Incidental Findings on cMR

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Conflict of Interest Statement

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None

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Definition of incidental findings

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any abnormality demonstrated on the images which is not related to the suspected condition that prompted the CMR examination in the first place

either cardiac

non-cardiac

Major findings

findings which **require initiation of a new treatment or needing follow-up**, or findings of an unclear nature needing further investigation (eg, lung abnormalities or renal masses)

Minor Findings:

considered **benign diseases and do not need any complementary** investigation nor follow-up or new treatment (eg, simple renal or hepatic cysts)

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Prevalence of incidental findings

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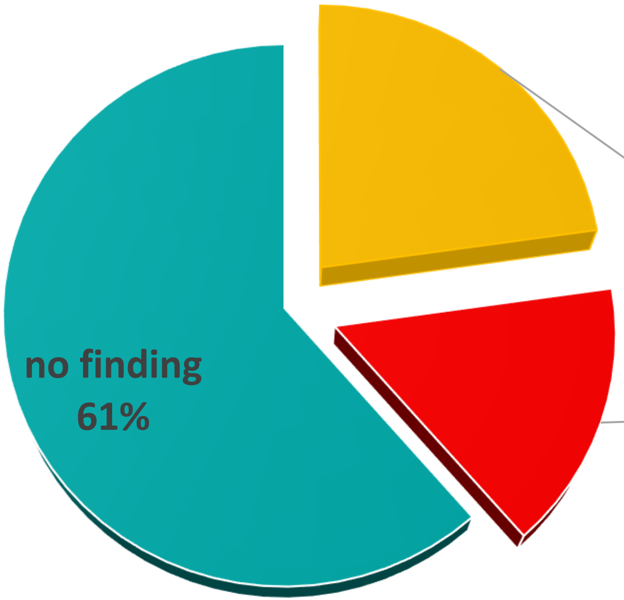
Metaanalysis 7122 patients



Major IEF	
New major IEF	4.2%
With management changes	3.3%
Requiring further NI testing	1.9%
Requiring biopsy	0.2%
Changing treatment	0.9%

Dunet J. Magn. Res. Im. 2016;43:929–939

Major findings

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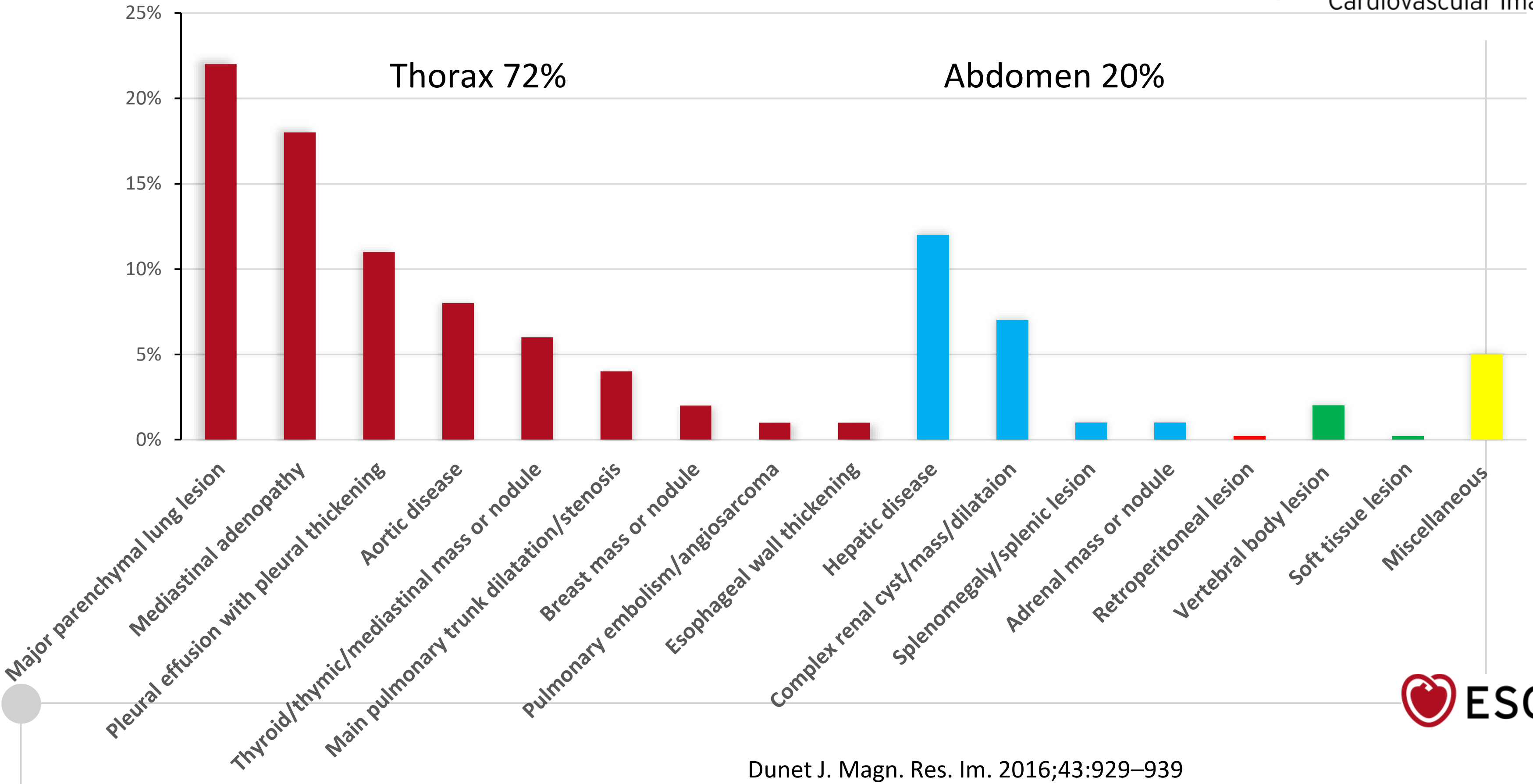

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Systematic approach for extracardiac findings

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All images acquired, even localizer images, should be routinely reviewed for incidental findings

Step 1 images should be systematically viewed from head to feet and from the periphery to the centre of the FOV.

Step 2 Evaluation should be performed using district symmetry/asymmetry

Step 3 check whether the incidental extra-cardiac finding has been already noted in other examinations evaluate eventual changes (increase in dimension, shape, etc.)

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What should we look for?

Neck

- **Thyroid Gland**
- **Adenopathies**

Thorax

- **Lung (airspace disease, mass)**
- **Pleura (effusion, neoplasm)**
- **Mediastinum**
  - **Oesophagus (hernia, mass, dilatation/thickening)**
  - **Solid & cystic masses, adenopathy**
- **Chest wall (breast, axilla)**
- **Bone (fracture, neoplasm, infection)**

Abdomen

- **Liver** (cyst/haemangioma, mass, parenchymal disease)
- **Kidney** (cyst, mass, hydronephrosis, parenchymal disease)
- **Adrenal Mass**
- **Spleen (size, lesion)**
- **Other: Gallstones/cholecystitis, Ascitis**

Neck: Thyroid

Normal Variants: additional pyramidal lobe

Common pathology

Diffuse goiter

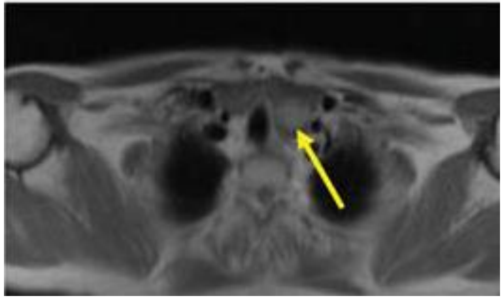
especially premenstrual women

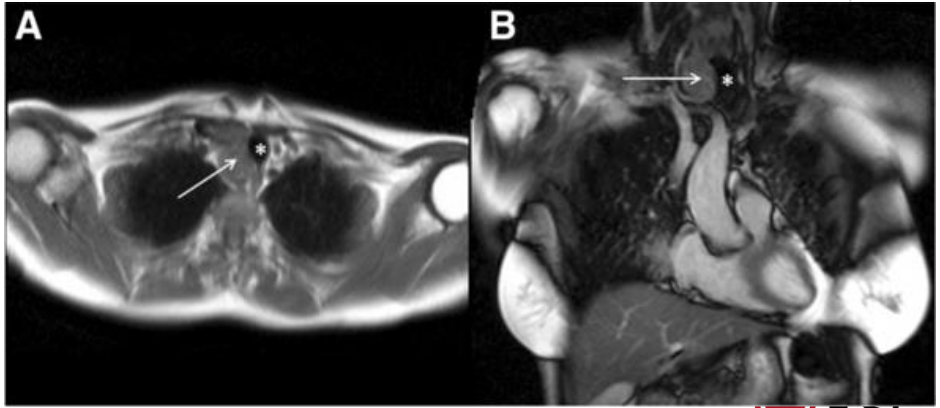
women:men ratio 4:1

decreases with age

Local nodules:

frequency increases with age





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Irwin Eur Hear J CV (2013) 14, 158–166

Neck: Thyroid

Key points

Look for local mass effect (trachea deviation or compression)

Define inferior extent of thyroid gland

CMR is unable to differentiate benign from malignant lesion because of insufficient spatial resolution to identify malignant features
(microcalcifications, intra-lesional vascularity and lobulated / irregular margin)

benign and malignant lesions have **similar tissue characteristics**
(isointense T1 and hypertintense T2)

Lesion size has limited correlation with malignancy, however
outcome is good when lesions are < 2 cm size

Indicental nodules without abnormal lymphnodes and/or invasion of local tissues
<1 cm in <35 years old or <1.5 cm in subjects ≥35 years do not need further workout

Order Echo / Scintigraphy and refer to Head/Neck radiologist for further workout.

Lung Masses

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Key points

most masses >3 cm are identified by cMR

nodules <3 cm may not all identified

size should be measured

25-30 mm: 26% PPV for malignancy

spiculated aspect: suggestive of malignancy

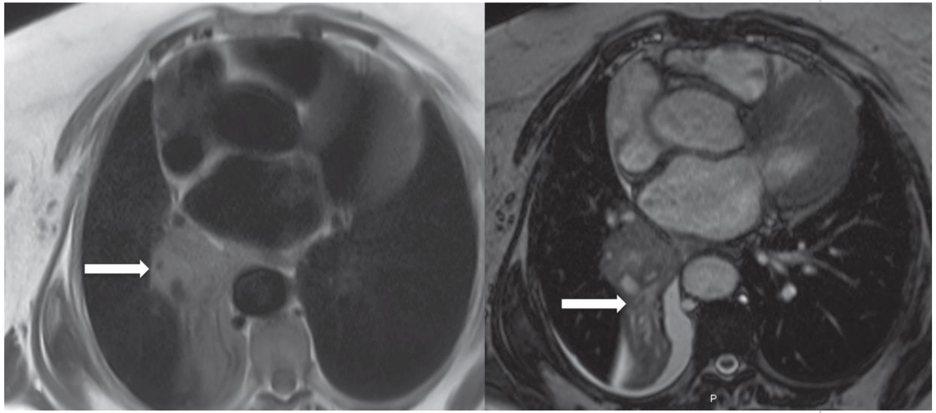
Review earlier exams (chest Rx and CT) if available

slow growth – malignant

very rapid growth – inflammatory

Request further characterization by CT

If concern for malgnancy finding should be flagged urgently to the referring clinician to facilitate an urgent referral



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Lung nodes

Recommendations for lung nodes

Nodule size: ≤ 4 mm

- Low risk[a] : No follow-up
- High risk[b] : Follow-up CT at 12 months and if no change, no further follow-up required

Nodule size: >4 – 6 mm

- Low risk[a] : Follow-up CT at 12 months and if no change, no further follow-up required
- High risk[b] : Initial follow-up CT at 6–12 months and then at 18–24 months if no change

Nodule size: >6 – 8 mm

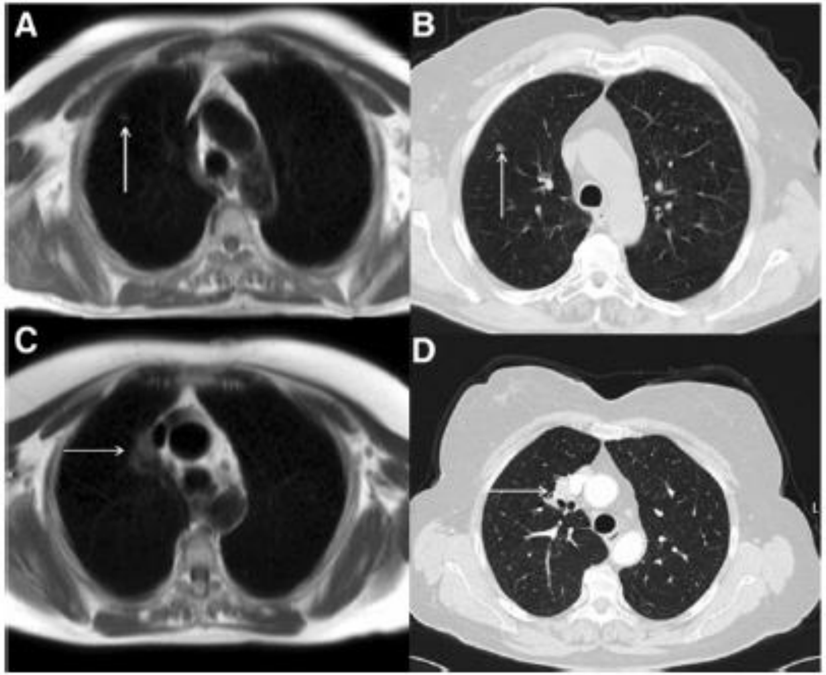
- Low risk[a] : Initial follow-up CT at 6–12 months and then at 18–24 months if no change
- High risk[b] : Initial follow-up CT at 3–6 months and then at 9–12 and 24 months if no change

Nodule size: >8 mm

- Follow-up CTs at around 3, 9 and 24 months

or

- Dynamic contrast enhanced CT, PET-CT, and/or biopsy



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Examples of Lung Masses

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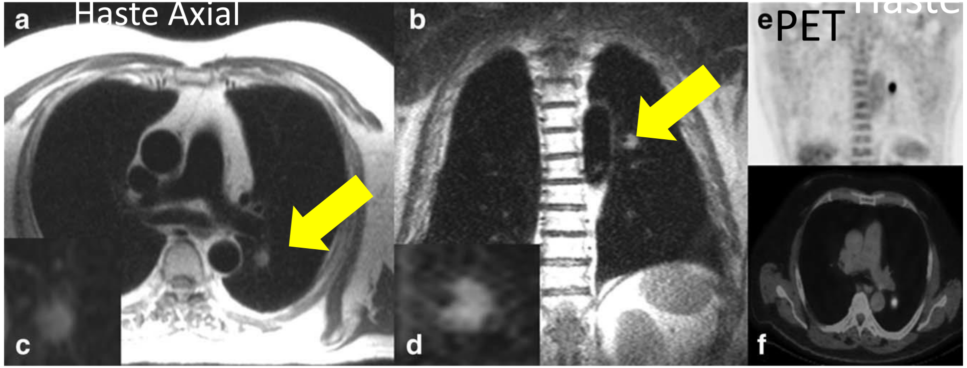
Lung cancer.



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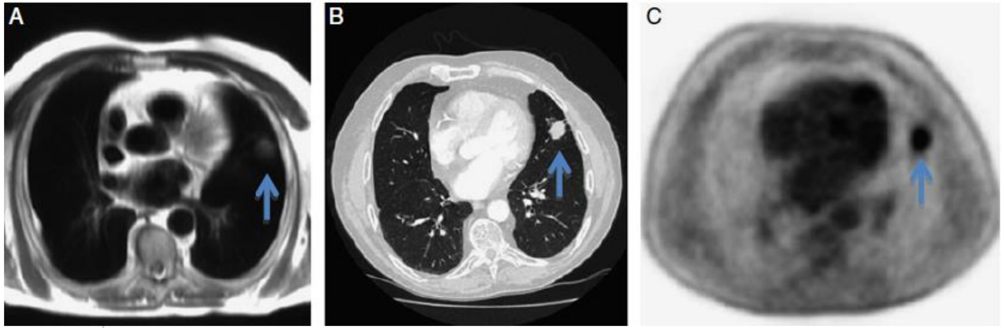
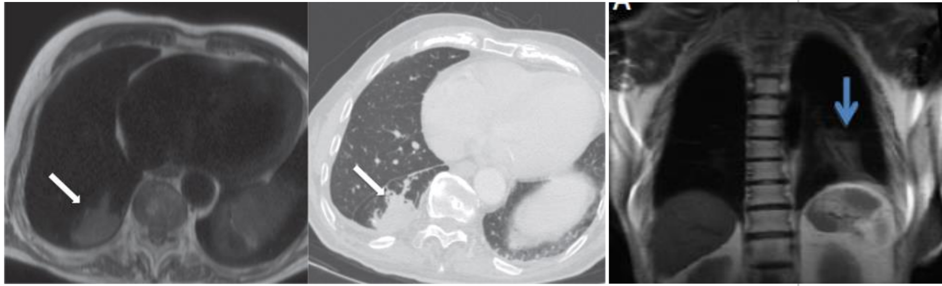
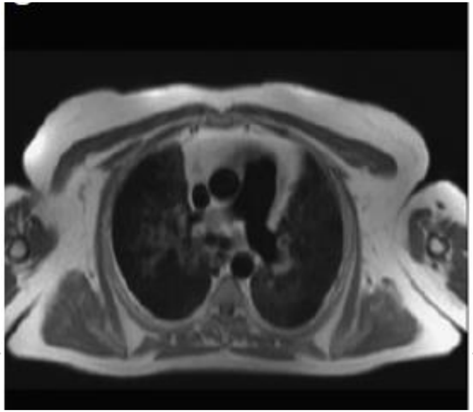


Mirsadree J Thor Im. 2014;29:92–97

Lung consolidation (infection)



Diffuse interstitial lung disease



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Pleura

Pleural Effusions

common finding

- Normal aspect:
  low T1-w and high T2-w. signals. (cave motion artifact)

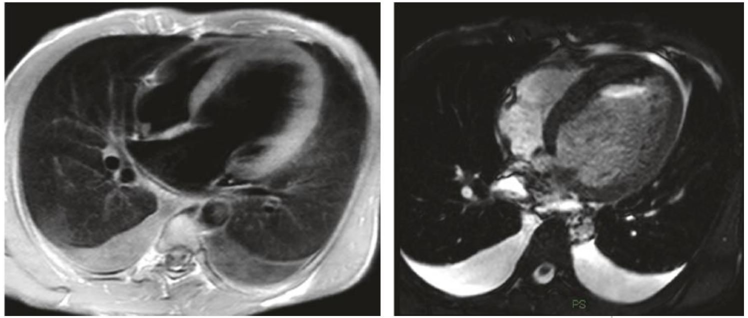
- **Complex aspect:**
  internal septae
  Pleural thickening

- **Malignancy** is suggested by persistent unilateral effusion, circumferential thickening, mediastinal extension and nodules

- **Suggested workout**: ultrasound guided sampling of pleural fuid

Azygos lobe fissure (variant in 1% of population)

Benign effusion



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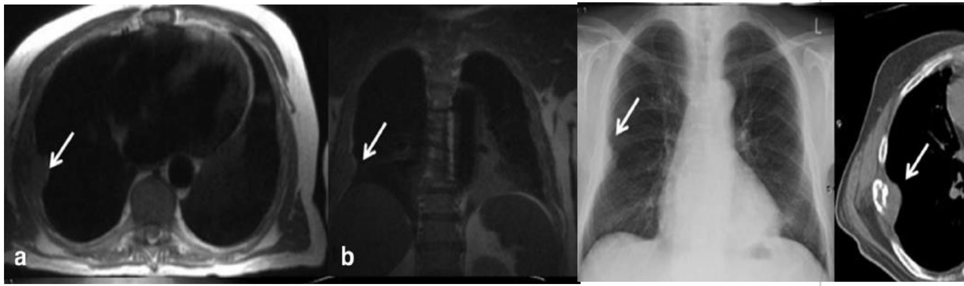
Plasmocytoma



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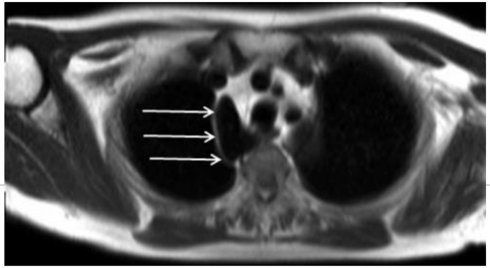
Azygos lobe fissure



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Thorax Mediastinal Lymphadenopathy

Most frequent abnormality of the mediastinum

Normal aspect

well-defined, oval entities with fatty hila

size <10 mm (cave accuracy of thick cMR slices)

however poor correlation between size and benignity

if **Abnormal appearing nodules**

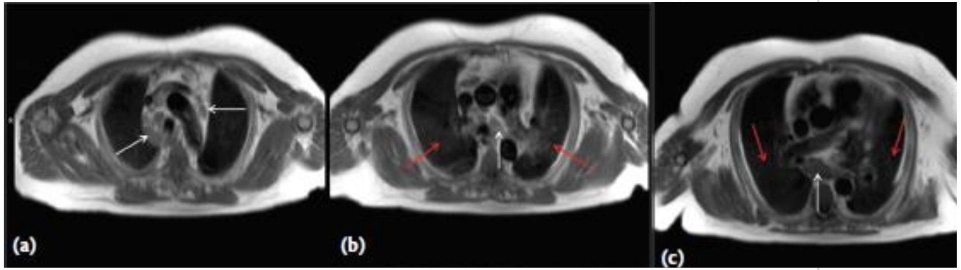
evaluate clinical history

ie history of lung, breast, head and neck, melanoma

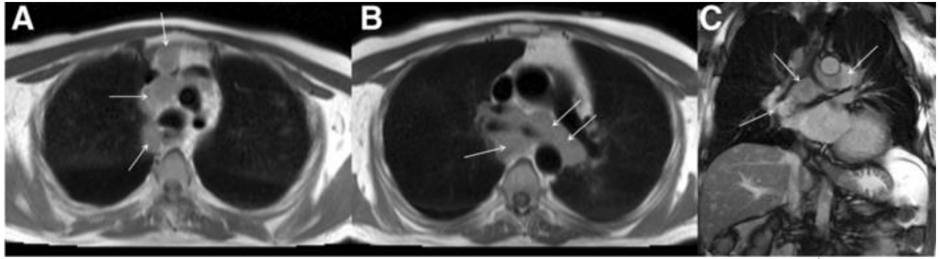
gastrointestinal and genitourinary carcinoma

symmetrical bilateral hilar lymphadenopathy suggests sarcoidosis or lymphoma. Lymphoma is suggested if masses encompas vascular structures

Sarcoidosis in a 62 yo man with heart block



lymphoma



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Thorax Mediastinal Masses

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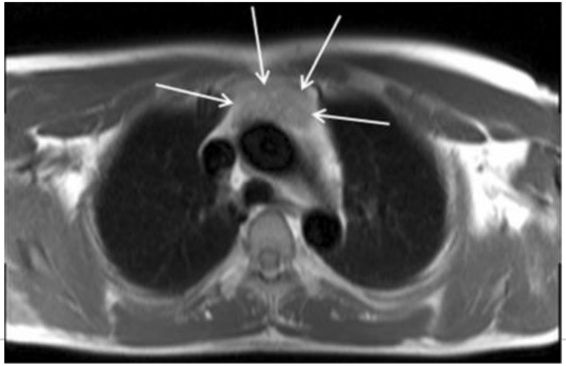
Anterior Mediastinal Masses

- Normal: thymus gland in children and young adults (<40 y) typical aspect: bi-lobed and concave margins

  Reactivation is possible at older age
- Abnormal: thymoma, lymphoma or teratoma

Thymus reactivation in a 20 year old male patient who had recently suffered from a severe pneumonia complicated with myocarditis.

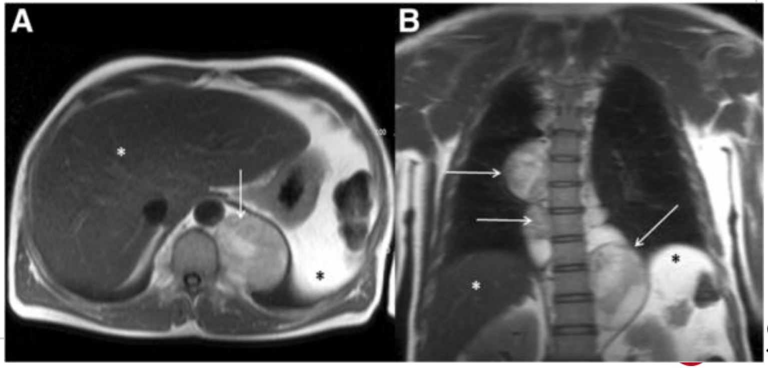


Posterior Mediastinal Masses

- lymphadenopathy and neurogenic tumours (schwannomas or neurofibromas)
- Extramedullary haematopoeisis in hematological disease (thalassemia, Blackfan Diamond..)
- hiatus hernia

  typical aspect: continuity with the oesophagus and stomach distally, may contain an air–fluid interface.

Extramedullar hematopoietesis in a thalassemia patient.



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Examples of Mediastinal masses

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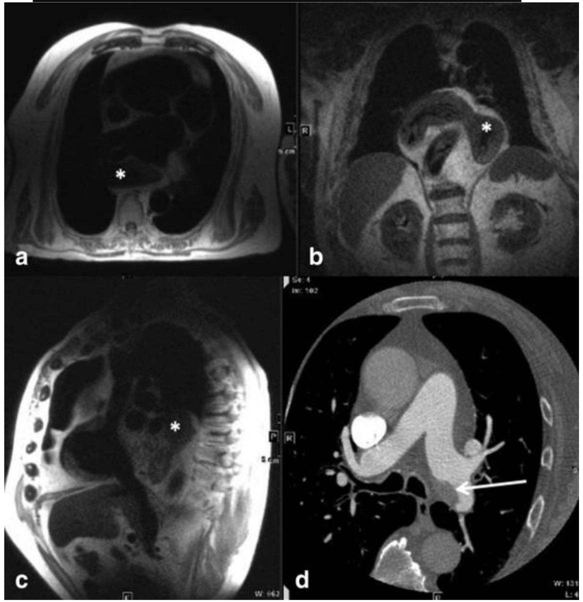
Gastric herniation and angiosarcoma



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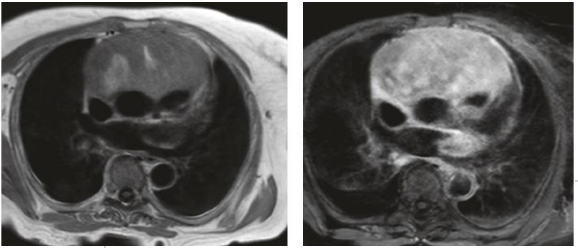
Ant. Mediast lymphoma



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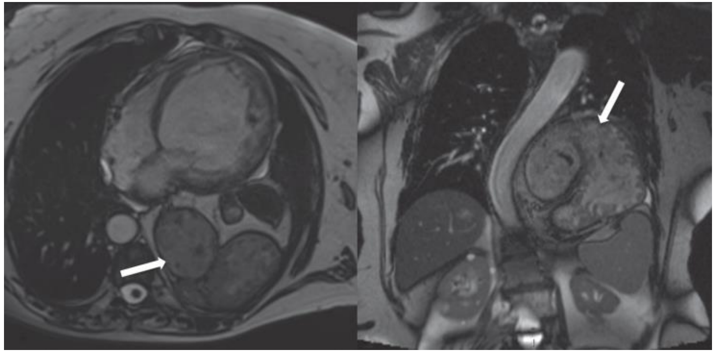
Hiatus hernia



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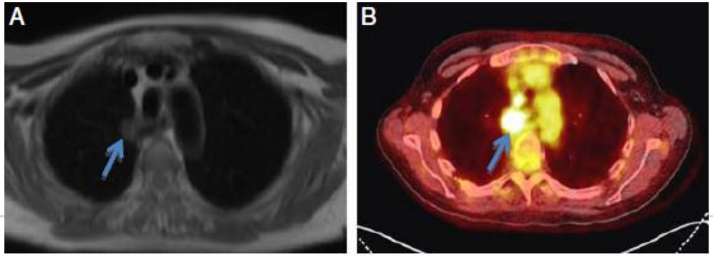
Esophageal tumor



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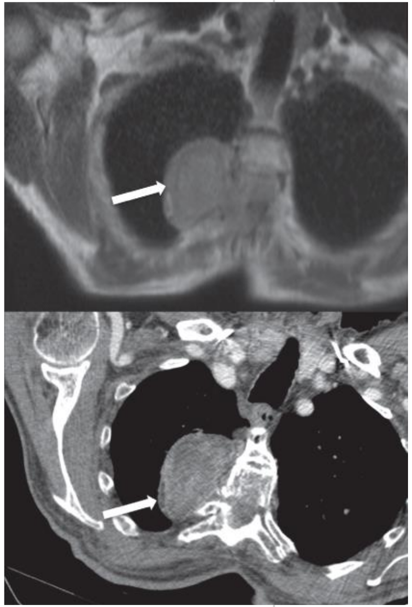
Schwannoma



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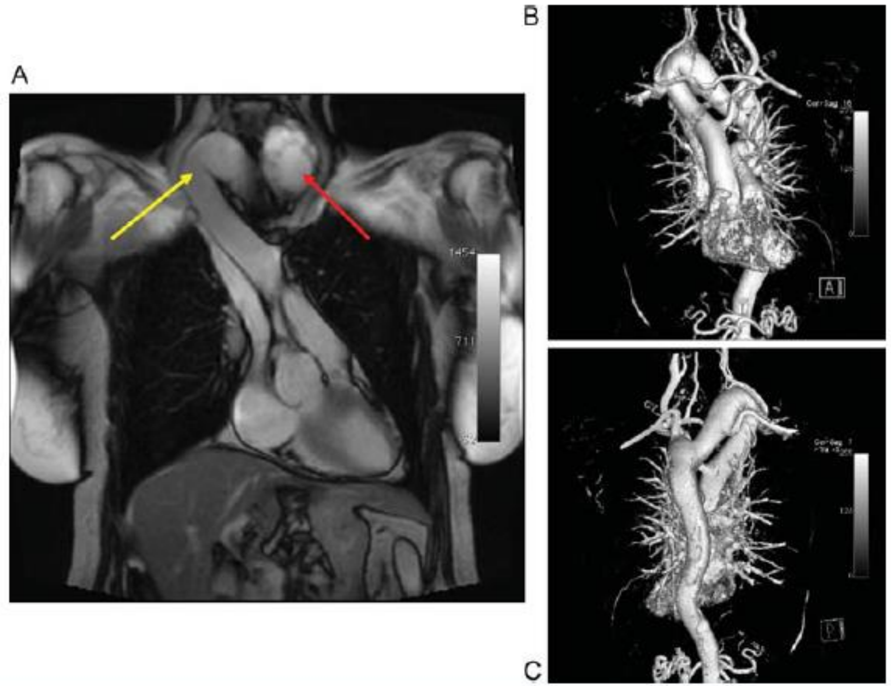
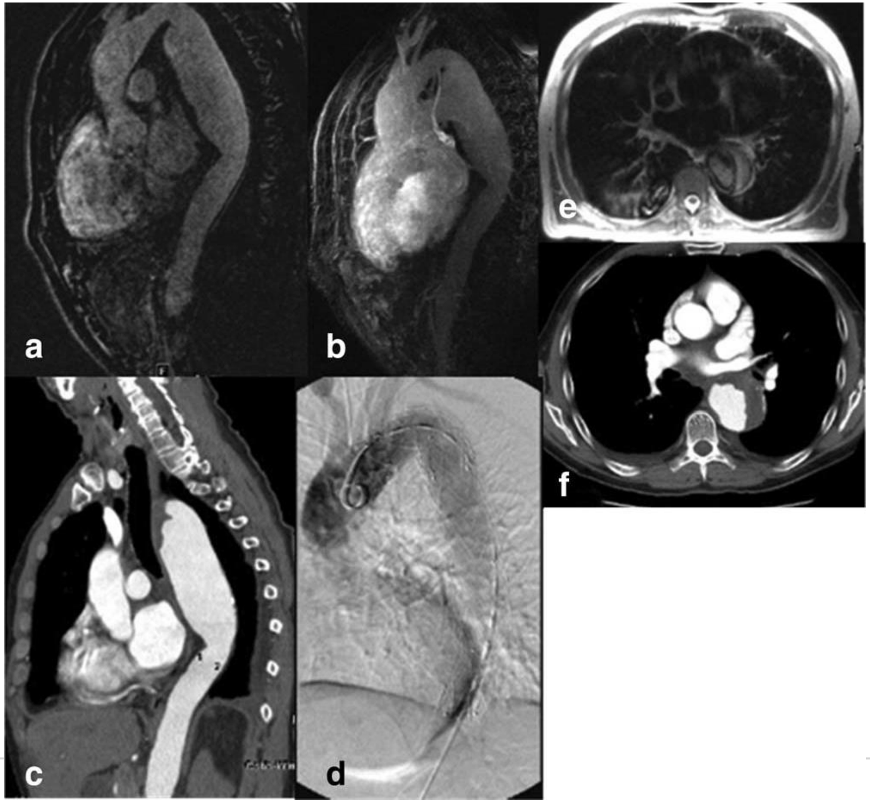
Vessels

Aneurysm of the descending aorta





Irwin Eur Hear J CV (2013) 14, 158–166

Sohns JMRI 39:68–76 (2014)

Pulmonary Embolism

Can sometimes be seen on

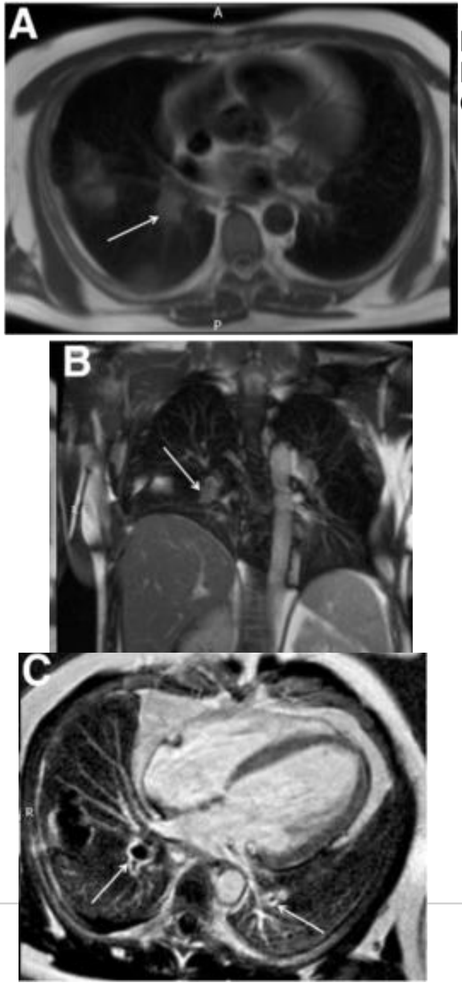
- **Dedicated MR pulmonary angiographic sequences**

- abnormal signal return from the pulmonary arteries on standard axial black blood and coronal bright blood images

- on LGE images, with similar imagingappearances to ventricular thrombus but within the pulmonary arterial tree

Look for PE in context of chest pain, elevated troponin but unobstructed coronary arteries

If clinical concern: order CT pulmonary angiogram



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Breast

Incidental lesions are noted in only 0.1–2.5% of cMR

However 50% are of concern.

- **<u>Benign lesions:</u>**
  - Fibrofatty replacement is common
  - Cysts are common > 40 years, fibroadenoma <40 years
- **<u>Concerning features</u>**
  - nipple inversion, cutaneous thickening
  - abnormal lymph nodes (axillar, int.mammary, supraclavicular) malignant nodes: increased cortical thickness, soft tissue infiltration of the fatty hilum, lobulated shape, and large size
  - history of breast cancer, mastectomy, breast implants
- **Look for other lesions (lung, bone)**

CMR is unable to make diagnosis, therefore all breast lesions identified on CMR should be referred to a specialist breast unit (mammography, echocardiography)

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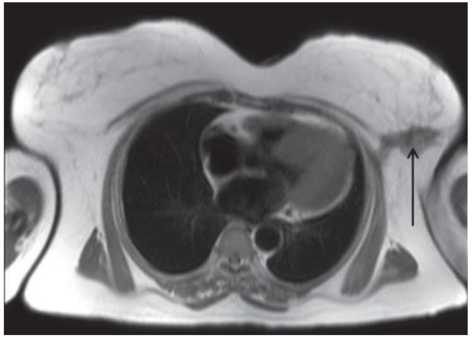
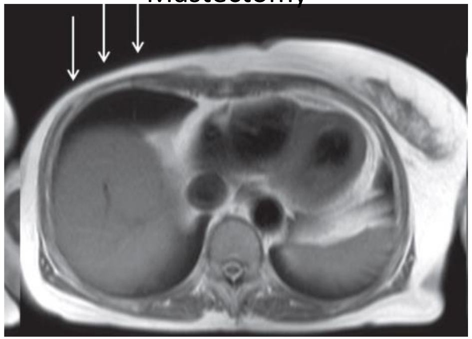
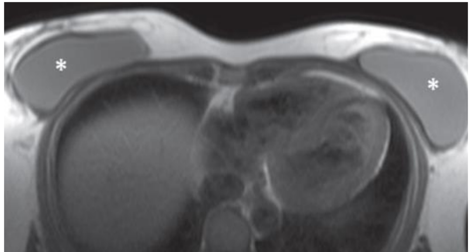
Spiculated BC lesion



Mastectomy



Implants



Bones

Pectus excavatum

- may have hemodynamic effects, explain ECG features (-T waves/ARVC)

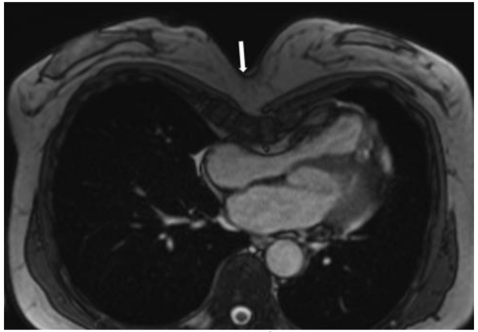
Focal vertebral body lesions

- Hemangiomas **(benign, common)**
  vascular, fatty benign lesions, high T1 and T2 w signal
  confirm by CT (polka dot appearance)

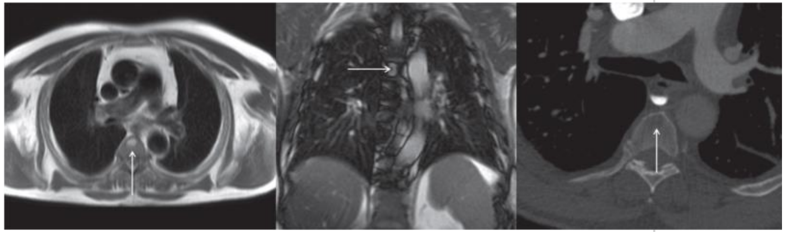
  benign lesion rarely extends into the pedicles or lamina of the vertebra.

- **Metastasis**
  Always low T1 signal (except melanoma)
  Osteosclerotic: Low T1 low T2
  Osteolytic: Low T1, high T2
  Concerning: multiplicity and surrounding abnormal soft tissue, demographic features of known/previous malignancy
  Look for associated vertebral body destruction or collapse and retropulsion of bony fragments towards the spinal canal.

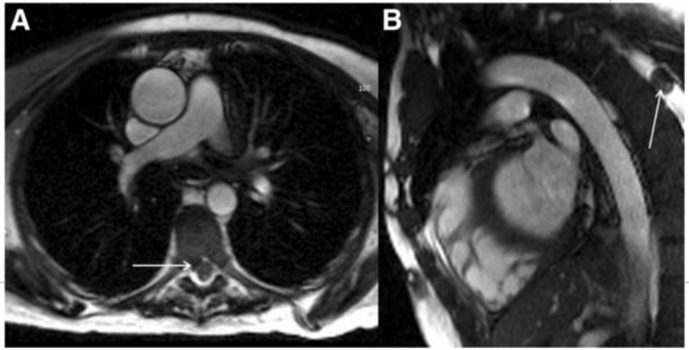
Pectus excavatum



Hemangioma



Focal lesion in spinal cord



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Abdomen: Liver

- **Simple cyst**
  - Low T1 High T2
  - well defined

- Metastatic lesions
  (colon, lung, breast, and gastric primary malignancies)
  - Variable T1 and T2, typically hypo-iso T1, hyper-iso T2 can mimic cysts in terms of signal characteristics
  - less well defined

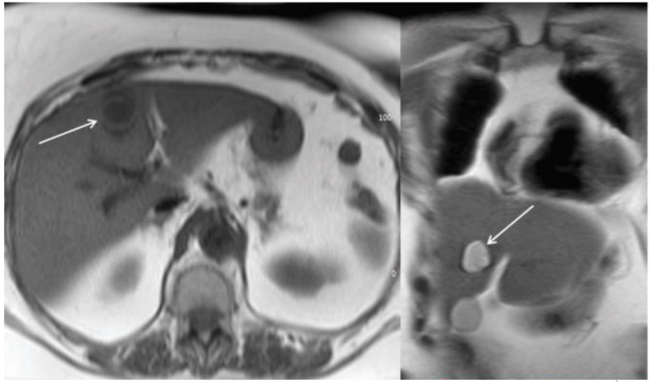
- Other Focal liver lesions **(haemangioma, focal nodular hyperplasia adenoma, and hepatocellular carcinoma)**

- **comprehensive liver lesion tissue characterization is not possible**

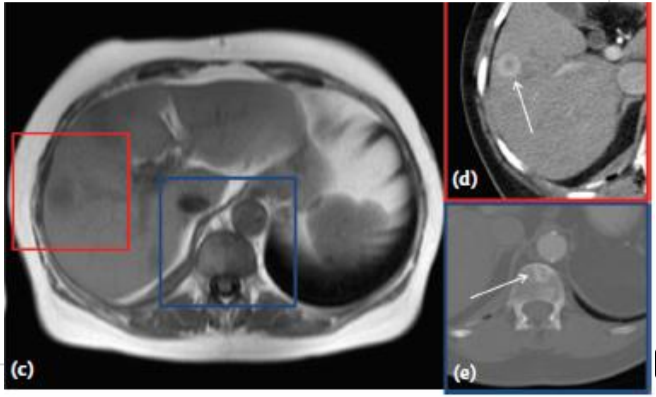
- **Clinical correlation is important**

- **For clarification request dedicated liver ultrasound, MRI, CT, or biopsy**

Simple cyst



Metastatic lesion



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Liver lesions example

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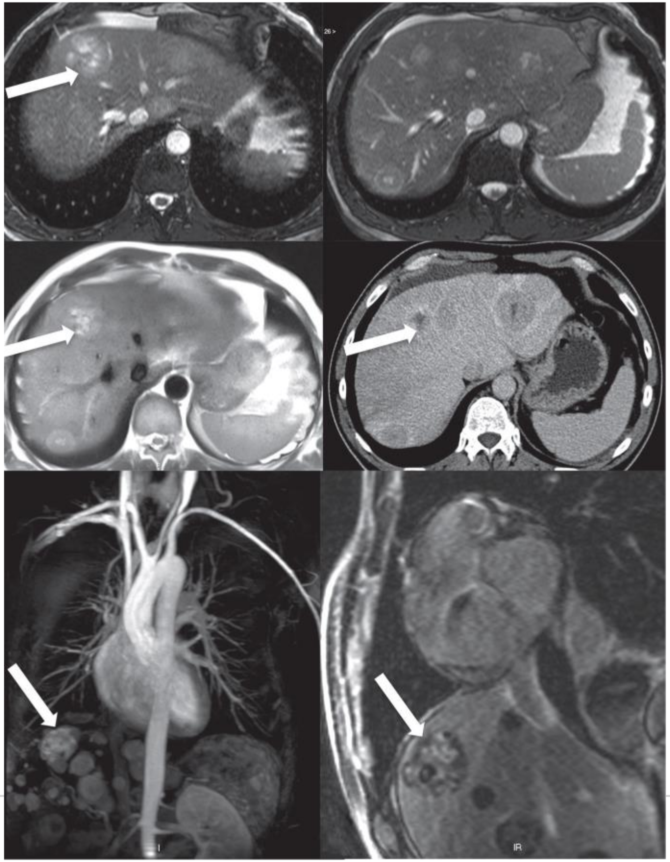
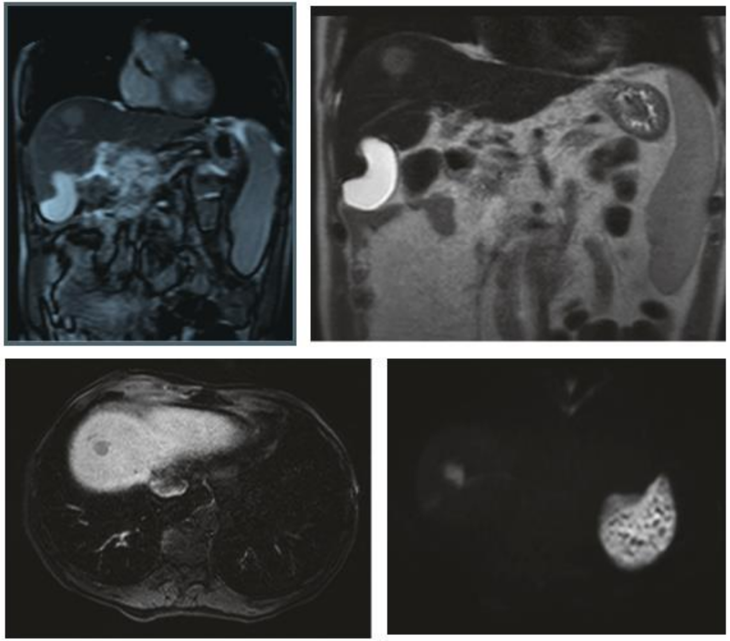
metastasis



nodular hepatocellular carcinoma



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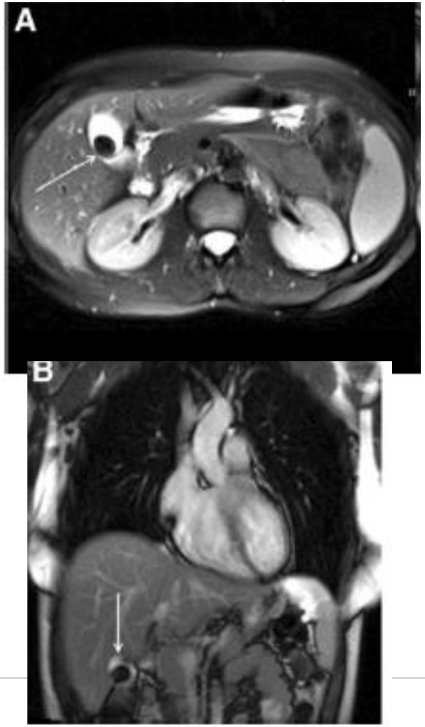
gallstones



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Kidney

Usually only upper part is visualized

Normal variations:

- **focal lobulations**
- **One kidney not visualized**
- **Horseshoe kidney**

Common pathology

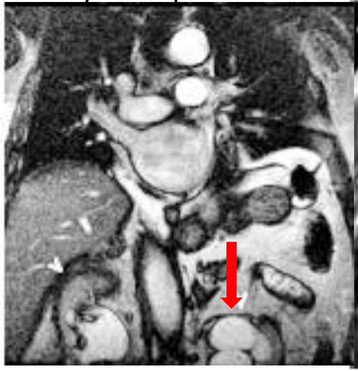
- **Benign Renal cysts**
  size and number are not relevant
  lack of filling on LGE

- **Malignant cysts**
  Bosniak classification: multiple septa and nodules, part cystic – part solid are concerning

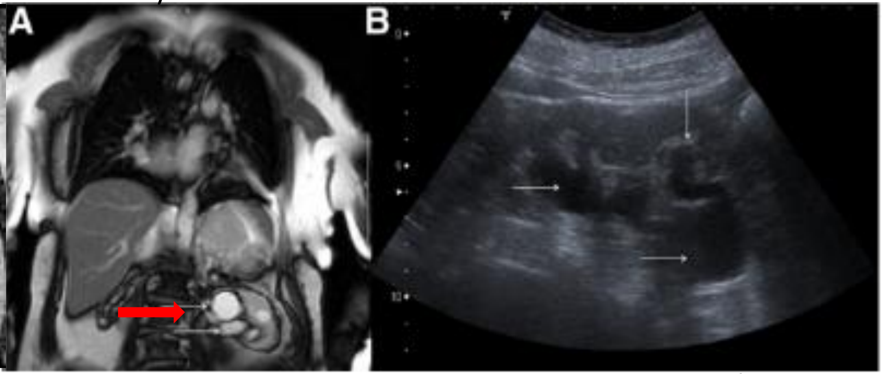
- **Review previous exams (stability is reassuring)**

- **Request Ultrasound and Urological opinion**

hydronephrosis

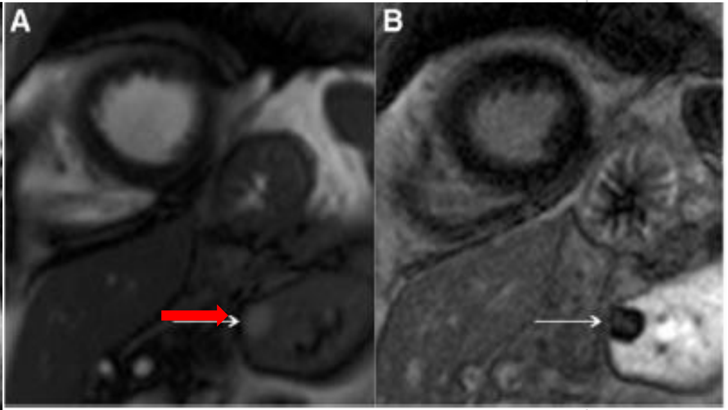


cyst



Renal tumor

Benign renal cyst



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McKenna The Open Cv Med J, 2008, 2, 20-25

Spleen

May be incompletely visualized

Normal size 12-15 cm in maximal bipolar direction

Accessory spleens are common

Splenomegaly

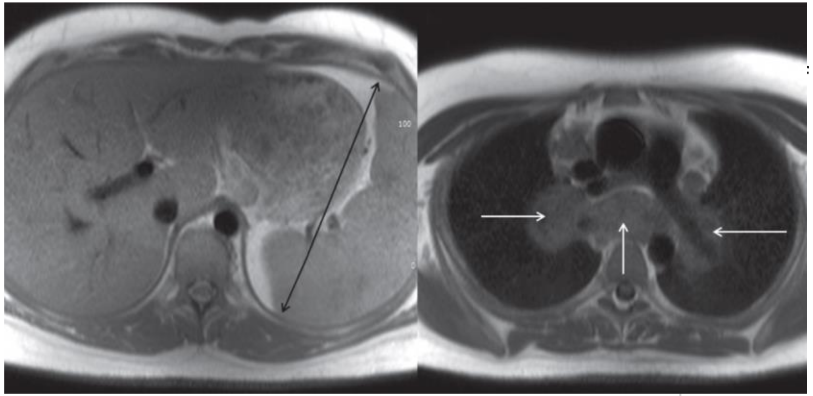
various etiologies: hematological diseases, right heart disorders, viral myocarditis)

Focal splenic lesions are uncommon

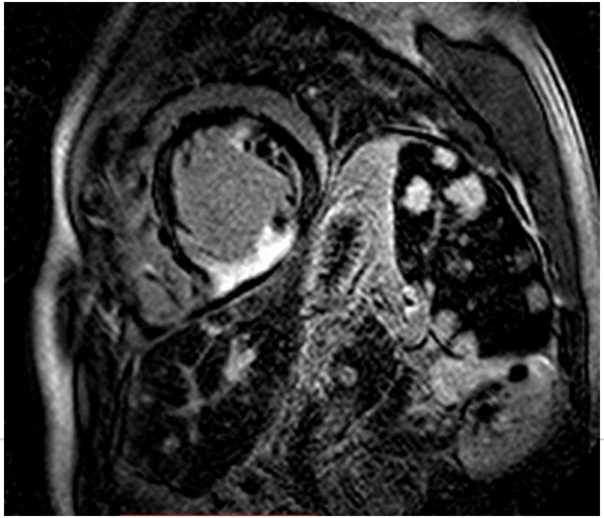
often hemangioma or focal trauma
Seek expert opinion

Ultrasound can confirm splenomegaly, however further imaging is rarely additive and the underlying aetiology needs to be determined clinically

Splenomegaly in lymphoma



Splenic lesion in multisystemic sarcoidosis



Adrenal glands

Invert V or T morphology

- right adrenal gland: posterior to the inferior vena cava and superior to the upper pole of the right kidney
- Left adrenal gland: anteromedial to the upper pole of the
- kidney and posterior to the pancreas

Normal size 2-6 mm thickness, 2-4 cm long

Pathology:

- Adrenal masses

- Malignancy (metastasis).

  if history of primary malignancy (lung, colon, breast or pancreas)

  intracellular fat is reassuring (lipid rich adenoma)
  In phase – Out phase MRI can confirm benignity

Request CT or adrenal MR to confirm

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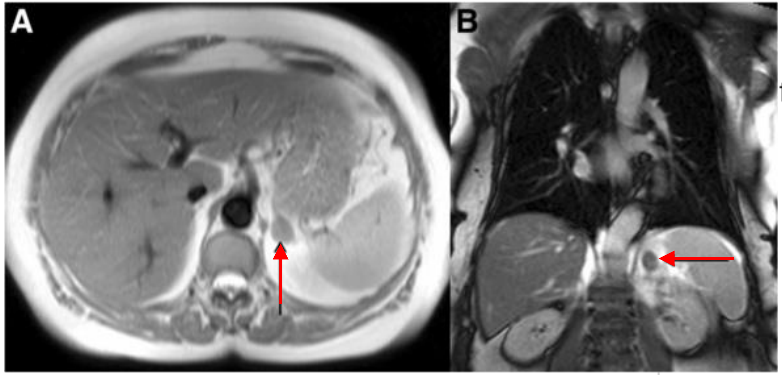
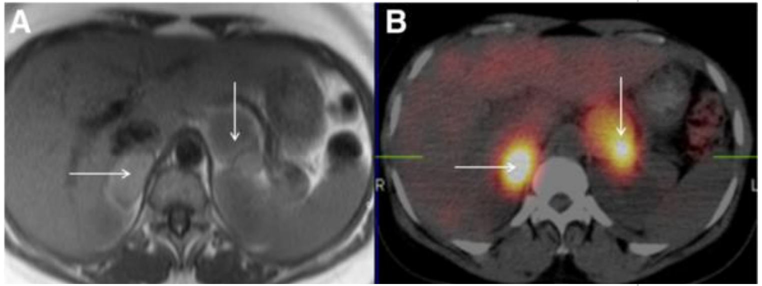
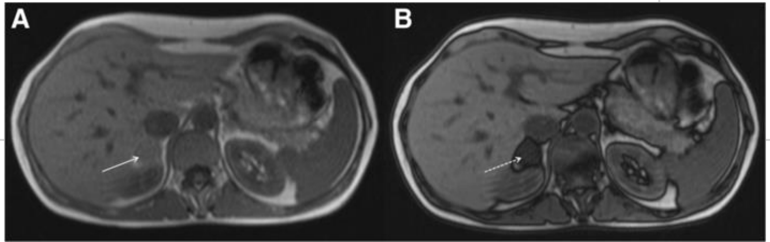
Adrenal nodule



Adrenal hypertrophy



In phase – Out phase MRI



Summary

Location	Normal Variant	Common pathology	Important signs	Further investigation
Neck	Pyramid lobe	Thyroid goiter Thyroid node	• Mass effect, Retrosternal extent • Lymphadenopathy, local invasion, size	Rev. prior exams & radiologist adv. Ultrasound
Mediastinum	Thymus	Lymphadenopathy	Size & contour -Loss of fatty hilum, Look for cause	Rev. prior exams & radiologist adv. CT
Lung	Azygos lobe fissure	Lung nodule <3cm Lung mass >3 cm Pleural effusion	• Look for 1^{ry} tumor, lymphadenopathy, Metastasis • Look for septation, pleural thickening	Rev. prior exams & radiologist adv. CT Fleitcher guidelines for nodules
Breast	Asymmetric fibrofatty change	Breast lesion Mastectomy, prothesis	• Look for metastasis • Look for recurrence / rupture	Seek expert radiologist input
Liver	Riedel's lobe	Cysts Metastasis Gallstones	• Look for 1^{ry} tumor • Look for cholecysttis	Rev. prior exams & radiologist adv. Ultrasound
Kidney	Foetal lobulation Pelvic, duplex, horseshoe	Renal cysts Hydronephrosis	• Look for complexity • Ureteric dilatation, calycial bluting	Rev. prior exams & radiologist adv. Ultrasound. Bosniak classific cysts
Spleen	Splenectoli	Splenomegaly Splenic lesion	• Look for cause	Rev. prior exams & radiologist adv. Ultrasound
Adrenal	Invert V or Y	Adrenal nodule (benign/malignant)	• Look for evidence of fat • Look for occult 1^{ry} tumor	Rev. prior exams & radiologist adv. CT/MR for staging. Biochemical test
Bones	Pectus excavatum/carin. Vertebral abnormal.	Haemangioma Metastasis	• High T1 and T2 • Low T1, assess collapse cord lesion	Rev. prior exams & radiologist adv. CT

Conclusions

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- A significant amount of the neck, thorax and upper abdomen is imaged at the time of routine clinical CMR.
- Extra-cardiac findings are common and an important proportion of these findings are clinically relevant, and therefore extracardiac findings should looked for and reported in cMR interpretation
- Individuals who report CMR have a professional and ethical duty to be adequately trained in the interpretation of extra-cardiac findings. If CMR studies are not read jointly with radiologists, in the presence of extra-cardiac findings the advice of radiologist should be sought, especially in case of incertainity.
- Ideally, CMR studies should be reported with immediate access to all previous radiological imaging and image reports for comparison. Indeed the most useful first step in the evaluation is to review what previous investigations the patient has had.
- CMR sequences are however suboptimal for characterizing incidental extra-cardiac findings, therefore it may not always be possible to definitively determine the cause or clinical importance and recognizing that an extra-cardiac abnormality is indeterminate may be the only valid conclusion that can be drawn from the images available.
- the most important step in the management of incidental extra-cardiac findings is communicating the importance to the referring clinician, with clear, unambiguous guidance on what further investigations.

ESC