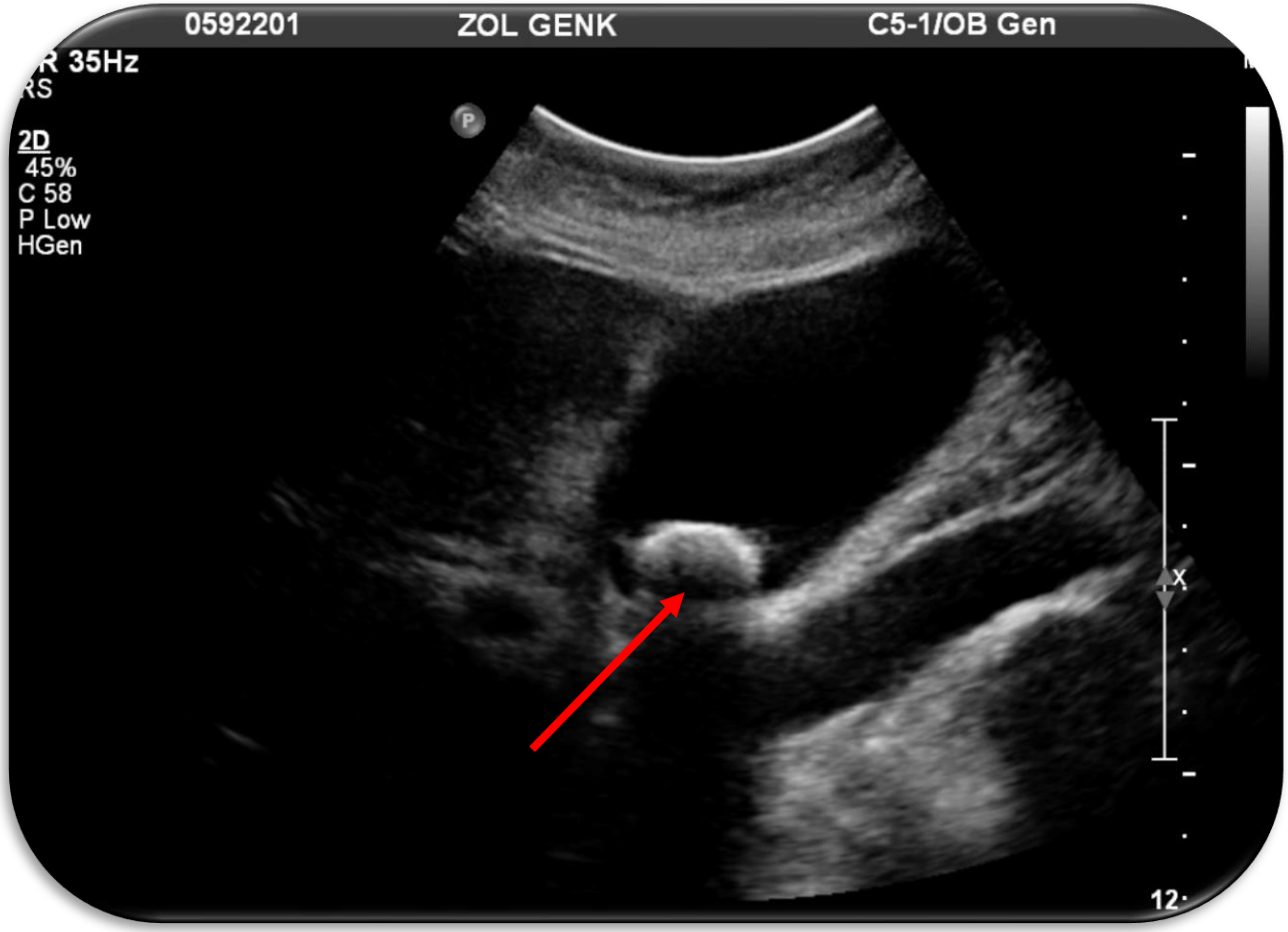
Bortoff G. et al. Galbladder stones: imaging and intervention. RadioGraphics 2000; 20:751–766

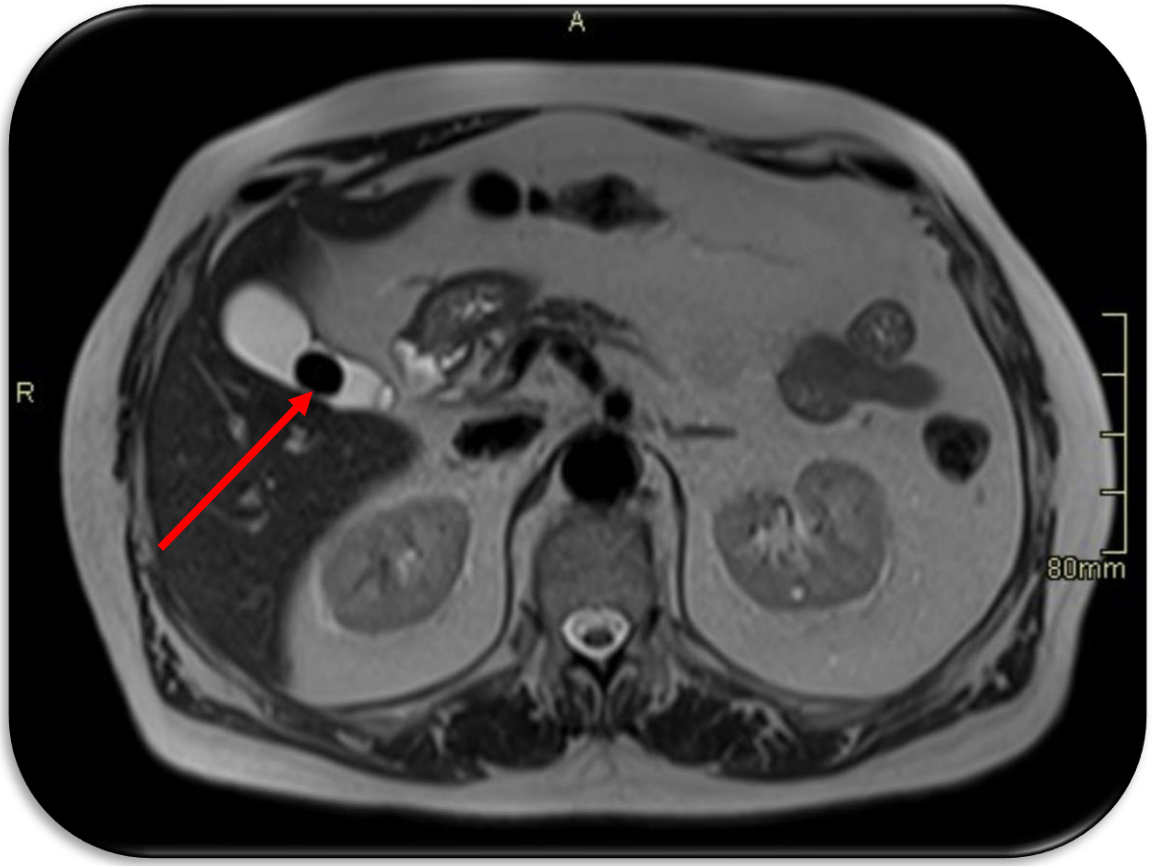
Right upper quadrant pain



Right upper quadrant pain



Right upper quadrant pain



Prostate pathology

Table 1. A summary of clinical usage, advantages, and disadvantages across imaging modalities for PCa imaging.

IMAGING MODALITY	CLINICAL USAGE	ADVANTAGES	DISADVANTAGES	FUTURE
Ultrasound-based	Initial detection and diagnosis	Office-based, widely available, inexpensive, real-time imaging	Limited tissue contrast between cancerous and benign tissue	mpUS-based approach (RTE, CEUS) may improve contrast
mpMRI-based	Initial diagnosis and recurrence, active surveillance, staging, metastatic involvement	Excellent tissue contrast for identification of clinically significant PCa	Expensive due to in-bore time, lack of real-time imaging, requires advanced training	Alternative in-bore options with real-time imaging being developed
mpMRI-ultrasound fusion-based	Initial detection and diagnosis, active surveillance	Office-based, combines multimodality information	Relatively costly, requires either fusion-device specific training or ample experience to perform cognitive fusion, registration errors during MRI-ultrasound fusion	Gaining popularity globally, but further improvements to minimize registration errors needed
PET-based	Staging, recurrence, metastatic spread	Offers ancillary information for tumor staging, characterization and metastatic involvement	Expensive, technological (e.g. attenuation correction) and/or clinical challenges (e.g. radiation exposure)	Development of specific radionuclides is an ongoing endeavor

CT is not accurate at detecting in situ prostate cancer. Scans of the abdomen and pelvis are commonly obtained before the onset of radiation therapy to identify bony landmarks for planning. In **advanced disease**, CT scan is the test of choice to **detect** enlarged pelvic and retroperitoneal **lymph nodes**, hydronephrosis and osteoblastic **metastases**.

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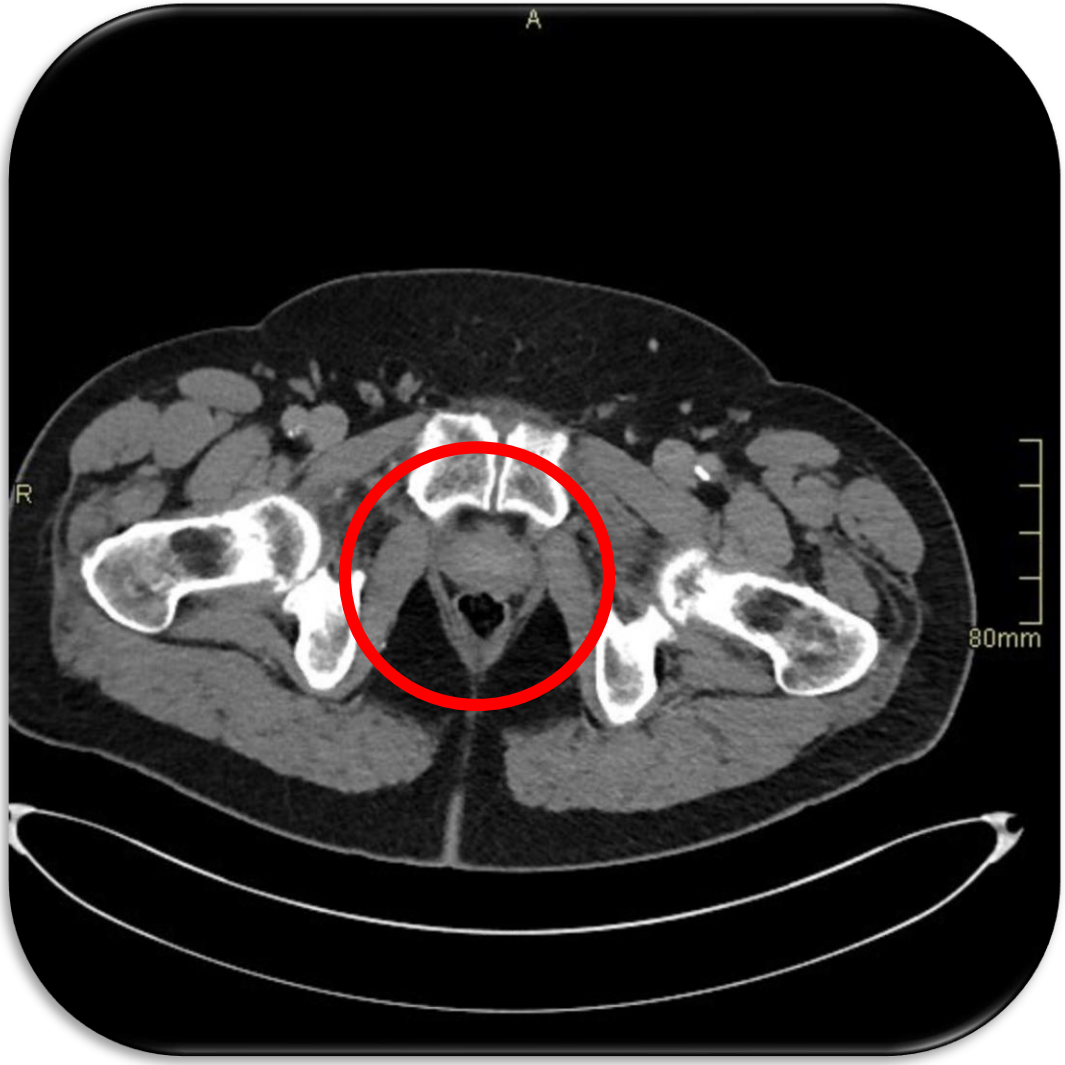
Sarkar and das. a review of imaging methods for prostate cancer detection. *Biomedical Engineering and Computational Biology* 2016:7(S1) 1–15
Lee JK, Stanley RJ, Heiken JP. Computed body tomography with MRI correlation. Lippincott Williams & Wilkins. (1998) ISBN:0781702917

Prostate pathology

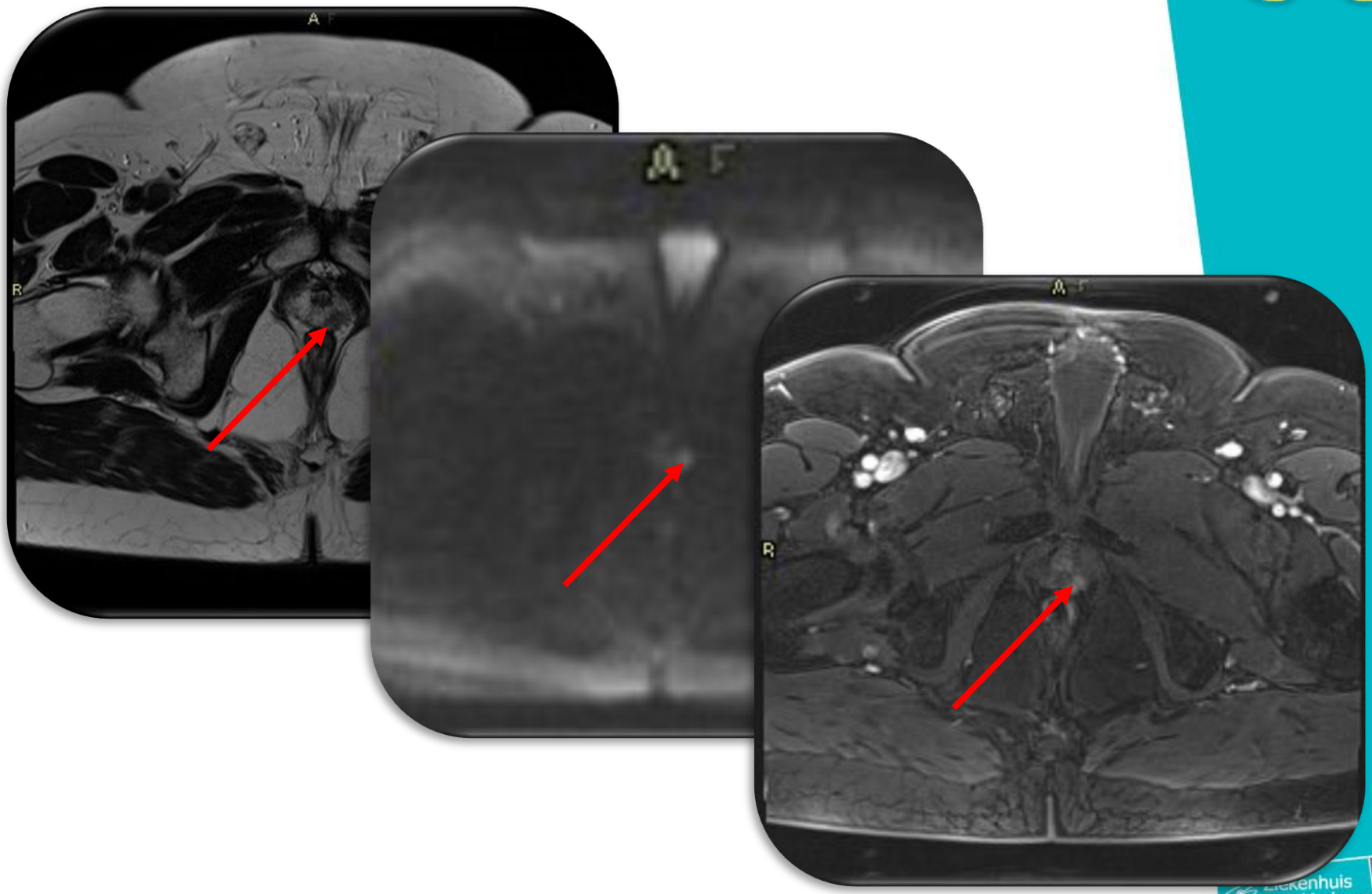
Benign Prostatic Hyperplasia

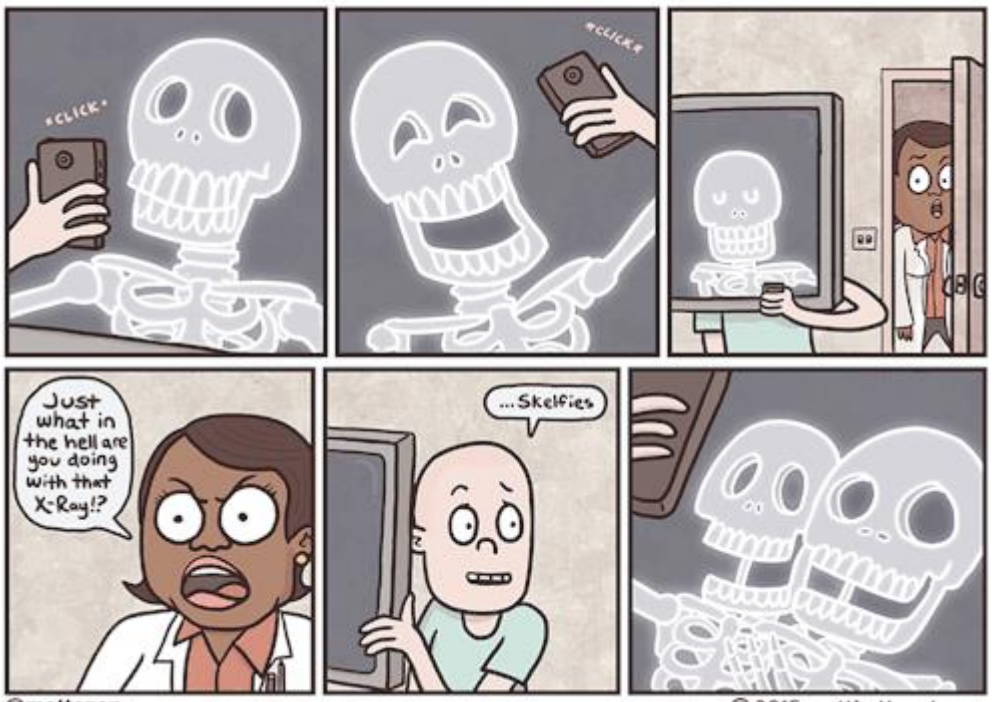
- **Ultrasound** has become the standard first line investigation after the urologist's finger.
- **CT** not typically used to assess the prostate, BPH is more frequently an incidental finding.

Prostate pathology



Prostate pathology




CLICK
CLICK
Just what in the hell are you doing with that X-Ray!?
...Skelfies
@mattczap
©2015 eatthattoast.com

Axial Spondyloarthropathy

- **Radiographic** changes reflect **structural damage** rather than active inflammation, which may delay the diagnosis by several years.
- MRI can serve as a biomarker of disease activity, allows monitoring, and can provide guidance for the treatment of affected patients.
- The new Assessment of SpondyloArthritis international Society (ASAS) criteria, which include MRI findings, facilitate early diagnosis and assessment of treatment response because of the capacity of **MRI** to help **detect active inflammation**.

Navalles M. et al., Sacroiliitis associated with axial spondyloarthropathy: new concepts and latest trends. RadioGraphics 2013; 33:933–956

Axial Spondyloarthropathy

Table 1
ASAS Criteria for the Classification of Axial Spondyloarthropathy

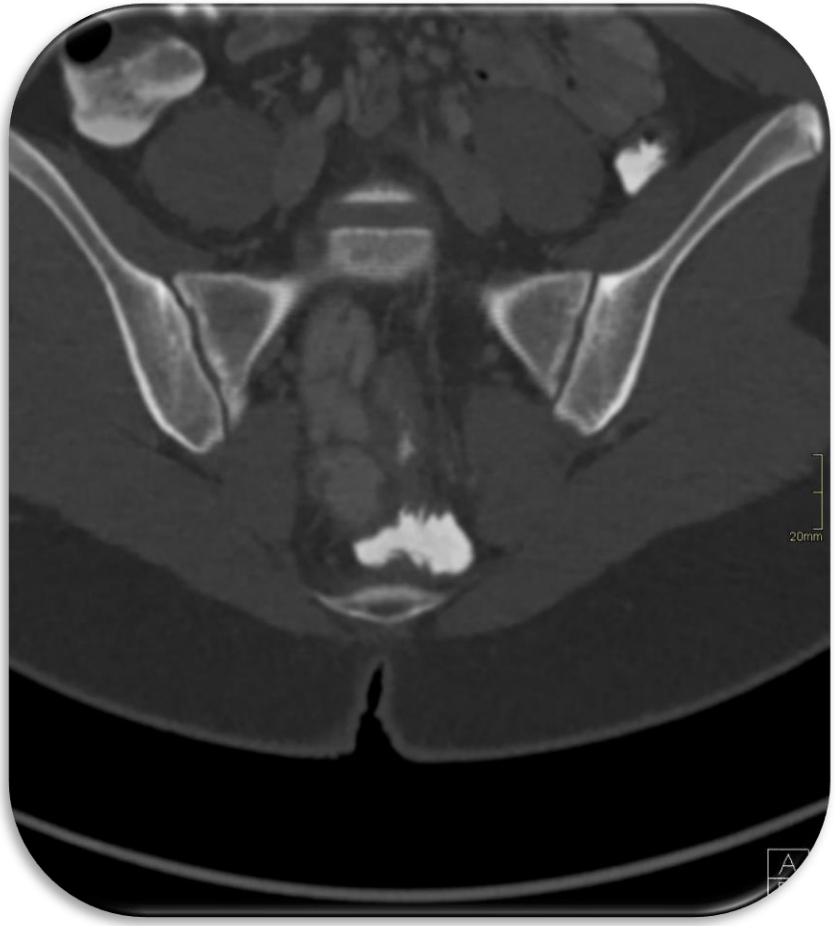
Criteria	Clinical Features of Spondyloarthropathy
Acute inflammation at MR imaging with bone marrow edema or osteitis, or definite radiographic changes according to the modified New York criteria, plus at least one clinical feature of spondyloarthropathy	Inflammatory back pain, arthritis, enthesitis (heel), uveitis, dactylitis, psoriasis, Crohn disease/colitis, good response to NSAIDs, family history of spondyloarthropathy, HLA-B27, elevated CRP level
Presence of HLA-B27 and at least two other clinical features of spondyloarthropathy	

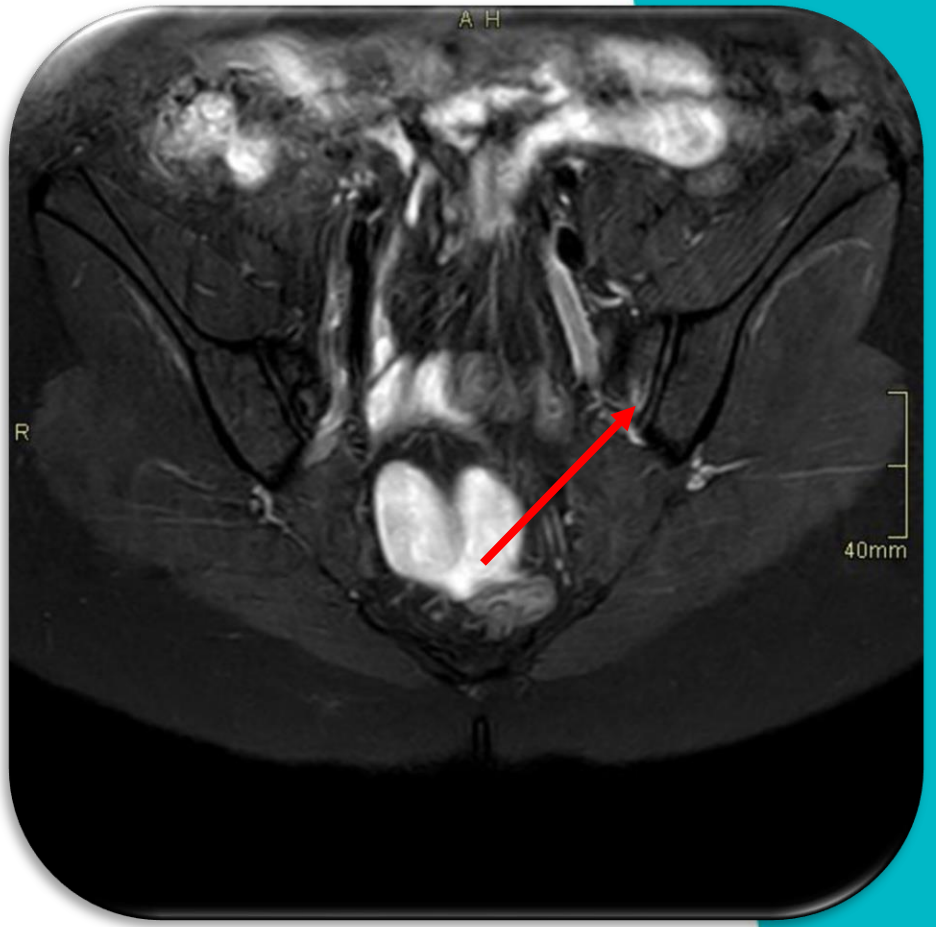
Note.—Criteria apply to patients with at least a 3-month history of back pain who are less than 45 years old at the onset of pain. CRP = C-reactive protein, NSAID = nonsteroidal anti-inflammatory drug.

MR imaging is becoming the **standard of reference** for the imaging of sacroiliitis. It helps detect **acute inflammatory** changes and can reveal **preradiographic disease**, allowing early diagnosis and treatment of sacroiliitis. In addition, MR imaging can help quantify inflammatory activity and can be used as a biomarker for activity and as a guide for the treatment of sacroiliitis, as well as an objective measure for monitoring in clinical trials.

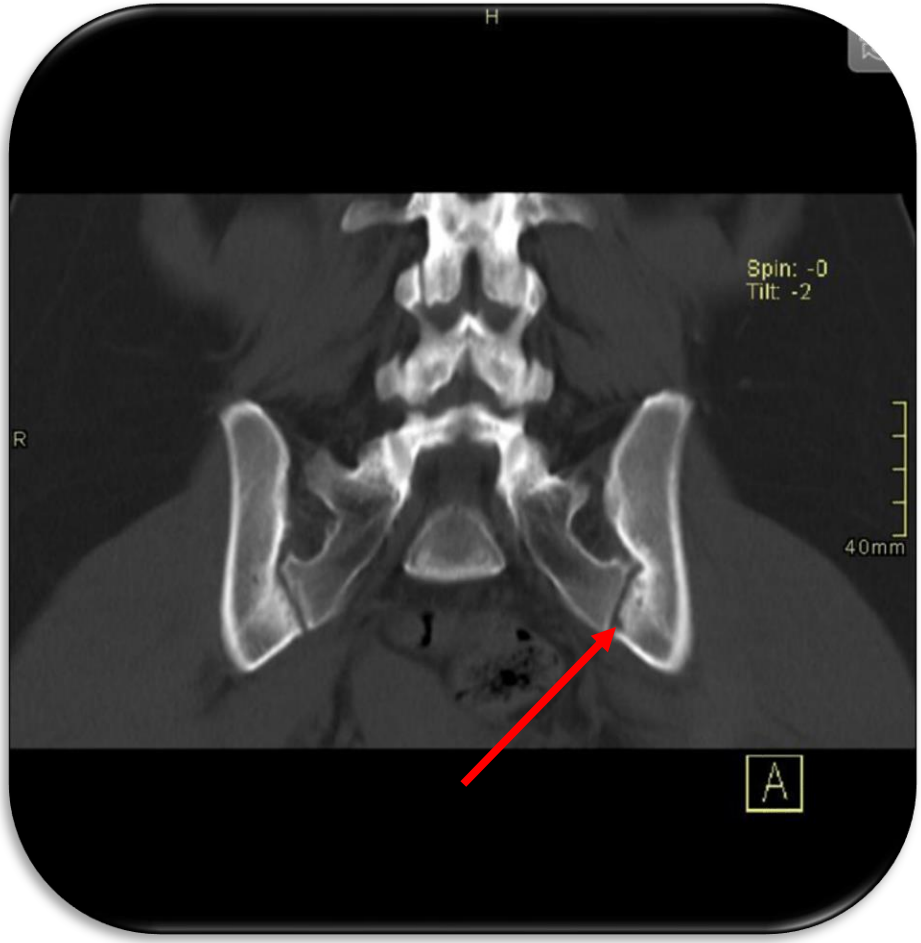
Navalles M. et al., Sacroiliitis associated with axial spondyloarthropathy: new concepts and latest trends. RadioGraphics 2013; 33:933–956

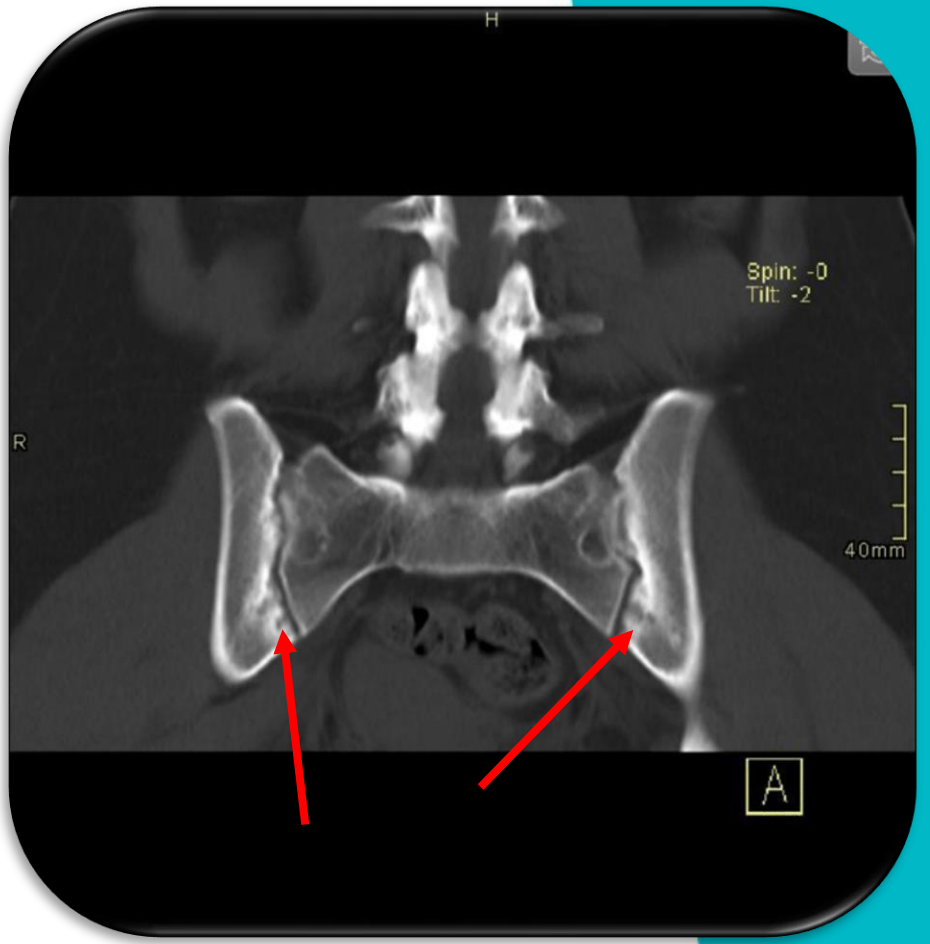
Sacro-iliitis



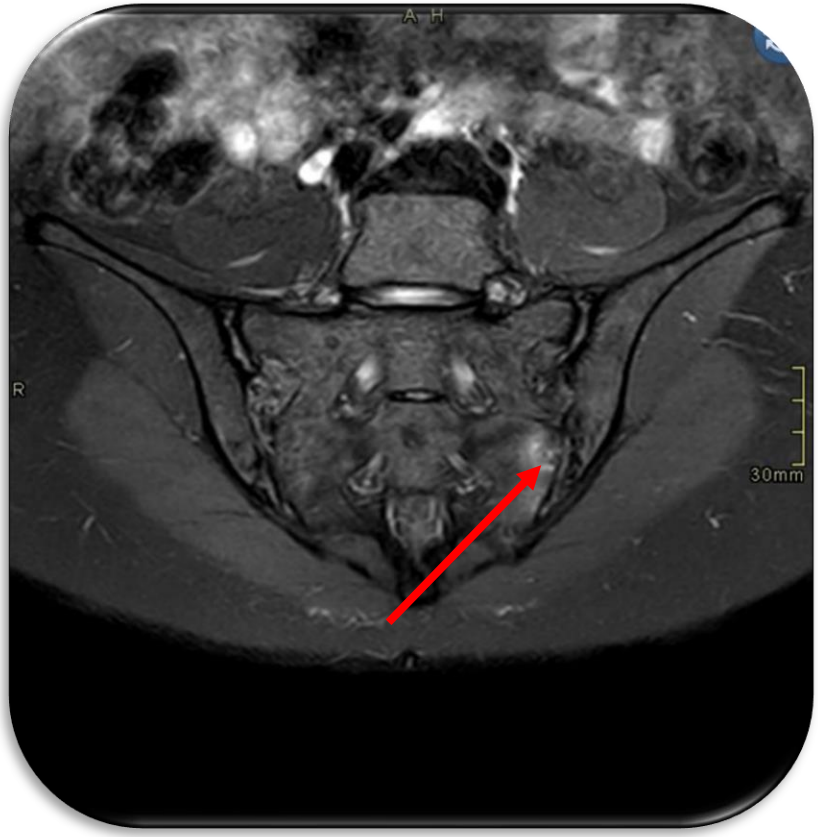


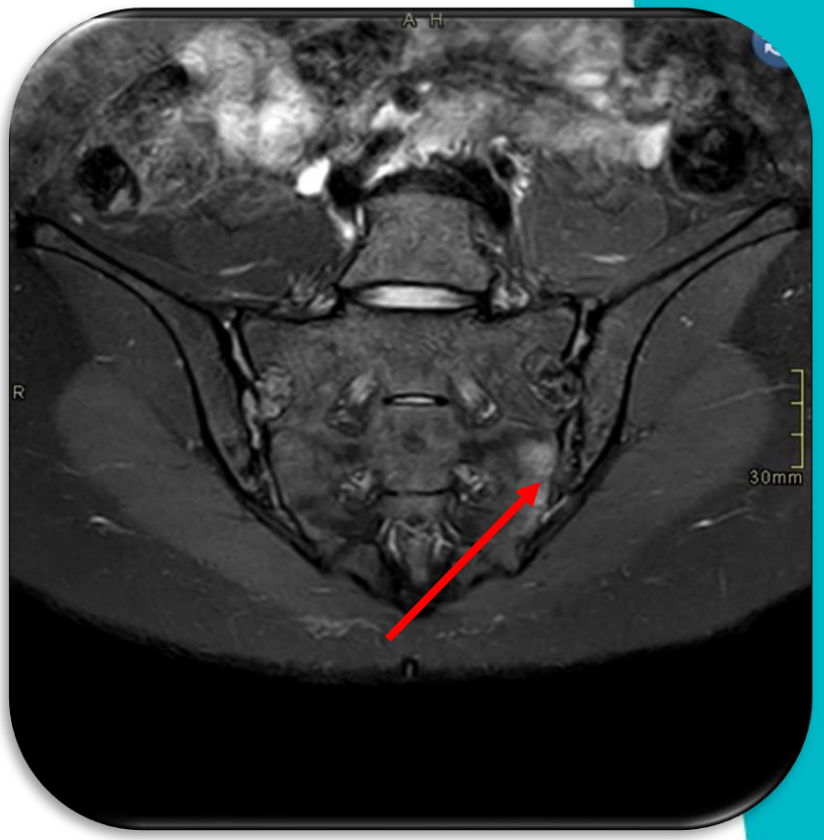
Sacro-iliitis





Sacro-iliitis





Knee pain

Common causes of adult knee pain

- Patellofemoral dysfunction
- Past Trauma: ligamentous sprains or meniscal tear
- Osteoarthritis
- Baker cyst
- Bursitis
- Inflammatory arthritis
- Septic arthritis
- Gout, pseudogout

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Calmbach WL, American Family Physician. 2003 Sep 1; 68 (5): 917-922

Knee pain

Plain Films Reveal Bony Abnormalities

- Osteoarthritis
  - Joint space narrowing – Sclerosis
  - Subchondral cysts
  - Spurring of tibial spines
  - Osteophytes
- Loose bodies
- Chondrocalcinosis
- Fracture

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Calmbach WL, American Family Physician. 2003 Sep 1; 68 (5): 917-922

Knee pain

CT Provides Cortical Detail

- Occult fractures
- Fracture fragment location
- Tumors
  - Periosteal reaction
  - Small amounts of calcification

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Calmbach WL, American Family Physician. 2003 Sep 1; 68 (5): 917-922

Knee pain

MRI Provides Definition of Soft Tissue

- Tendonitis or tendon tears
- Articular cartilage
- Meniscustears
- Bone bruise/marrow edema
- Strains
- Cysts
- Bursitis
- Tumors
- Osteonecrosis

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Calmbach WL, American Family Physician. 2003 Sep 1; 68 (5): 917-922

Knee pain

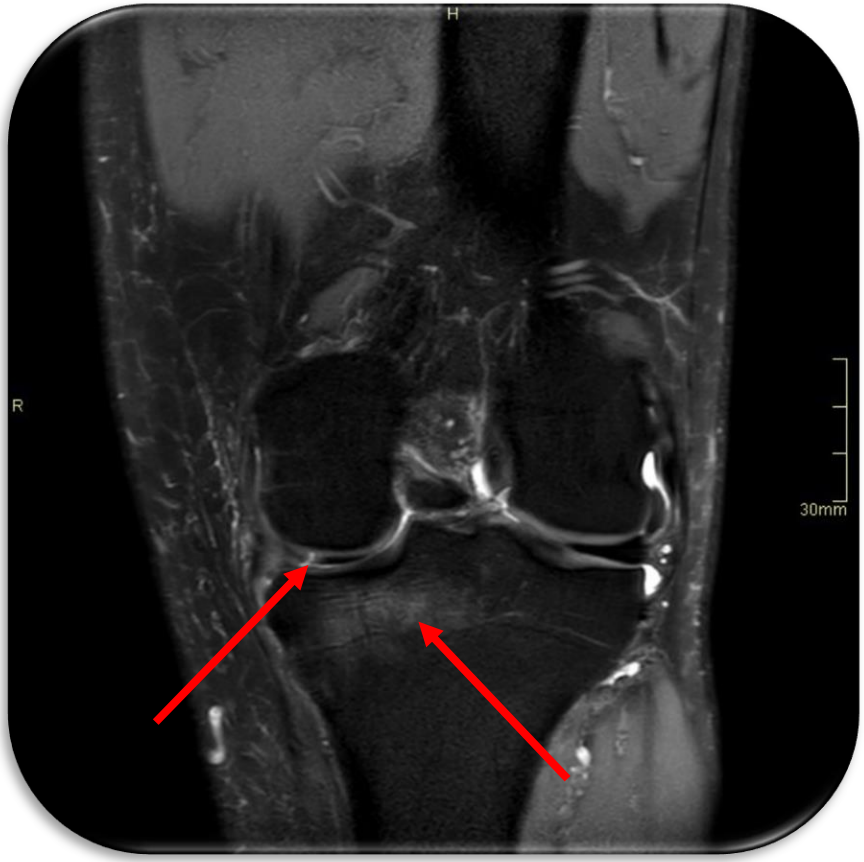
- **MR imaging** enables the **most comprehensive imaging** assessment of the knee and when performed early after injury, MR imaging is both cost-effective.
- Radiographs may demonstrate an acute fracture but commonly are either negative or may demonstrate indirect signs of an acute soft-tissue injury.
- **CT** is usually reserved for diagnosis of **suspected fractures or assessment of complex fractures**, although associated ligamentous injuries may be evident. Dual-energy CT has also been evaluated in imaging of the musculoskeletal system, principally for evaluation in patients with suspected gout. Preliminary studies using dual-energy CT have shown a high sensitivity and specificity for detection of bone marrow edema in traumatic knee injuries and some success with imaging of ACL injuries.

Ziekenhuis Oost-Limburg

Naraghi A. et al. Imaging of Athletic Injuries of Knee Ligaments and Menisci: Sports Imaging Series. Radiology: Volume 281: Number 1—October 2016

Knee pain

Knee pain



Knee pain

Bottom Line

- CT, the future looks bright
- But…it ain't all sunshine and rainbows (Rocky Balboa)

"BLAH BLAH BLAH BLAH BLAH BLAH, BLAH BLAH BLAH BLAH BLAH."

SOMEONE FAMOUS

Ziekenhuis Oost-Limburg

Dank u voor uw aandacht

Ziekenhuis Oost-Limburg