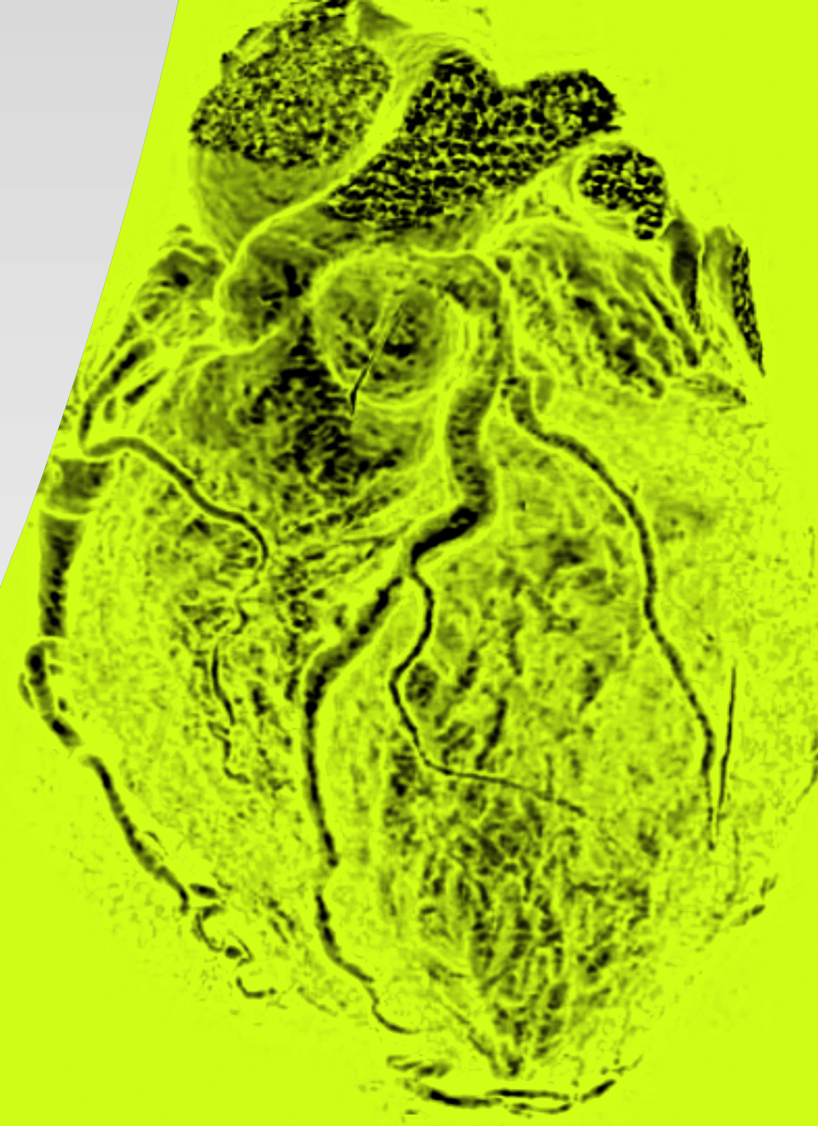
MODERN RADIOLOGY eBook

Cardiac Imaging



ESR EUROPEAN SOCIETY OF RADIOLOGY

Preface

Modern Radiology is a free educational resource for radiology published online by the European Society of Radiology (ESR). The title of this second, rebranded version reflects the novel didactic concept of the ***ESR eBook*** with its unique blend of text, images, and schematics in the form of succinct pages, supplemented by clinical imaging cases, Q&A sections and hyperlinks allowing to switch quickly between the different sections of organ-based and more technical chapters, summaries and references.

Its chapters are based on the contributions of over 100 recognised European experts, referring to both general technical and organ-based clinical imaging topics. The new graphical look showing Asklepios with fashionable glasses, symbolises the combination of classical medical teaching with contemporary style education.

Although the initial version of the ***ESR eBook*** was created to provide basic knowledge for medical students and teachers of undergraduate courses, it has gradually expanded its scope to include more advanced knowledge for readers who wish to 'dig deeper'. As a result, ***Modern Radiology*** covers also topics of the postgraduate levels of the ***European Training Curriculum for Radiology***, thus addressing postgraduate educational needs of residents. In addition, it reflects feedback from medical professionals worldwide who wish to update their knowledge in specific areas of medical imaging and who have already appreciated the depth and clarity of the ***ESR eBook*** across the basic and more advanced educational levels.

I would like to express my heartfelt thanks to all authors who contributed their time and expertise to this voluntary, non-profit endeavour as well as Carlo Catalano, Andrea Laghi and András Palkó, who had the initial idea to create an ***ESR eBook***, and - finally - to the ESR Office for their technical and administrative support.

Modern Radiology embodies a collaborative spirit and unwavering commitment to this fascinating medical discipline which is indispensable for modern patient care. I hope that this ***educational*** tool may encourage curiosity and critical thinking, contributing to the appreciation of the art and science of radiology across Europe and beyond.

Minerva Becker, Editor
Professor of Radiology, University of Geneva, Switzerland

Cardiac Imaging

CHAPTER OUTLINE:

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CHAPTER OUTLINE:

Signage

<■> **CORE KNOWLEDGE**

>■< **FURTHER KNOWLEDGE**

<!> **ATTENTION**

>|< **COMPARE**

<?> **QUESTIONS**

<↑> **HYPERLINKS**

<∞> **REFERENCES**

CHAPTER OUTLINE:

MODERN RADIOLOGY eBook

Based on the ESR Curriculum for Radiological Education

Cardiac Imaging

CHAPTER OUTLINE:

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Chapter Outline

/ Anatomy

CHAPTER OUTLINE:

Anatomy

The heart is located in the centre of the thoracic cavity, in the middle mediastinum

- Behind the sternum and the costal cartilages, which protect it like a shield
- In front of the vertebral column, from which it is separated by the oesophagus and aorta
- On top of the diaphragm, which separates it from the underlying viscera
- Between the two lungs

Its shape can be approximated to that of a truncated cone, that is orientated in the thorax with its apex projecting forward, to the left and downward, and the base faces in a posterior direction.

The weight is about 250-300 g in the adult, measuring 12 cm in length, 9-10 cm in width and about 6 cm in thickness.

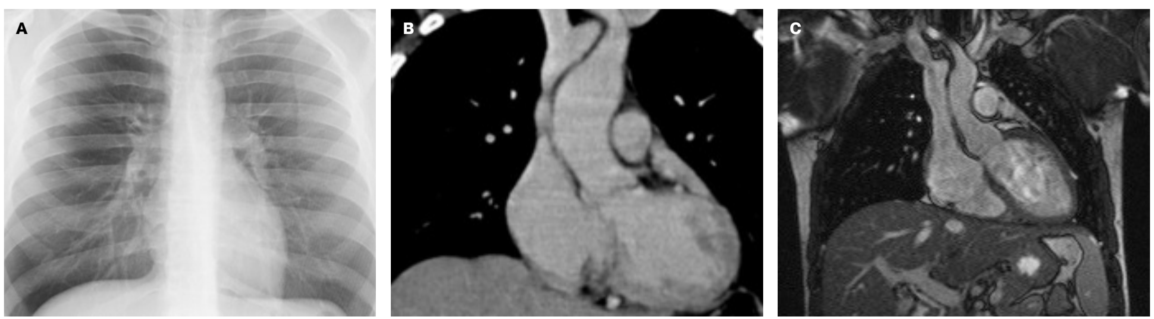
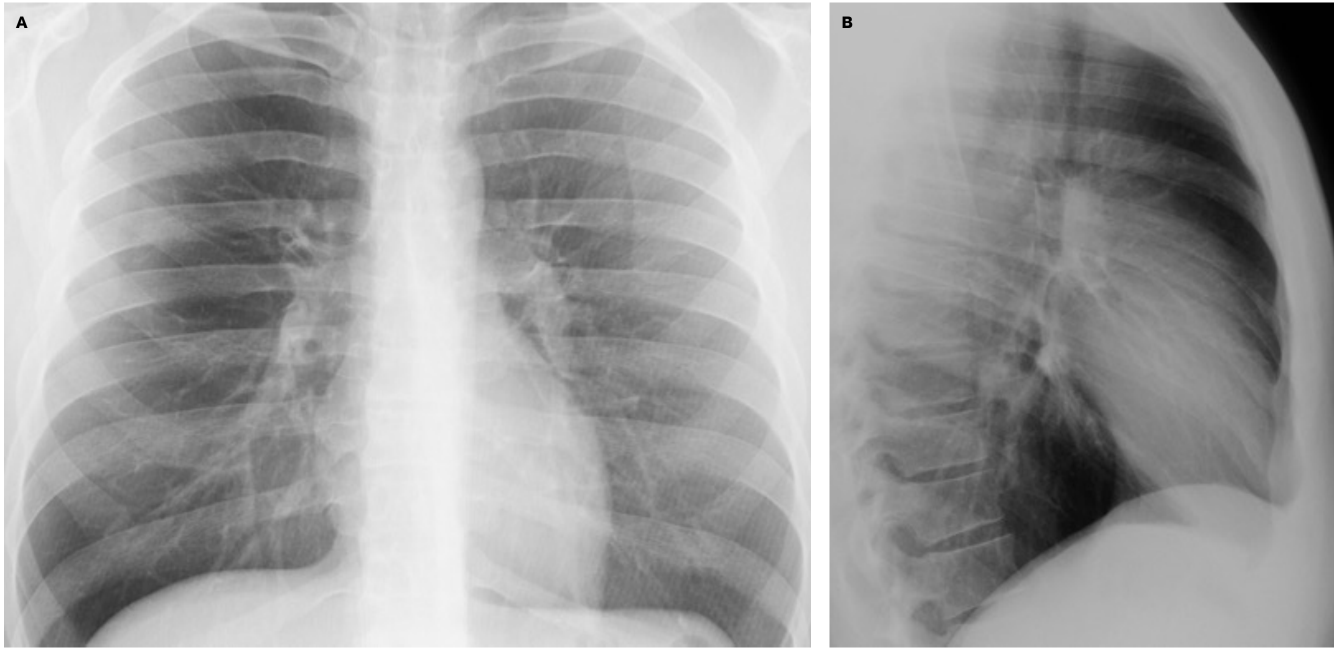


FIGURE 1

Different coronal views of the heart on a conventional X-ray (**A**: PA projection), CT (**B**) and MRI (**C**) images.



Cardiac Imaging

CHAPTER OUTLINE:

FIGURE 2

Chest X-ray; the cardiac silhouette can be appreciated on the PA (**A**) and left lateral (LL, **B**) projections.

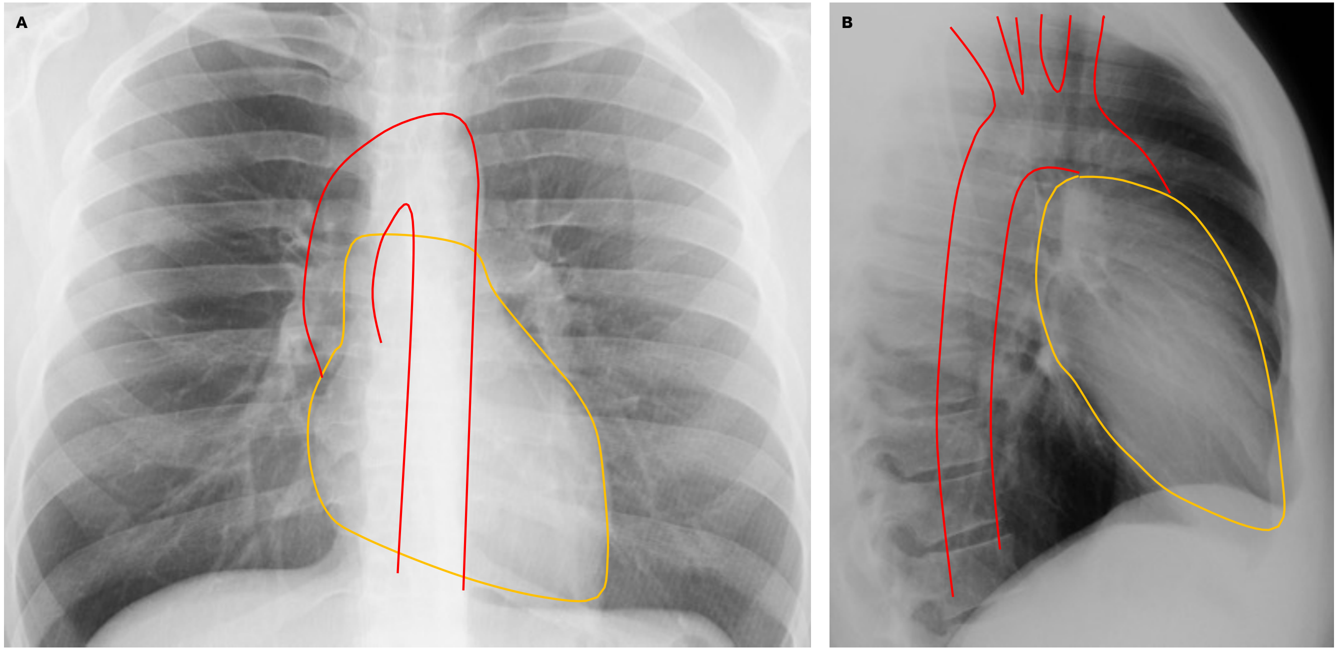


FIGURE 3

Chest X-ray (CXR): **A**: postero-anterior (PA) view; **B**: left lateral (LL) view; the **yellow line** encircles the cardiac silhouette, that projects for 1/3rd on the right side and 2/3rds on the left side of the midline. The **red line** encircles the thoracic aorta: ascending aorta arises from the left ventricle and continues in the aortic arch and then in the descending aorta, whose outline is easier to appreciate in the LL projection rather than in the PA projection.

/ **Cardiac** Imaging

CHAPTER OUTLINE:

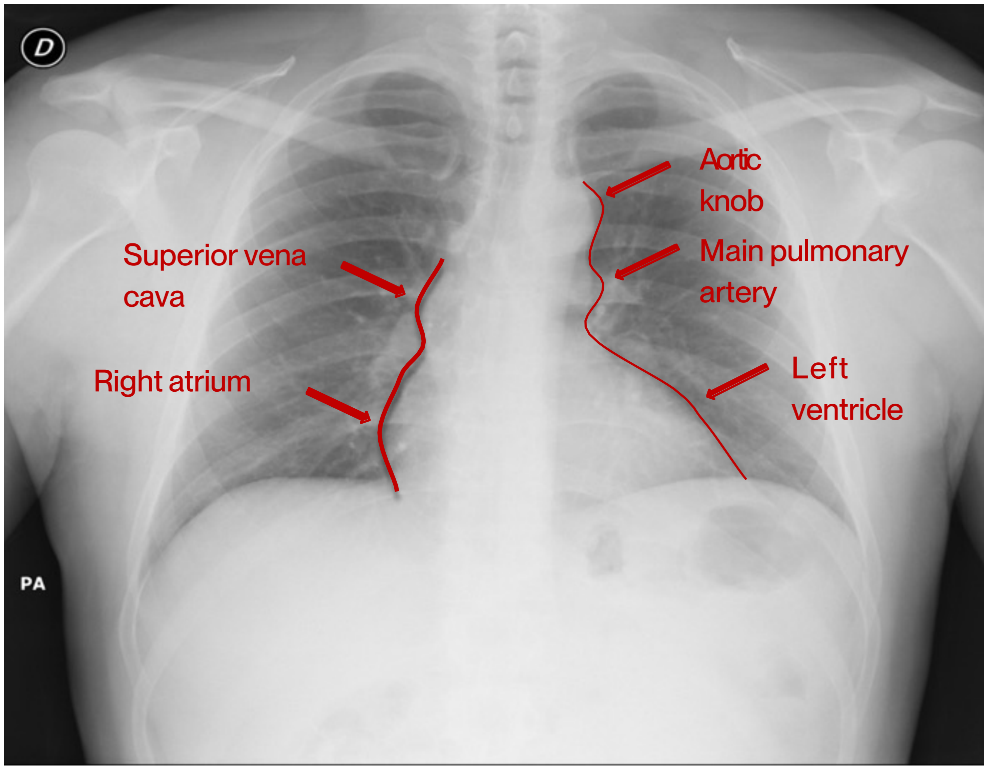


FIGURE 4

Cardiac contours on chest X-ray PA projection

On the right side, two contours can be identified, the superior one is a low-density line close to the vertebral column, it is caused by the superior vena cava. This contour meets inferiorly with the second one, formed by the right atrium.

On the left, we can identify three contours: the most cranial one is known as the aortic knob, it is formed by the overlapping of the aortic arch and the the first portion of the descending aorta. Just below this first contour is the second one, the main pulmonary artery. The third and most caudal of the left contours is formed by the left ventricle.

FIGURE 5

Computed Tomography (CT) series of coronal slices showing the heart (**yellow line**) located in the mediastinum between the two lungs, and the thoracic aorta (**red line**). The aorta can be clearly seen originating from the left ventricle at the aortic valve.

/ Cardiac Chambers

The heart has four chambers: two right chambers and two left chambers separated by interatrial and interventricular septa.

Right atrium and right ventricle receive blood from the superior and inferior vena cava and eject it into the pulmonary trunk.

Left atrium and left ventricle receive blood from the pulmonary veins and eject it into the aorta.

The atria have thin walls and a reservoir function, they receive blood from the veins and convey it into the corresponding ventricles through the atrioventricular valves (mitral and tricuspid).The ventricles have a pump function, they push the blood into the large arteries through the semilunar valves (aortic and pulmonary).

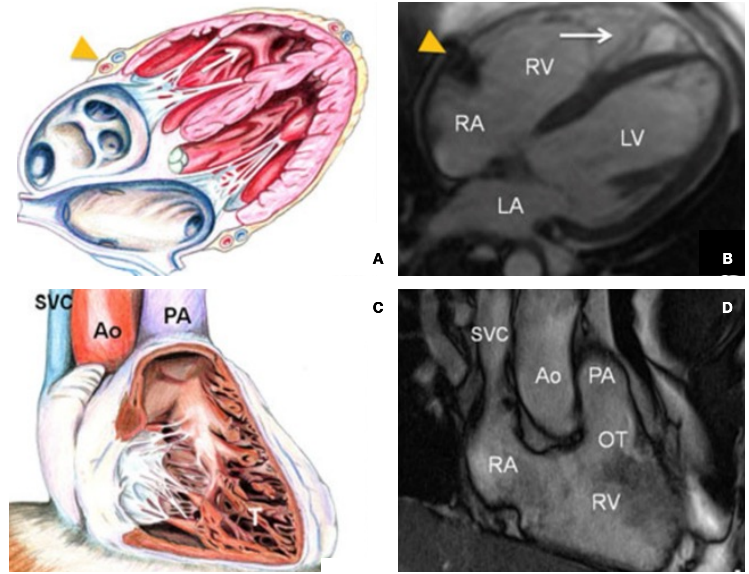


FIGURE 6

Freehand drawings (**A**, **C**) and corresponding MRI images on four chamber (**B**) and three chamber view (**D**) demonstrating right ventricular anatomy. We can appreciate the moderator band (**white arrow**), and the right atrio- ventricular groove (**yellow arrowheads**), containing the right coronary artery and small cardiac vein.

In (**D**) the RA and RV are depicted along with the OT, the PA and the inflow tract (SVC).

RA = right atrium, RV = right ventricle, LA = left atrium, LV = left ventricle, SCV = superior vena cava, Ao = aorta, PA = pulmonary artery, OT = right ventricular outflow tract. T = trabeculations.

Figure reproduced from: Galea, N., Carbone, I., Cannata, D. et al. Right ventricular cardiovascular magnetic resonance imaging: normal anatomy and spectrum of pathological findings. Insights Imaging 4, 213–223 (2013). https://doi.org/10.1007/s13244-013-0222-3

/ Cardiac Valves

Atrioventricular valves: open during diastole and close during systole

- / Tricuspid valve, on the right side, made of three leaflets
- / Mitral valve, on the left side, made of two leaflets

Semilunar valves: so named for the crescent shape of their cusps, open during systole and close during diastole

- / Aortic valve, on the left side, typically tricuspid
- / Pulmonary valve, on the right side

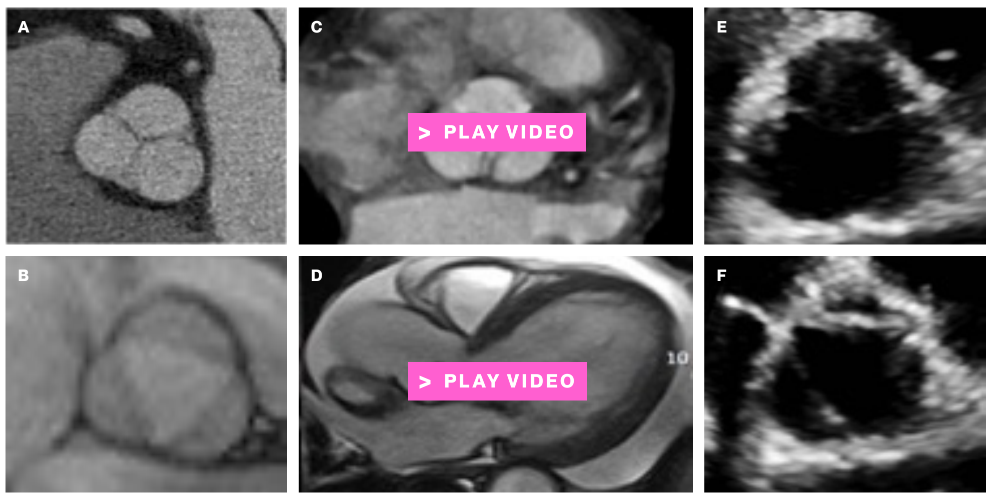


FIGURE 7

Aortic valve morphology on CT (**A**) and MR scans (**B**). Aortic valve function on cine CT (**C**) showing cusps movement and cine MR (**D**) showing transvalvular flow, which appears as a «black jet». Echocardiographic images of a closed (**E**) and open (**F**) aortic valve.

Pericardium

A thin flask-shaped fibroserous membrane, that contains the heart and the roots of the great vessels and is composed of two layers, the inner serosa (also referred as the visceral pericardium) and the outer serosa (parietal pericardium). It forms a complete sac filled with up to 50 mL of plasmatic ultrafiltrate.

Innervation

The heart has extrinsic and intrinsic innervation, which stimulate the heartbeat independently and coordinately. The cardiac conduction system consists of a pacemaker centre at the level of the sinus node and conduction pathways that transmit the pulse up to the ventricular myocardium.

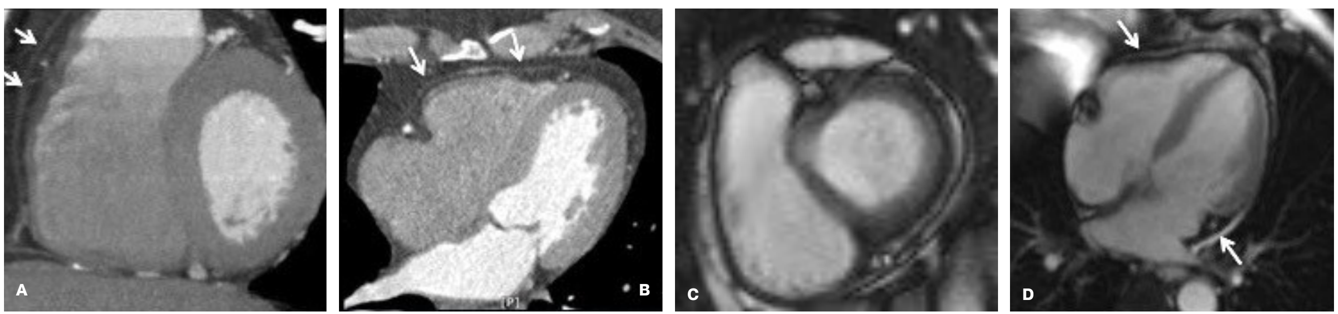


FIGURE 8

CT scan (**A**, **B**) showing normal appearance of pericardium. Normal pericardium is also shown as it appears on “white-blood” MRI sequences (**C**, **D**).

/ Blood Supply

Coronary Anatomy

Two coronary arteries arise from the sinuses of the aortic root: the right coronary artery (RCA) from the right sinus, the left main coronary artery (LM) from the left sinus.

- RCA descends in the coronary sulcus between right atrium and ventricle, turns posteriorly onto the diaphragmatic surface of the heart still following the sulcus. It gives off atrial and acute marginal branches.
- LM passes between pulmonary trunk and left auricle before entering the coronary sulcus, here it divides into the left anterior descending artery (LAD) and Left circumflex artery (LCX).
    - LAD descends obliquely towards the apex in the anterior interventricular septum while giving off diagonal and septal branches.
    - LCX runs in the coronary sulcus up to the diaphragmatic surface of the heart giving off obtuse marginal branches.

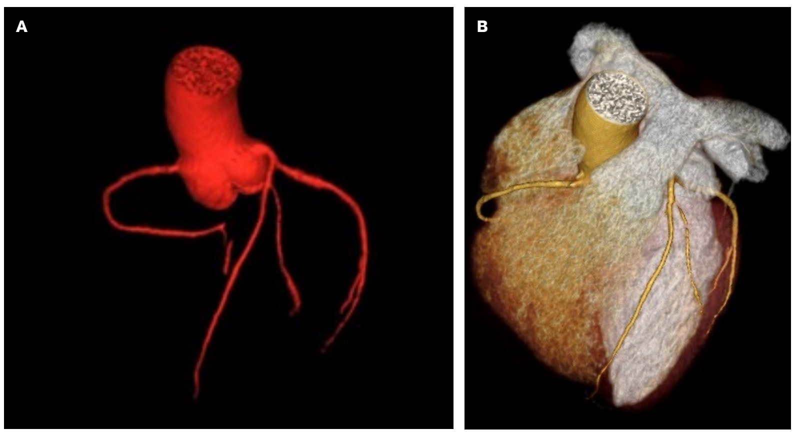


FIGURE 9

(**A**) CT 3D Volume Rendering of the aortic root and coronary tree. (**B**) CT 3D Volume Rendering of heart and coronary tree.

- RCA supplies the right atrium and ventricle, the sinoatrial and atrioventricular nodes and the posterior one third of the interventricular septum (in cases of right dominance, see below).
- LAD supplies the anterior two thirds of the interventricular septum and the anterior wall of the left ventricle.
- LCX supplies the lateral wall of the left ventricle and the left atrium.

Venous Drainage

The coronary veins return deoxygenated blood from the myocardium back to the right atrium. Most venous blood returns via the coronary sinus.

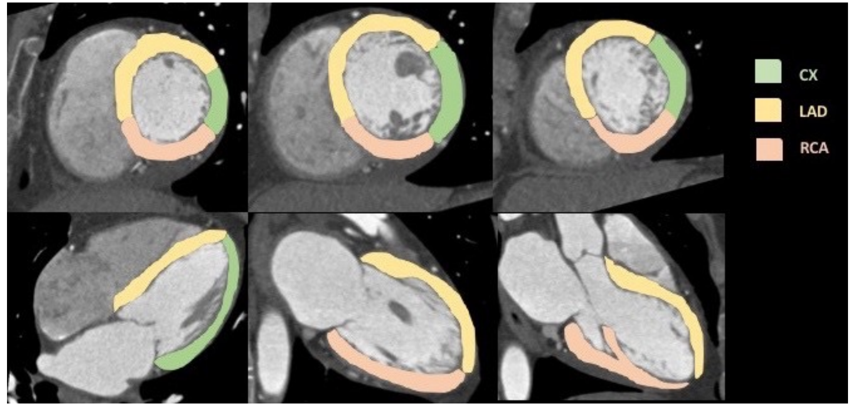


FIGURE 10

Graphic representation of the coronary artery territories.

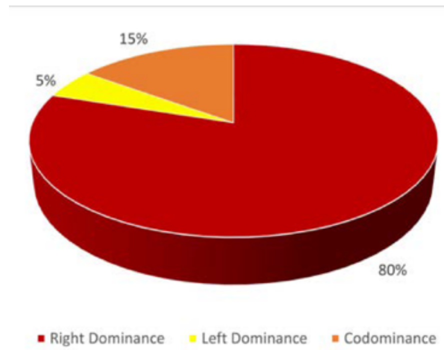


FIGURE 11

Coronary dominance refers to the coronary artery giving off the posterior interventricular artery. Right dominance occurs in 80% of the population, left dominance (from the LCX) in 5% and codominance in 15%.

Strengths, Weaknesses and Role of Imaging Modalities

CHAPTER OUTLINE:

Chest X-Ray

Chest X-ray can show abnormalities in the size and shape of the heart, which may indicate heart failure, pericardial effusion or heart valve disorders. Moreover, chest X-ray may reveal pulmonary changes as a consequence of heart disease (e.g. pulmonary oedema as result of congestive heart failure).

The main limitation of this modality in the study of the heart is the difficulty in distinguishing the various overlapping cardiac structures, as they share similar radiographic density.

Understanding what makes up the normal contours of heart and mediastinum on a PA chest X-ray is an important skill for most physicians, as it is required to correctly allocate any abnormality that is detected.

CHAPTER OUTLINE:

The Cardiothoracic Ratio

The cardiothoracic ratio is a simple yet effective tool to look for cardiomegaly. This ratio must be measured on a PA chest X-ray and is calculated dividing the widest horizontal diameter of the heart by the maximal horizontal diameter of the thoracic rib cage. A normal ratio should be < 0.5, values above this point to cardiomegaly or other pathologies (pericardial effusion).

<!> ATTENTION

Cardiothoracic ratio on CXR: You shouldn't measure the cardiothoracic ratio on an AP projection as the cardiac silhouette is typically magnified in these cases. Cardiothoracic ratio is useful to detect eccentric hypertrophy of the heart, concentric hypertrophy will generally go undetected.

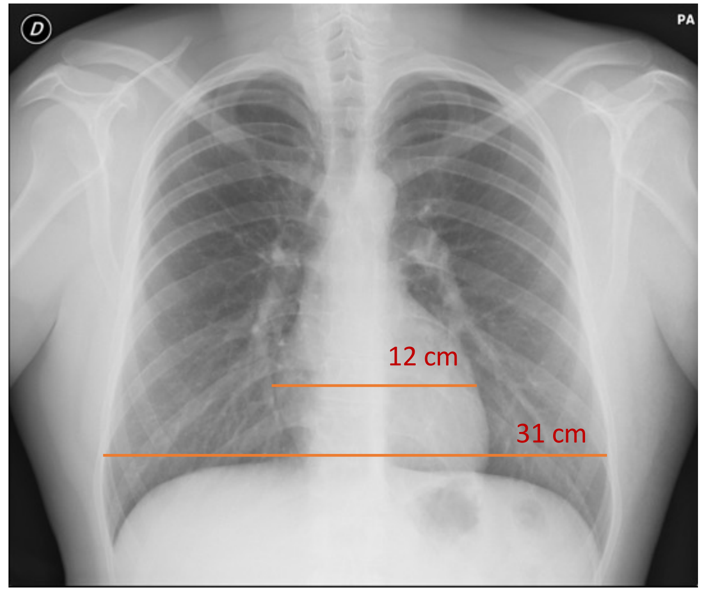


FIGURE 12

Chest X-ray (PA) showing a normal cardiothoracic ratio (< 0.5).

Cardiac Imaging

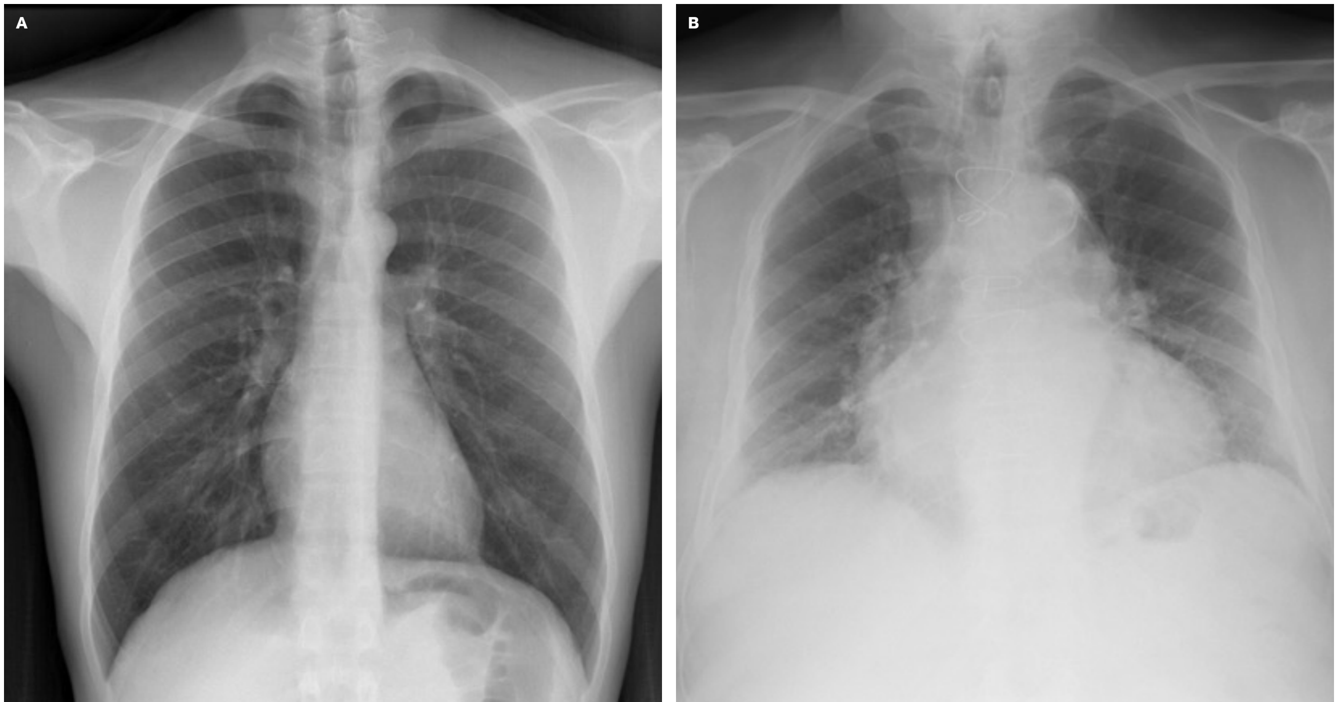
CHAPTER OUTLINE:

>|< COMPARE

In the Patient A the cardiothoracic ratio is 0.41 (< 0.5), while in the Patient B it is 0.55 (> 0.5), an evidence of cardiac enlargement.

FIGURE 13

Chest X-ray in a 27 years old healthy patient (**A**) and in a patient affected by post-ischaemic heart failure (**B**).



CHAPTER OUTLINE:

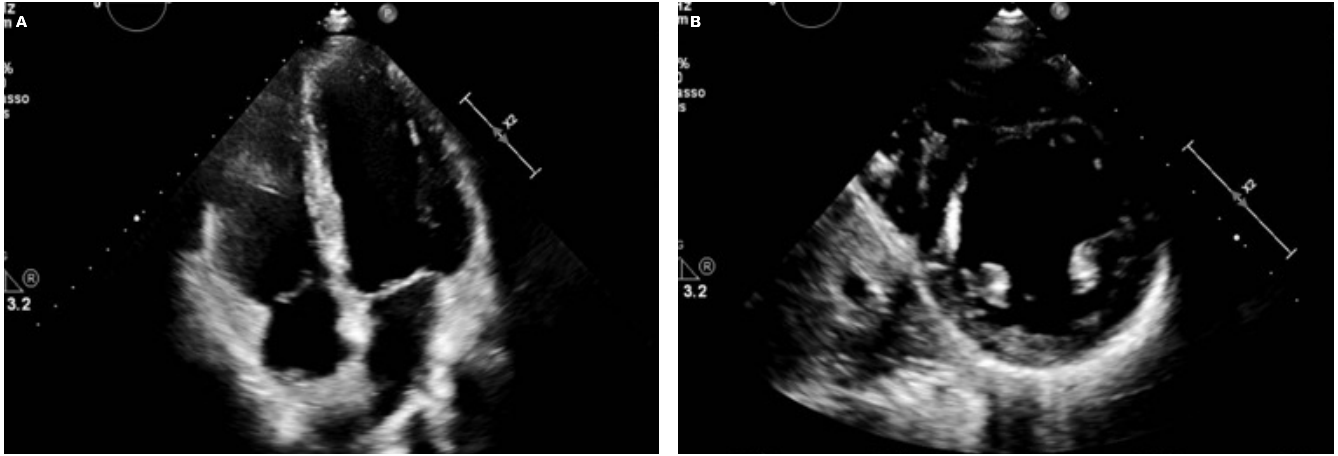
/ Echocardiography

Echocardiography (ultrasonography, US) is often used as a first step in the evaluation of cardiac pathologies, as it is a low cost, widely available and non-invasive technique.

Possible pitfalls of echocardiography are the acoustic impedance of the thorax, which can be overcome using a transoesophageal approach, and inter-operator variability.

The main goals of echocardiography are:

- To study cardiac anatomy: characterisation of Congenital Heart Disease (CHD), evaluation of pericardial effusion and detection of intracardiac masses or thrombi.
- To estimate cardiac function: assessment of cardiac motility and cardiac chamber 's performance (ejection fraction, EF; end-diastolic volume, EDV; end-systolic volume, ESV).
- To study cardiac valves: evaluation of valves morphology and thickness, estimation of transvalvular flow and detection of valvular stenosis or insufficiency, using Doppler-US.



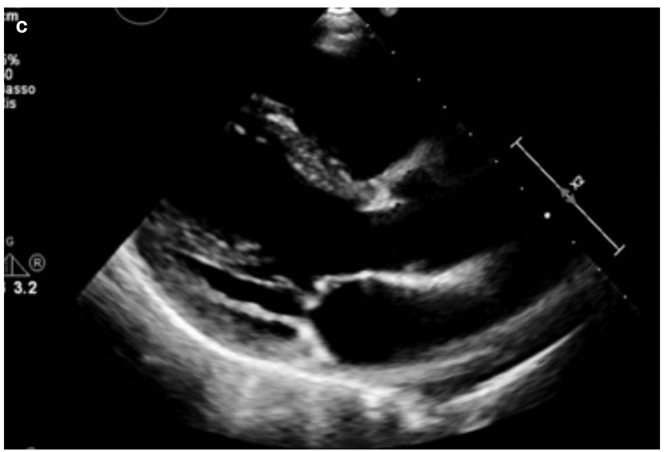


FIGURE 14

Echocardiographic images of a healthy patient on 4 chamber (**A**), short axis (**B**) and 3 chamber (**C**) views.

/ Cardiac Imaging

CHAPTER OUTLINE:

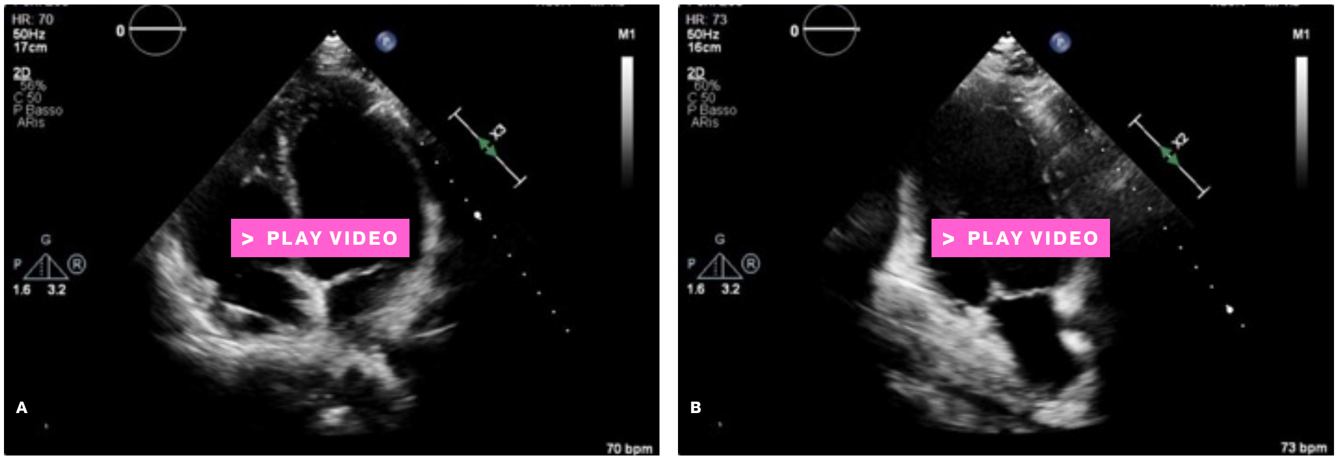


FIGURE 15

Echocardiographic videos of a healthy patient on 4 chamber view (**A**) and 2 chamber (**B**) views.

CHAPTER OUTLINE:

/ Cardiac CT

CT scanning of the heart allows precise assessment of heart and coronary anatomy, made possible by the fast image acquisition and by the possibility to synchronise image capture and heart beat (ECG-gating).

Iodinated, intravenous contrast media are used for most cardiac protocols, in order to opacify the blood vessels and heart chambers; the formulations used are typically high-concentration.

Drawbacks of CT include radiation dose delivered, increased by ECG-gating, and potential toxicity of iodinated contrast media.

When coronary arteries are being investigated (Coronary CT Angiography) ECG-gating is fundamental to reduce the effects of heart motion. Heart rates that are excessively high (mostly above 70 bpm) lead to image quality that is hardly diagnostic even with the support of ECG-gating, making radiation dose unjustifiable. Such patients cannot undergo Coronary CT Angiography or need reduction of their heart rate through the use of B-blockers.

The accuracy of Coronary CT Angiography can be increased through the use of short – acting nitrates; these drugs cause vasodilation of the coronary arteries and allow better visualisation of the coronary lumen.

<∞> REFERENCE

European Heart Journal (2008) 29, 531–556

ECG – gating consists in synchronisation of image acquisition and cardiac cycle to get an image of the heart as if it were still. Gating can be retrospective or prospective, in the first case images are acquired during most of the cycle and subsequently reconstructed in definite phases, whereas in the second case images are only acquired in a single phase of the cycle, usually in diastole. The latter modality allows radiation dose reduction but increases the risk of artifacts linked to heart rhythm. Because of the increased risk of artifacts, prospective gating is mostly used in patients with slow, regular heart beat. Furthermore valve function and wall motion can only be studied with retrospective gating, as it allows visualisation of these structures during the whole heart cycle.

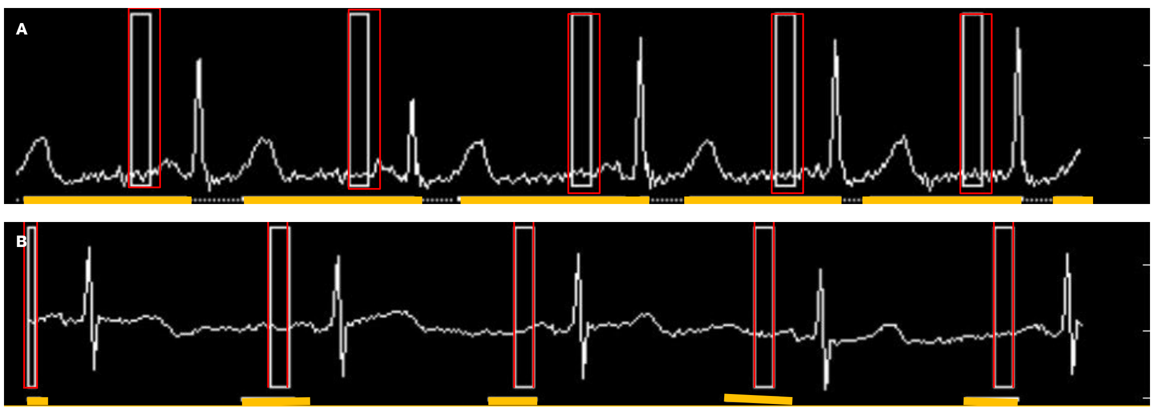


FIGURE 16

Graphs showing cardiac CT acquisition with retrospective (**A**) and prospective (**B**) ECG gating: the orange lines show the time interval of the cardiac cycle in which the image is acquired, while the red rectangles show the time interval of image reconstruction.

Cardiac MRI

Cardiovascular Magnetic Resonance Imaging (CMR) can be used in the diagnostic and prognostic evaluation of multiple cardiovascular pathologies; it also provides the most accurate functional information regarding heart physiology (i.e., cardiac volumes and ejection fraction) and allows high resolution anatomical assessment without the drawback of ionising radiation.

- Unenhanced CMR is useful for morphological and functional studies, but the injection of gadolinium-based contrast media allows tissue characterisation, the true strength of this technique, consisting in the detection of vital, suffering (oedematous) and necrotic/fibrotic myocardium.
- CMR is also able to study blood flow dynamics, looking for valvular stenosis and insufficiency, turbulence and shunts.
- ECG-gating can be applied to MRI as well, respiratory motion is reduced by acquiring images in breath holding.
- The main drawbacks of cardiac MRI are its costs, the exam duration (it can span from 30 to 60 minutes) and the limited availability of dedicated scans and operators.

/ Cardiac Planes

An advantage of cardiac MRI is that images can be acquired in any plane. Traditional axial, coronal and sagittal planes have little use in the study of the heart, as this organ has a very specific orientation. Some specific planes are used in cardiac MRI to best visualise the heart:

/ **Horizontal long axis** (four chamber view): this plane is perpendicular to the interventricular septum and passes through the cardiac apex and the atrioventricular valves . It allows complete view of the 4 heart chambers, the interventricular septum, the free walls and the atrioventricular valves.

/ **Vertical long axis** (two chamber view): this plane passes through the apex and the mitral valve as well but is parallel to the interventricular septum, allowing visualisation of the left ventricle and atrium.

/ **Short axis:** This plane is perpendicular to the interventricular septum and somewhat parallel to the atrioventricular plane. More of these planes are drawn at different levels along the interventricular septum, allowing visualisation of this important structure in between the left and right ventricles or the left and right atria. This view is particularly useful to perform volumetric measurements that allow calculation of stroke volume and ejection fraction.

/ **Three chamber view:** This plane allows visualisation of aortic root and valve, LV outflow and inflow tracts and portions of left atrium and ventricle.

Different MRI sequences will have the blood depicted as hyperintense or hypointense when compare with the myocardium. Morphological sequences will generally be “black-blood”, functional sequences will be “bright blood”.

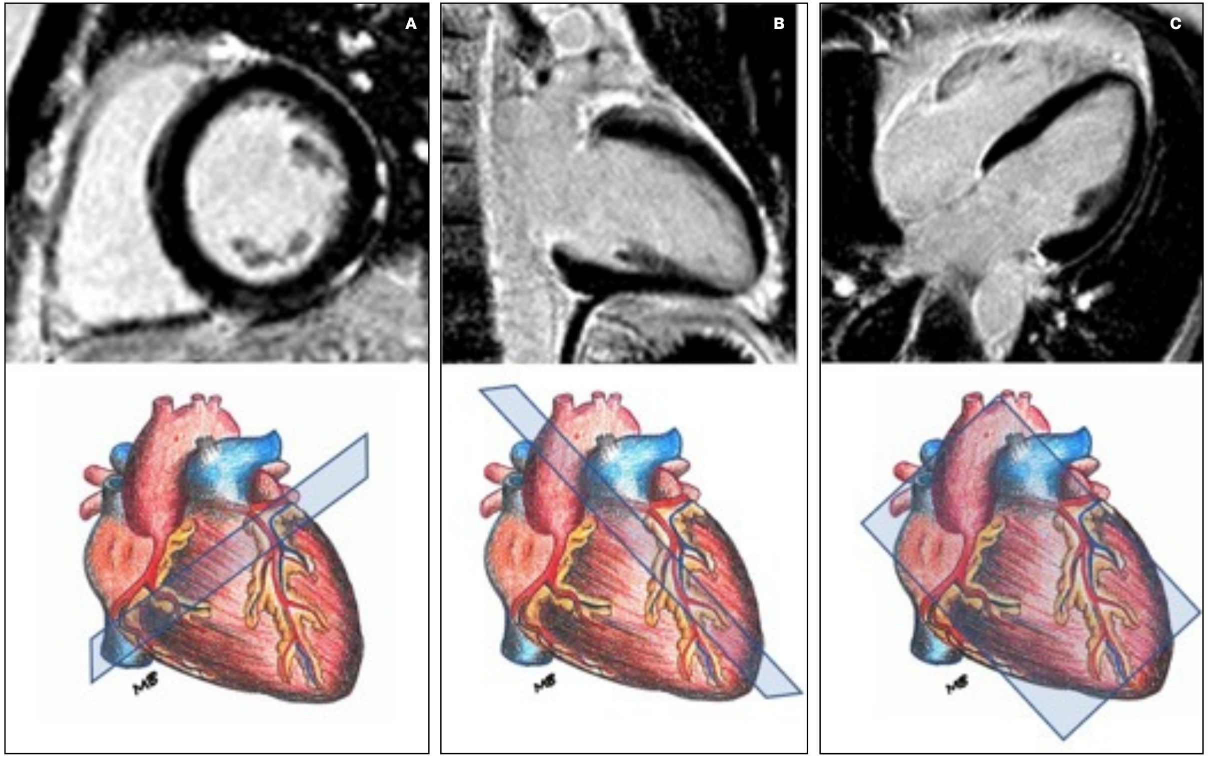


FIGURE 17

Late gadolinium enhancement (LGE) sequences and corresponding schematic drawings illustrating the short axis plane (**A**), 2 chamber plane (**B**) and 4 chamber plane (**C**) - There is no pathological parietal enhancement (upper rows).

CHAPTER OUTLINE:

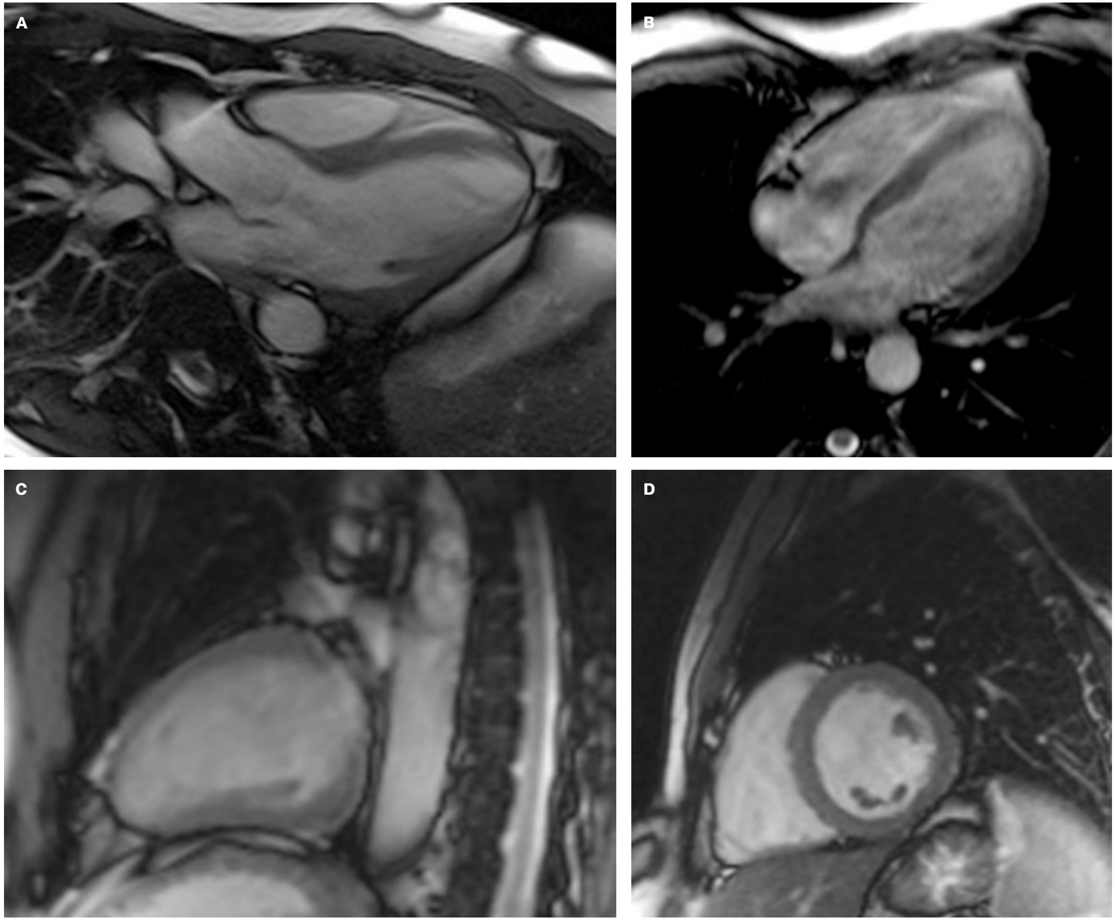


FIGURE 18

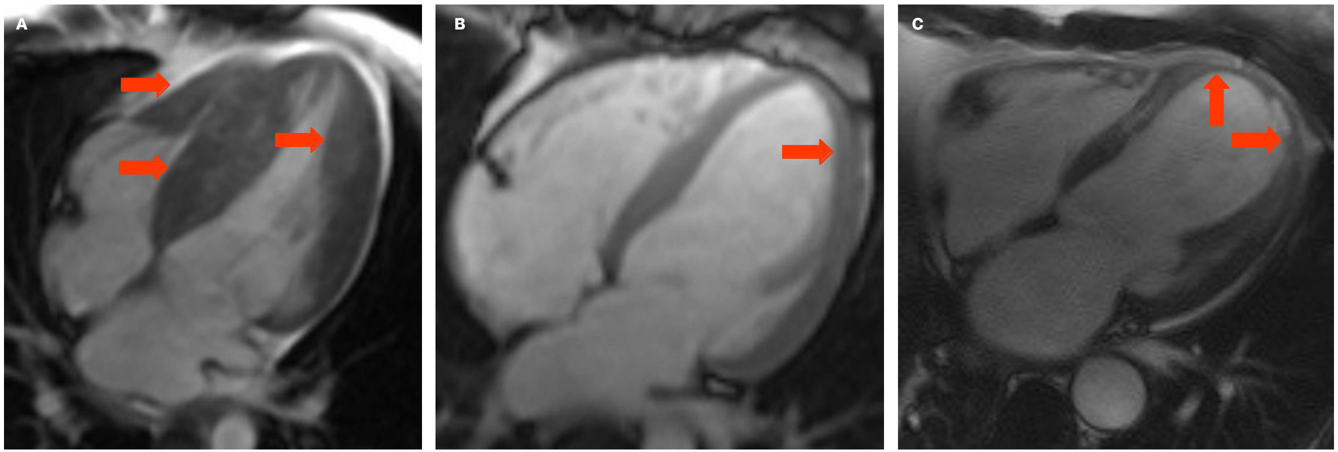
Three chamber view (**A**)

Four chamber view (**B**)

Two chamber view (**C**)

Short axis view (**D**)

>|< COMPARE



Hypertrophic (Thickened)

Normal

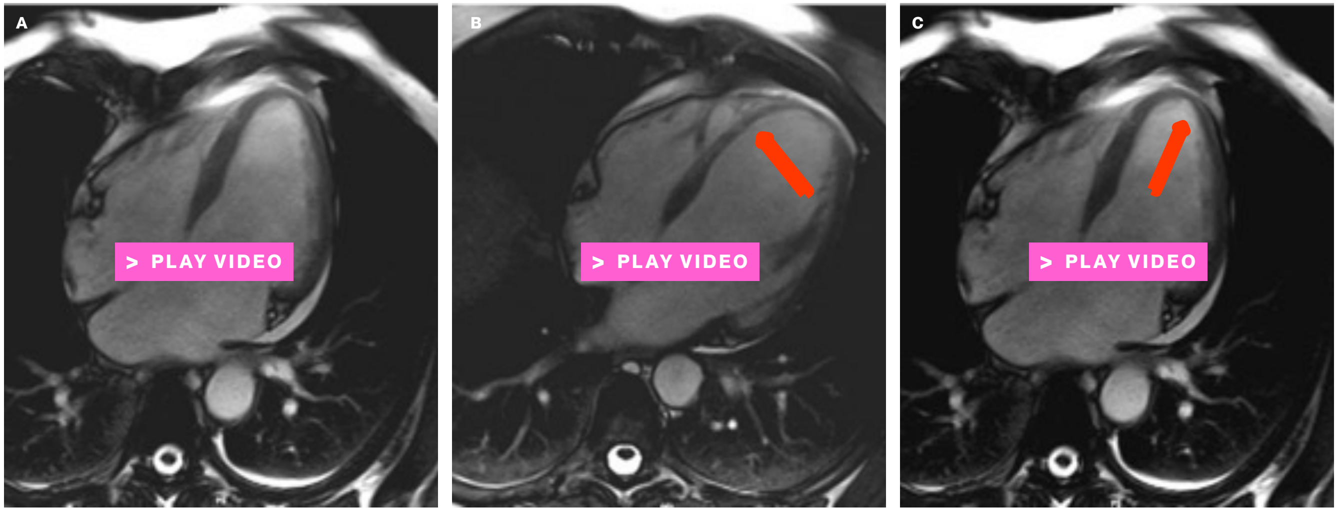
Remodelled (Thinned)

FIGURE 19

Cine Steady-state-free-precession (SSFP) MR in four chamber view showing increased thickness of ventricular wall (**A**; **red arrows**), normal thickness (**B**; **red arrow**) and decreased thickness (**C**; **red arrows**).

CHAPTER OUTLINE:

>|< COMPARE



Normal

A-/Hypokinetic

FIGURE 20

Cine Steady-state-free-precession (SSFP) MR four chamber view showing normal wall contraction (**A**), septal a-/hypokinesia (**B**; **red arrow**) and apical dyskinesia (**C**; **red arrow**).

/ Nuclear Medicine

Nuclear medicine techniques have a leading role in cardiac pathologies, thanks to their ability to evaluate myocardial perfusion, metabolism and function.

The main techniques used in cardiac evaluation are Single Photon Emission Computerised Tomography (SPECT) and Positron Emission Tomography (PET).

- SPECT imaging, performed at rest and stress state, is used to evaluate myocardial perfusion. The radiotracer (mostly thallium-201 and technetium-99m), administered intravenously, reaches viable cardiomyocytes, where it accumulates proportionally to myocardial perfusion. By using 3D reconstruction techniques, it is also possible to calculate functional parameters, such as End Diastolic Volume (EDV), End Systolic Volume (ESV) and Ejection Fraction (EF), which have an important prognostic role.
- PET imaging is important in the evaluation of myocardial viability. The key concept is that hypoperfused but viable cardiomyocytes maintain glucose metabolism (hibernating myocardium): by administering 18-F-FDG, a glucose analogue, PET studies can highlight mismatch between myocardial perfusion and glucose intake, typical of hibernating myocardium.

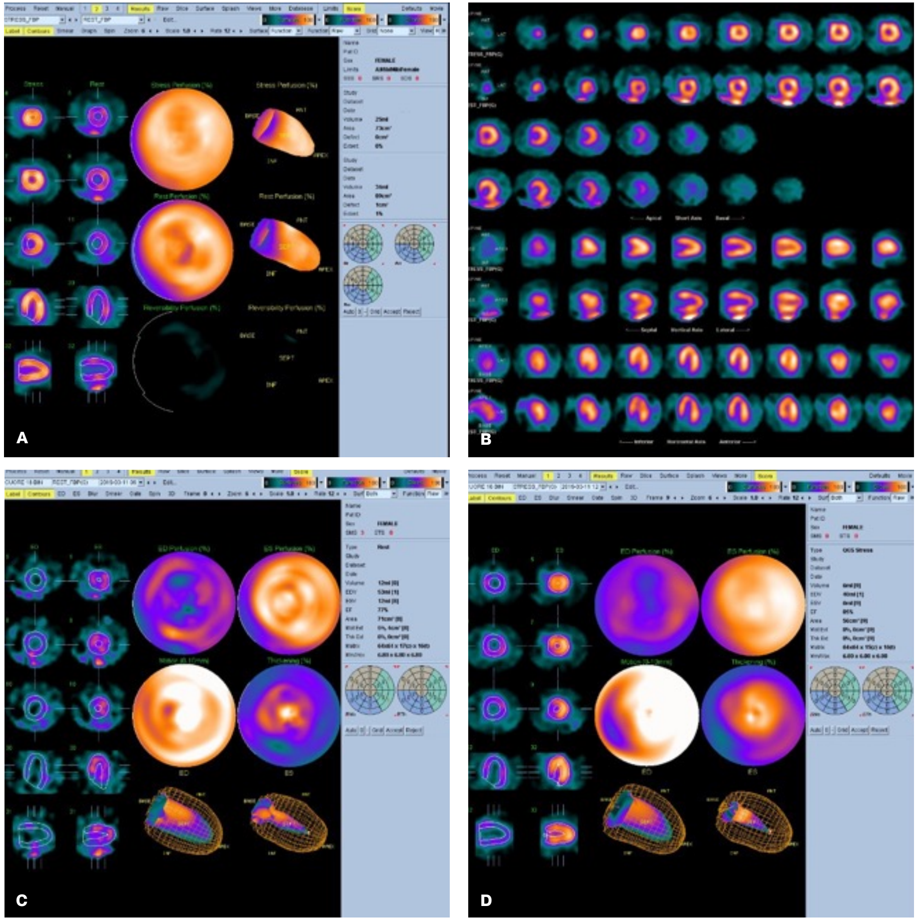


FIGURE 21

A) Myocardial perfusion SPECT study with 99mTc-sestaMIBI at rest and after stress showing images in three orthogonal planes. The radiotracer is evenly distributed in the left ventricle both at rest and after stress.

B) Three-dimensional tomographic reformatted images of left ventricular perfusion with polar maps to evaluate both qualitatively and quantitatively the presence of any perfusion defect, in terms of Summed Stress Score (SSS) and Summed Rest Score (SRS). In this study there is no significant perfusion defect, neither at rest nor under stress.

C and **D)** Tomographic reformatted images of gated – SPECT acquisitions for evaluation of left ventricular regional function and semiquantitative estimation of ventricular volumes and ejection fraction.

/ Cardiac Imaging

CHAPTER OUTLINE:

Ischaemic Heart Disease (IHD)

CHAPTER OUTLINE:

/ Coronary Artery Disease (CAD)

Suspected coronary artery disease (CAD):
the aim of imaging is to identify an obstructive coronary artery disease condition prior to infarct development. The strategies are the direct visualisation of the coronary tree or by functional tests that, by increasing the blood request from the myocardium, can induce a condition of transient ischaemia, documented as perfusion defect (Scintigraphy, Stress-MR) or anomalies of contractility (Echocardiography).

Stable setting:

- Echocardiography (contractility defects)
- Myocardial perfusion scintigraphy (perfusional defects)
- MRI (perfusional and contractility defects)

  All these tests can be performed as "stress - tests", thus increasing their diagnostic abilities
- Cardiac CT
  - Cardiac Calcium Scoring (detection of coronary calcifications): as support to risk stratification
  - Coronary CT Angiography (anatomical search of stenosis) for early detection of obstructive CAD in symptomatic patients with negative functional tests or asymptomatic patients with unconclusive functional tests or patients unable to perform functional tests.

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Vasc Health Risk Manag. (2017) 13, 427–437

Curr Cardiol Rep. (2016) 18

Curr Cardiovasc Imaging Rep. (2017) 10

Cardiovasc Diagn Ther. (2017) 7, 189–195

CHAPTER OUTLINE:

Acute chest pain (emergency setting):

/ Echocardiography (contractility defects and assessment of complications)

/ Triple-rule-out CT (detection of coronary occlusion, rule out other cardiovascular causes of acute chest pain)

/ Invasive coronary angiography (detection and treatment of an occlusive plaque)

Known CAD:

/ CT (patency of coronary stents and coronary artery bypass grafts)

/ MRI (assessment of cardiac viability mainly for prognostic purposes)

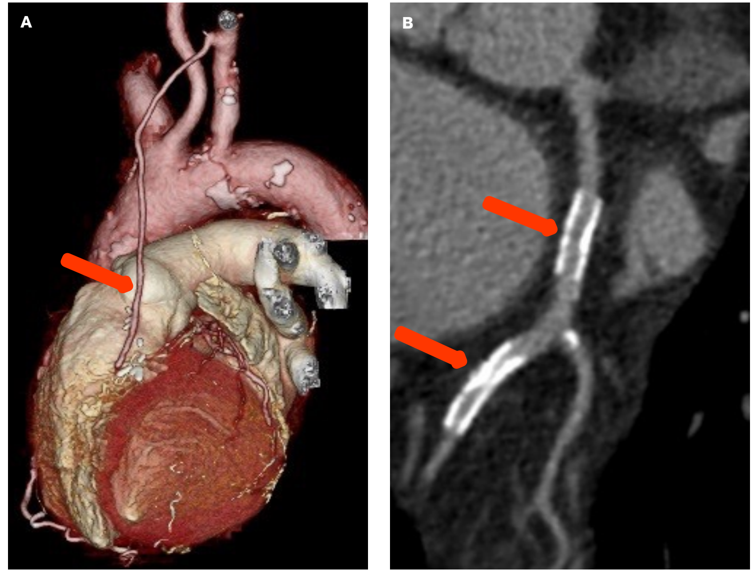


FIGURE 22

Coronary artery bypass graft of left internal mammary artery on left descending artery (**A**, **arrows**) and 2 stents on the circumflex artery (**B**, **arrows**).

<∞> REFERENCE

Thorac Dis. (2017) 9 (Suppl 4), S283–S288

Main Imaging Modalities in CAD versus Non-CAD: Strengths and Weaknesses

			CORONARY ARTERY DISEASE: SUSPECTED		CORONARY ARTERY DISEASE: KNOWN
MODALITY	STRENGHTS	WEAKNESSES	STABLE SETTING	UNSTABLE SETTING	
Echocardlography	1) Inexpensive 2) Fast 3) Real-time 4) Wide availability	1) Operator-dependent 2) Small acoustic window 3) Low sensitivity and specificity	Detection of contractility defects, at rest and stress state	Detection contractility defects and assessment of complications	
Myocardial Perfusion Scintigraphy	1) Relatively inexpensive 2) Functional information	1) Radioactivity 2) Low sensitivity 3) Use of radiopharmaceutical	Detection of perfusion defects		
Computed Thomography	1) Extremely high negative predictive value 2) Detection of collateral findings	1) Radioactivity 2) Use of contrast agent	1) Cardiac Calcium Scoring can detect coronary calcification and support risk stratification 2) Coronary CT angiography allows plaque detection and charaterisation	Triple-rule-out CT to detect coronary occlusion, rule out other cardiovascular causes of acute chest pain	Assessment of patency of coronary stents and coronary artery bypass grafts
Magnetic Resonance Imaging	1) High sensitivity and specificity	1) Expensive 2) Low availability 3) Radiation free 4) Use of Contrast agent	Can detect perfusional and contractility defects, at both rest and stress state		Assessment of cardiac viability and prognostic study
Invasive Coronary Angiography	1) High sensitivity and specificiy 2) Therapeutic	1) Invasivity 2) High radiation dose 3) Use of contrast agent 4) Expensive	Confirmation and treatment of a signiftcative stenosis detected in other modalities. It Is still the gold standard In CAD.	Detection and treatment of an occlusive plaque	

/ Main Imaging Modalities in CAD versus Non-CAD: Strengths and Weaknesses

MODALITY	MYOCARDITIS	CARDIO-MYOPATHIES	VALVULOPHATIES	PERICARDIAL DISEASE	CONGENITAL HEART DISEASE	CARDIAC MASSES
Echocardlography		Allows first diagnostic and functional evaluation	Diagnostic role and quantification of flow defects	Detection of effusion	Morphological and functional evaluation	Detection of the abnormality
Myocardial Perfusion Scintigraphy						
Computed Thomography			Morphological study, detection of calcifications, important preoperative role	Detection of effusion and calcifications	Best anatomical characterisation	Best anatomical characterisation
Magnetic Resonance Imaging	Provides diagnostic and prognostic information	Comprehensive diagnostic, functional and prognostic evaluation	Thorough flow rate and functional study	Differential diagnosis of pericardial thickening	Thorough anatomical and functional assessment	Follow-up

CHAPTER OUTLINE:

/ Coronary CT Angiography in CAD

There are a variety of techniques to image coronary artery disease. Coronary angiography has been the main exam for many years, and it is still the gold standard in the evaluation of coronary artery stenosis, but in certain patient groups it may be replaced by coronary CT angiography (cCTA).

Coronary CT angiography can easily evaluate coronary atherosclerosis and classificate it on the basis of:

- Composition of the plaques: calcified, mixed, soft;
- Distribution of the plaques: isolated and diffuse;
- Severity of the stenosis:
  0% = no visible stenosis;
  1-24% = minimal stenosis;
  25-49% = mild stenosis;
  50-69% = moderate stenosis;
  70-99% = severe stenosis;
  100% = occlusion

<!> ATTENTION

Cardiac CT is especially important because of its very high negative predictive value, meaning that a negative exam excludes presence of CAD.

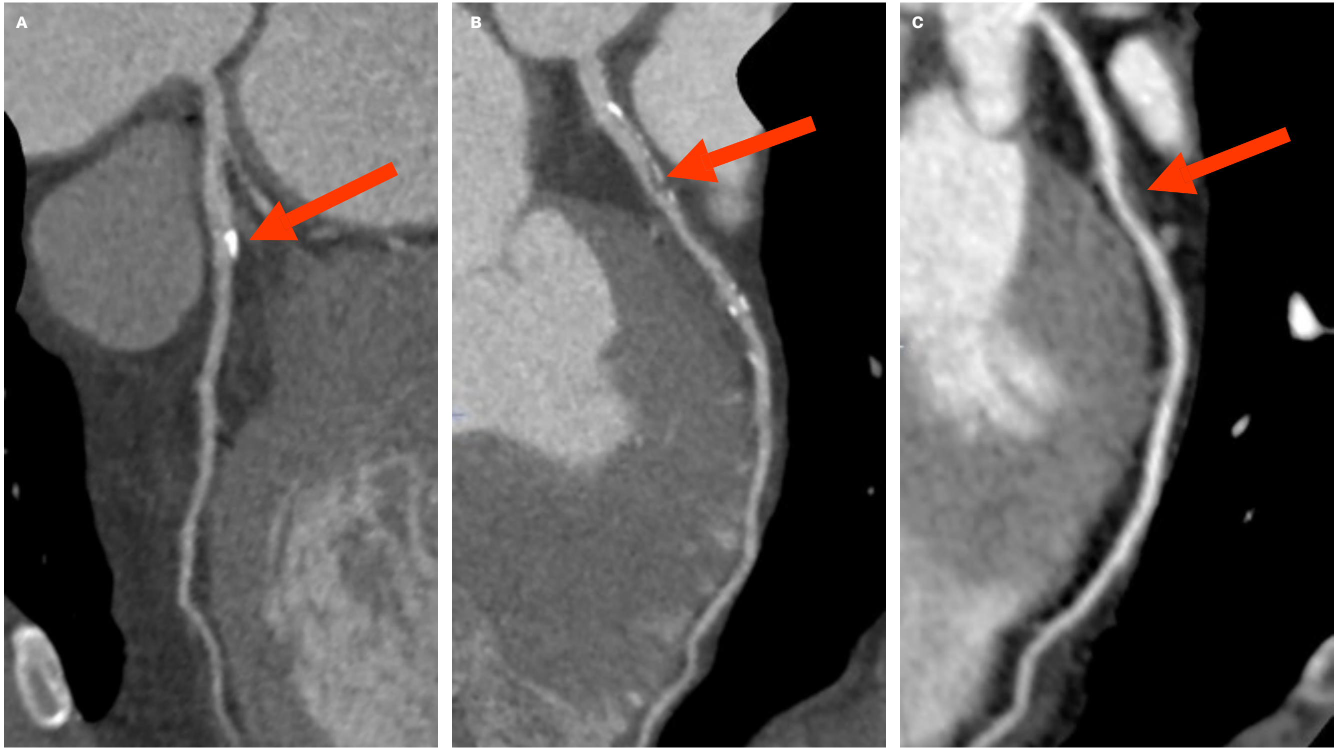


FIGURE 23

Classification of coronary plaques (**arrows**) on the basis of their composition: Calcific (**A**), mixed (**B**) and soft (**C**) plaques.

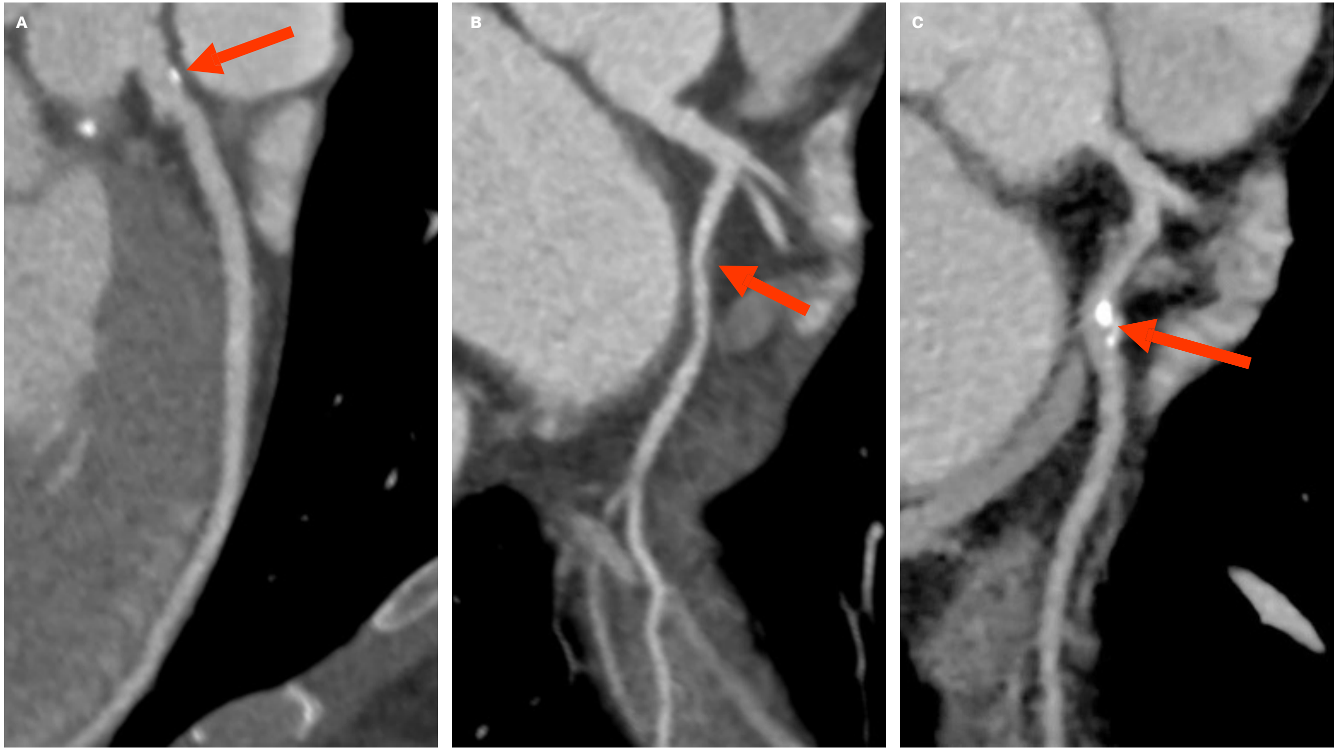


FIGURE 24

Classification of coronary plaques on the basis of severity of the stenosis: minimal (**A**), mild (**B**) and moderate (**C**) stenosis.

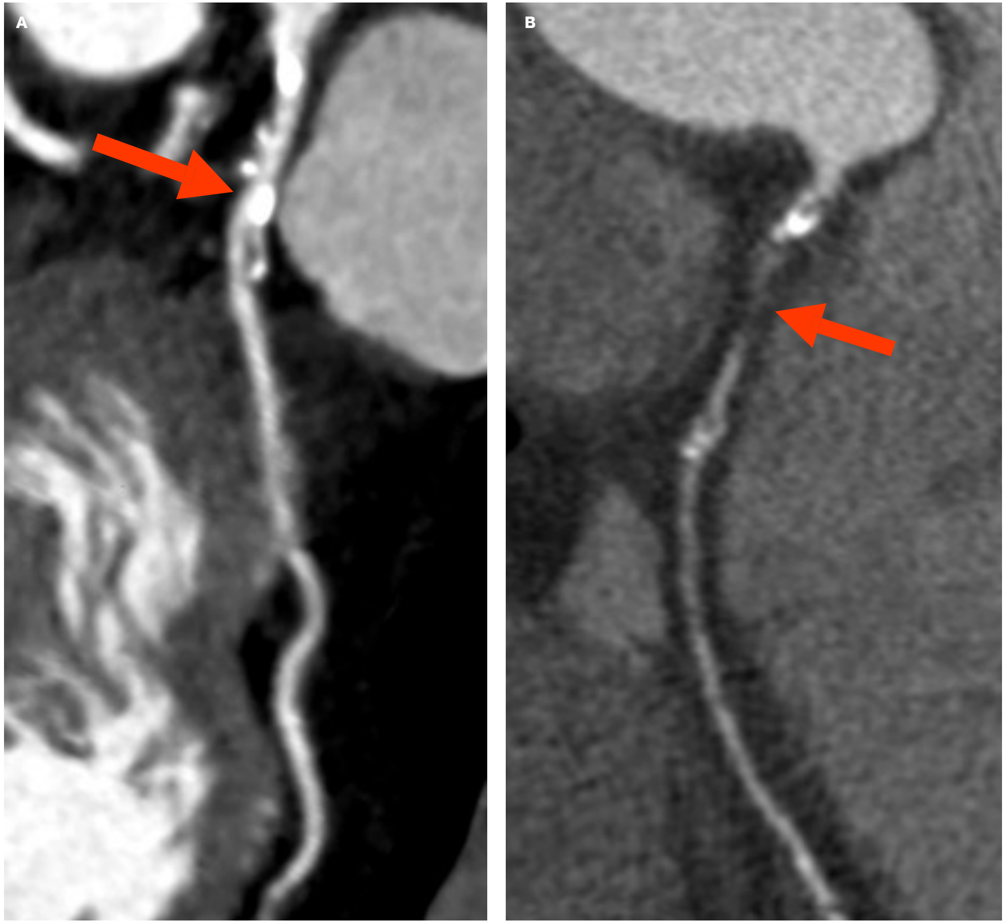


FIGURE 25

Classification of coronary plaques on the basis of severity of the stenosis: severe stenosis (**A**) and occlusion(**B**).

/ MRI, SPECT and Stress Imaging in CAD

MRI can also play a role in the evaluation of CAD, by performing a non-invasive assessment of myocardial perfusion, function and myocardial viability.

In the past decades, SPECT techniques were widely used to evaluate myocardial perfusion. This technique blends i.v. injection of a radioactive isotope with a 3D image acquisition, leading to localisation of the disease by comparing image at stress and rest state.

Nuclear perfusion studies are gradually being replaced by MRI stress test, which in conjunction with a dobutamine infusion, can be used to detect wall motion abnormalities induced by ischaemia. The technique has been shown to have a comparable safety profile to dobutamine stress echocardiography. Dobutamine stress cardiac MRI (CMR) may be useful in patients with sub-optimal acoustic windows, especially those in whom pharmacologic perfusion imaging using adenosine is contra-indicated.

Perfusion CMR is more widely used than dobutamine stress CMR. Recent studies have confirmed the good diagnostic accuracy of CMR perfusion imaging at 1.5 Tesla (T), as compared with nuclear perfusion imaging. Finally, quantitative CMR perfusion measurements demonstrate good correlations with FFR measurements.

<∞> REFERENCE

European Heart Journal (2013) 34, 2949–3003

/ Myocardial Infarction

Myocardial infarction results from obstruction to blood flow in one district of the coronary tree, with resultant myocardial ischaemia. It is an acute event typically presenting with severe chest pain. Expedite diagnosis is crucial in this setting as these patient should undergo reperfusion as soon as possible. In this context, time saving modalities are especially useful.

- Chest X-rays are useful to exclude other causes of chest pain (e.g., pneumonia) but not to the direct diagnosis of acute myocardial infarction (AMI); sometimes they can demonstrate indirect and non specific signs of heart failure.

- Echocardiography, is a fast exam that allows a first confirmation of the diagnostic hypothesis of myocardial infarction. The typical finding in the acute setting is a regional wall motion abnormality of the affected walls (those perfused by the occluded coronary artery). Mitral regurgitation can also be seen when the ischaemia involves the papillary muscles.

- Coronary CT Angiography in the context of a Triple-rule-out protocol can assess patency of coronary arteries in the setting of acute chest pain, but only when the ECG alone is not enough to have diagnostic certainty.

- Invasive Coronary Angiography allows direct visualisation of the obstruction to blood flow. It is a pivotal modality as in the same context it is possible to proceed with primary percutaneous coronary intervention (primary PCI) with angioplasty and stenting to treat the stenosis.
  Patients with high clinical suspicion of Acute Myocardial Infarction (AMI) should undergo prompt revascularisation with no need for further diagnostic evaluation.

<∞> REFERENCE

Academic Emergency Medicine (2013) 20, 861– 871

Br J Radiol. (2016) 89

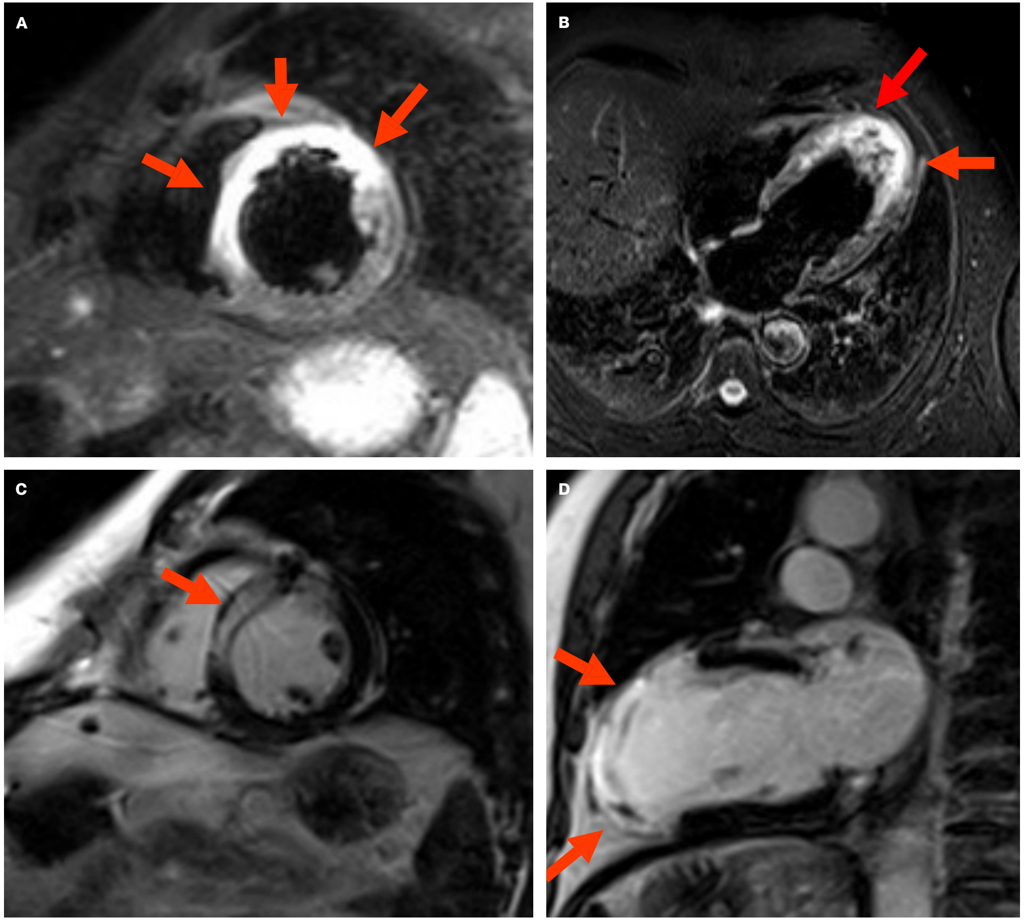
European Radiology (2009), 19, 789-799

Circulation Journal (2009) 73, Issue 9, 1577-1588

/ Cardiac Imaging

CHAPTER OUTLINE:

- Myocardial scintigraphy can assess myocardial viability by detecting reversible perfusion defects through comparison of the images at rest and stress state.
- MRI in the acute setting can detect the presence of oedema in regions of the myocardium that are salvageable (“myocardium at risk”); on the basis of MRI findings it is possible to indicate the likelihood of success of revascularisation procedures.
- Perfusion MRI at rest and stress state using a “first-pass” techniques can detect a signal increase in normal myocardium and limited enhancement in the ischaemic one.
- MRI is also useful to identify the scar tissue using “delayed enhancement” techniques.
- MRI imaging can also provide information about cardiac function by estimating cardiac volumes (EDV, ESV, SV that can be increased) and contractility (that can be compromised), using cine-MRI sequences.
- In the chronic setting, delayed enhancement cardiac magnetic resonance is particularly useful in identifying patients with ischaemic cardiomyopathy and severe left ventricular dysfunction who would benefit from myocardial revascularisation.



<! > ATTENTION

Extremely interesting and useful is the accumulation of contrast medium in areas of necrosis 15-20 minutes after injection, a phenomenon referred to as delayed (or late) gadolinium enhancement (DE or LGE). Different patterns of delayed enhancement can shed light on the differential diagnosis of several different cardiac pathologies.

FIGURE 26

Cardiac MRI in a case of acute myocardial infarction (AMI):

A and B: T2 weighted with fat suppression images showing an increased signal of the anterior, lateral and anteroseptal wall (**arrows**), due to the presence of oedema.

C and D: LGE (late gadolinium enhancement) sequences showing pathological parietal enhancement of the same segments (**arrows**), due to the presence of necrosis, with a transmural distribution pattern.

FIGURE 27

(**A**) LGE (late gadolinium enhancement) sequences showing pathological parietal enhancement of the anterior, anteroseptal and lateral wall, due to the presence of necrosis/fibrosis, with a subendo-mesocardial distribution pattern, in a patient with myocardial infarction. (**B**) LGE sequences showing subepicardial and midwall parietal enhancement in a patient with long-standing dilated cardiomyopathy. (**C**) Scattered pathological enhancement in a patient with Anderson – Fabry disease.

<!> ATTENTION

The pattern of late gadolinium enhancement (LGE) can differentiate infarction (subendocardial or transmural) from non-ischaemic dilated cardiomyopathy (mid-wall or subepicardial) and infiltrative diseases (scattered or subepicardial).

Complications of Myocardial Infarction

The main complication of myocardial infarction are intracardiac thrombi, aneurysm/ pseudoaneurysm and heart failure.

- **Aneurysm** and **pseudaneurysm:** chest X-ray may show a localised bulge along the ventricular wall, with or without a thin rim of calcification. CT, MRI and echocardiography are more specific in the identification of myocardial morphologic alterations.
- **Thrombi:** they can be easily detected by echocardiography, which is the first line exam. CT is able to distinguish cardiac masses from thrombi, as the latter lack contrast enhancement. The same information can be provided by MRI with the use of gadolinium contrast.
- **Heart failure (HF):** Chest X-ray can demonstrate some indirect features of HF, such as cardiomegaly, pleural effusion, Kerley B lines and interstitial oedema. Echocardiography is the first-line exam and can evaluate cardiac chamber volumes, valvular function, ejection fraction and pericardial effusion. Cardiac CT also provides information about left and right ventricular structure and function, cardiac venous anatomy and pulmonary venous system. MRI is particularly useful in distinguishing the cause of HF and providing information about prognosis, especially when echocardiographic findings are inconclusive.

REFERENCE

Diagnostic and Interventional Imaging (2012) Volume 93, Issues 7–8, 578-585

<!> ATTENTION

In order to distinguish true aneurysms from pseudoaneurysms (one is surrounded by myocardium and the other is a contained rupture lined by pericardium) MRI is the best option, showing a dyskinetic segment with focal bulging of the pericardium, in the case of pseudoaneurysm.

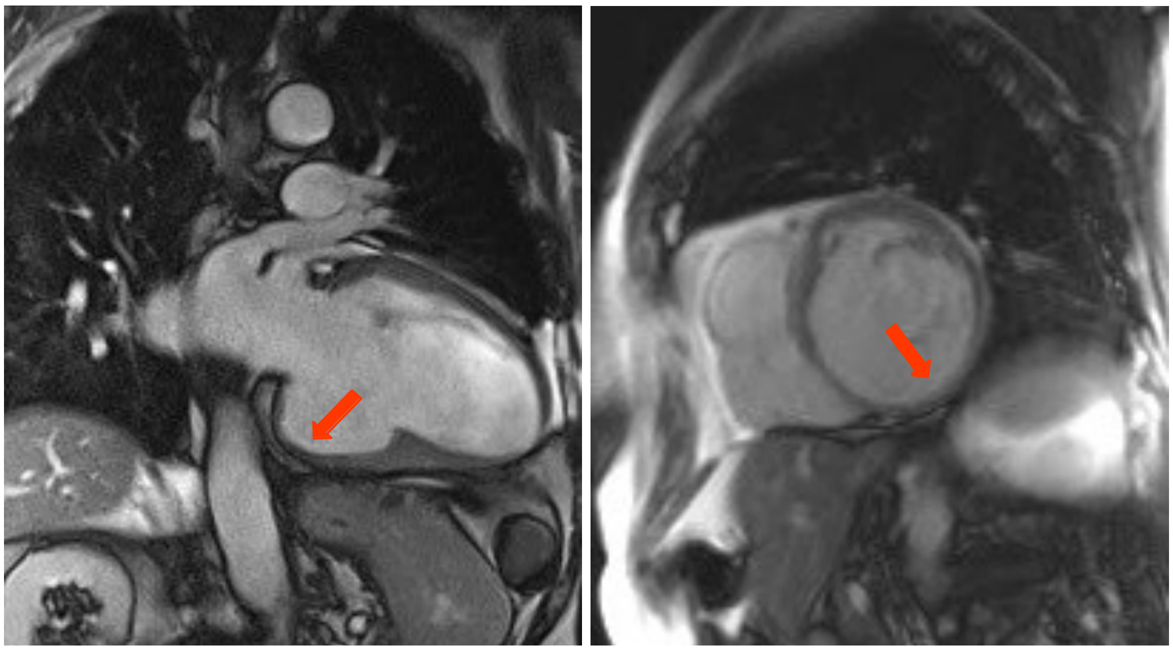


FIGURE 28

Cardiac MRI performed one year post AMI, showing presence of an aneurysm of the infero-basal wall.

CHAPTER OUTLINE:

/ **Cardiac** Imaging

FIGURE 29

(**A** and **B**) Cardiac CT multi-planar reconstruction of a pseudoaneurysm of the inferior wall (**arrows**) in a patient with a previous AMI. (**C**) Cardiac MR movie of the same patient. The pseudoaneurysm is indicated by an asterisk and a large thrombus is indicated by the blue arrow.

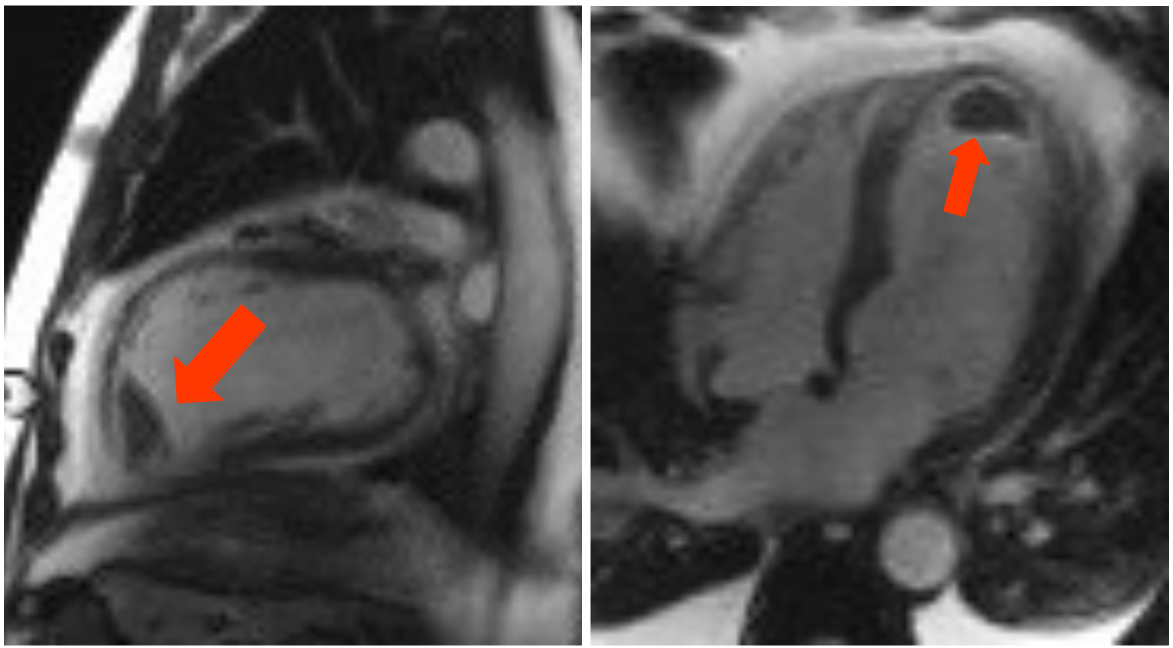


FIGURE 30

Cardiac MRI: LGE sequences showing the presence of a sizeable apical thrombus (**arrows**) in a patient with a previous apical AMI.

Cardiomyopathies and Myocarditis

CHAPTER OUTLINE:

/ Non-Coronary Artery Diseases

Myocarditis

- MRI (diagnostic and prognostic role)

Cardiomyopathies

- Echocardiography (first diagnostic and functional evaluation)
- MRI (comprehensive diagnostic, functional and prognostic evaluation)

Valvulopathies

- Echocardiography (diagnostic role and quantification of flow defects)
- CT (morphological study, detection of calcifications, important preoperative role)
- MRI (thorough flow rate and functional study)

Pericardial Diseases

- Echocardiography (detection of pericardial effusion)
- CT (detection of pericardial effusion and calcifications)
- MRI (differential diagnosis of pericardial thickening)

Congenital Heart Disease

- Echocardiography (morphological and functional evaluation)
- Cardiac MRI and Magnetic resonance angiography (thorough anatomical and functional assessment)
- CT angiography (best anatomical characterisation)

Cardiac Masses

- Echocardiography (detection of the abnormality)
- CT (best anatomical characterisation)
- MRI (follow up)

/ Myocarditis

Myocarditis is inflammation of the myocardium, it is usually either infectious or autoimmune in aetiology and can have a wide spectrum of different clinical presentations, ranging from a completely asymptomatic course to acute cardiac failure, with chest pain being a common symptom in most cases.

The population affected is typically younger than the one more at risk for myocardial infarction, the differential diagnosis between the two conditions is anyway very important, and can be troublesome, as myocarditis typically shows elevation of cardiac enzymes and alterations of the ECG as well. It shouldn't come as a surprise therefore, that myocarditis underlies many cases of acute chest pain with completely negative coronary angiograms.

<∞> REFERENCE

Chetrit M, Friedrich MG. The unique role of cardiovascular magnetic resonance imaging in acute myocarditis. F1000 Res. 2018;7:F1000 Faculty Rev-1153. Published 2018 Jul 30.

Baeßler B, Schmidt M, Lücke C et al. Modern Imaging of Myocarditis: Possibilities and Challenges. Fortschr Röntgenstr 2016; 188: 915 – 925.

While the gold standard in the diagnosis of myocarditis remains endomyocardial biopsy, cardiac MRI is a fundamental diagnostic tool in this setting.

- In the acute setting cardiac MRI shows presence of intramyocardial oedema and delayed enhancement. Distinction of myocardial infarction and myocarditis is allowed by the distribution of the enhancement, subendocardial and dependent on coronary artery distribution in myocardial infarction, subepicardial and irrespective of coronary arteries in myocarditis.
- In the chronic setting, oedema will disappear, while the myocardial scar will remain visible as a stripe of delayed enhancement.
- Useful prognostic information comes from cardiac MRI thanks to several parameters, including extension of delayed enhancement, degree of functional compromise and involvement of the right ventricle. The utility of designing follow-up scans is still being debated, as several cases heal completely while other go on to develop ventricular dilation and congestive heart failure.

Cardiac CT can only be useful to exclude other causes of analogous clinical presentation.

/ Cardiac Imaging

CHAPTER OUTLINE:

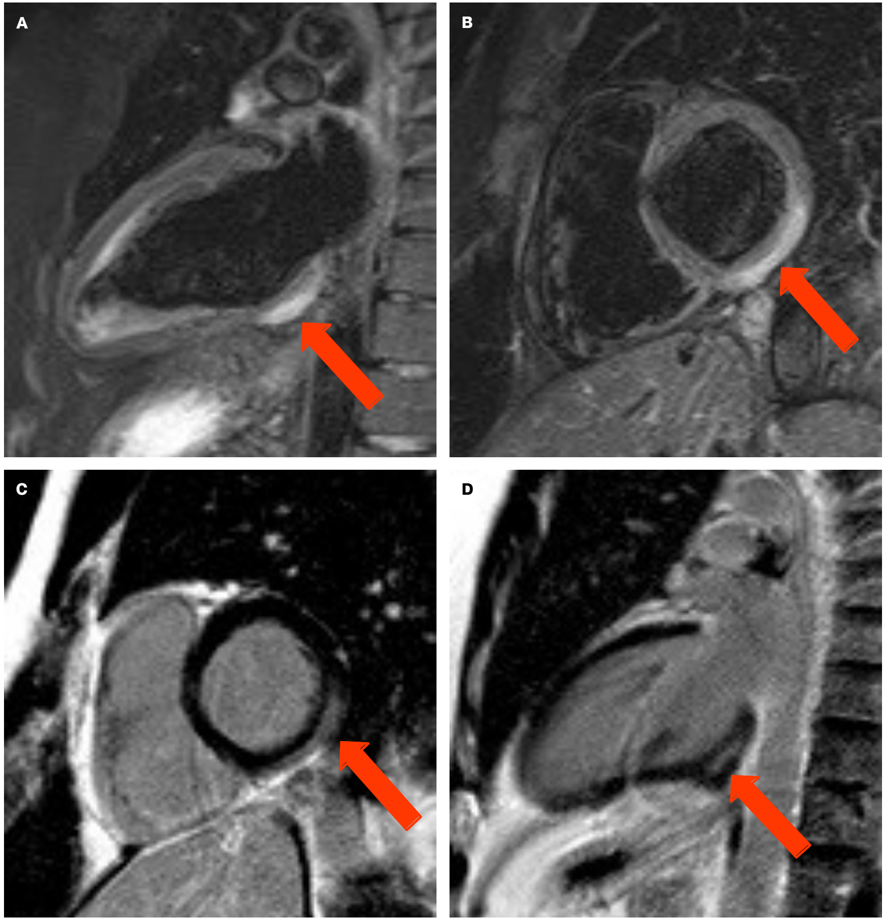


FIGURE 31

Cardiac MRI in a case of acute myocarditis:

A and **B**: T2 fat suppressed images showing an increased signal of the inferior and infero-lateral wall, due to the presence of oedema, with a subepimesocardial distribution pattern.

C and **D**: LGE sequences showing pathological parietal enhancement of the same segments, due to the presence of necrosis/fibrosis, with a subepimesocardial distribution pattern.

/ Cardiomyopathies

Cardiomyopathies form a heterogeneous group of diseases in which the heart is abnormal in structure or function in the absence of ischaemic, valvular, hypertensive and congenital causes.

Cardiomyopathies are most commonly classified according to their phenotype as dilated cardiomyopathy, non-dilated left ventricle cardiomyopathy, arrhythmogenic right ventricular cardiomyopathy and restrictive cardiomyopathy, irrespective of their true aetiology.

- Echocardiography is commonly the first test used to find abnormalities in these patients, but it can only provide broad morphological and functional information, with no insights on aetiology and prognosis.
- Cardiac MRI is an invaluable tool in many of these diseases, as it gives the best functional evaluation, important morphological information and crucial prognostic and etiological classification.

Hypertrophic cardiomyopathy is most often genetic in origin but can also result from amyloidosis or Fabry disease. It is characterised by increased wall thickness (hypertrophy), characteristically asymmetrical and often associated to outflow tract obstruction. Microscopically we can appreciate fibrosis and disarray of the muscular fibres, which are the likely cause of the increased risk of sudden death.

Cardiac CT can only be useful to exclude other causes of analogous clinical presentation.

<∞> REFERENCES

JACC Cardiovasc Imaging. (2017) 10 1180–1193

World J Cardiol. (2016) 8, 132–145

Eur Heart J Cardiovasc Imaging. (2017) 18, 237–253

Arbelo, E., Protonotarios, A., Gimeno, J. R., Arbustini, E., Barriales-Villa, R., Basso, C., ... & Kaski, J. P. (2023). 2023 ESC Guidelines for the management of cardiomyopathies: Developed by the task force on the management of cardiomyopathies of the European Society of Cardiology (ESC). European heart journal, 44(37), 3503-3626.

/ Cardiac Imaging

CHAPTER OUTLINE:

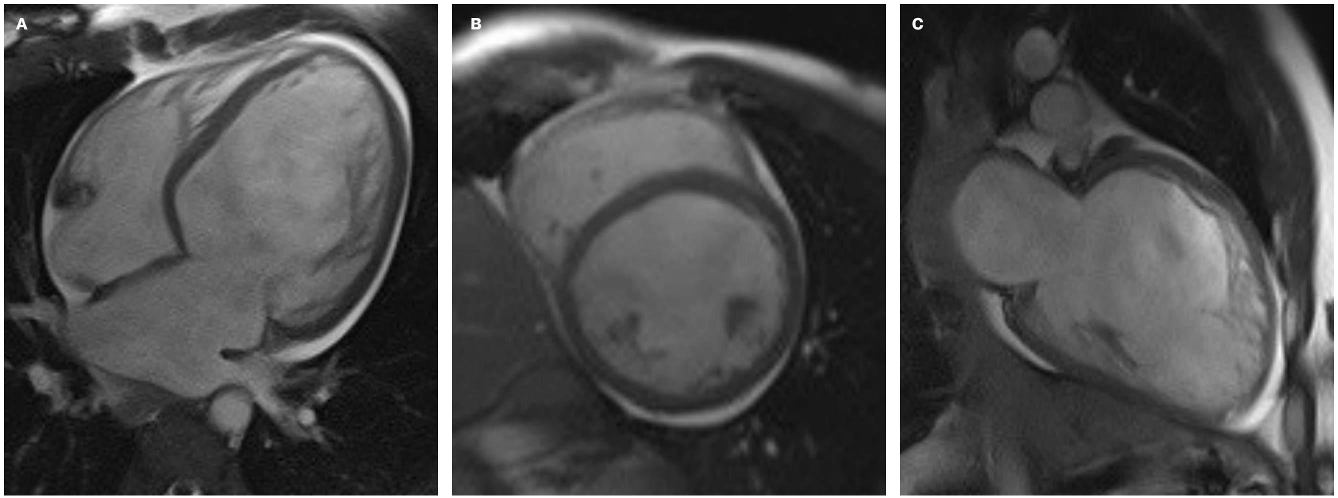


FIGURE 32

Cardiac MRI showing increased volumes of the cardiac chambers in a patient with dilated cardiomyopathy (Left ventricle parameters: EDV/Body surface area 151 mL/m2 normal values in the same age and sex group: 53-97) on 4 chamber (**A**), short axis (**B**) and 2 chamber (**C**) plane.

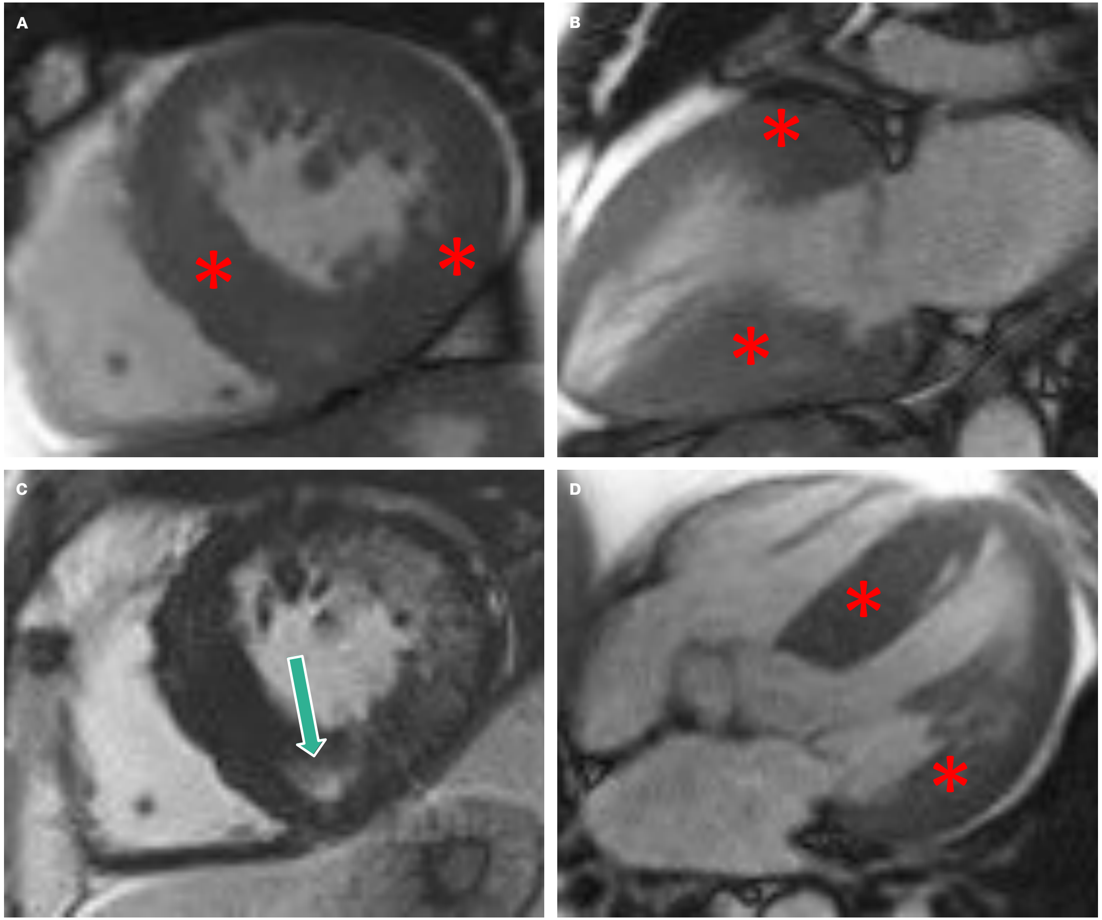


FIGURE 33

Cardiac MR of a patient with hypertrophic cardiomyopathy showing ventricular wall thickening (**asterisks**), mostly affecting septal and inferior wall, in short axis (**A** and **C**), 2 chamber (**B**) and 4 chamber (**D**) view. (**C**): LGE sequence showing an area of fibrosis in the inferior interventricular junction (**arrow**).

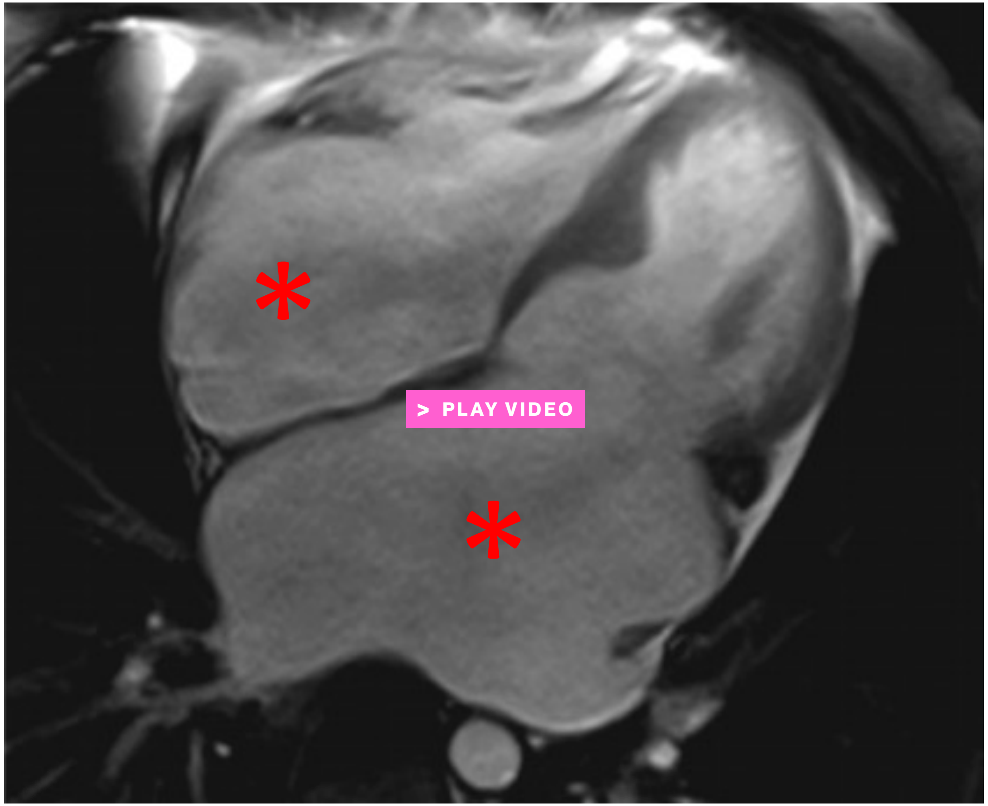


FIGURE 34

Cine-MRI in four chamber view, showing decreased compliance and impaired relaxation of the left ventricle in a patient with restrictive cardio-myopathy. Dilated atria (**asterisks**).

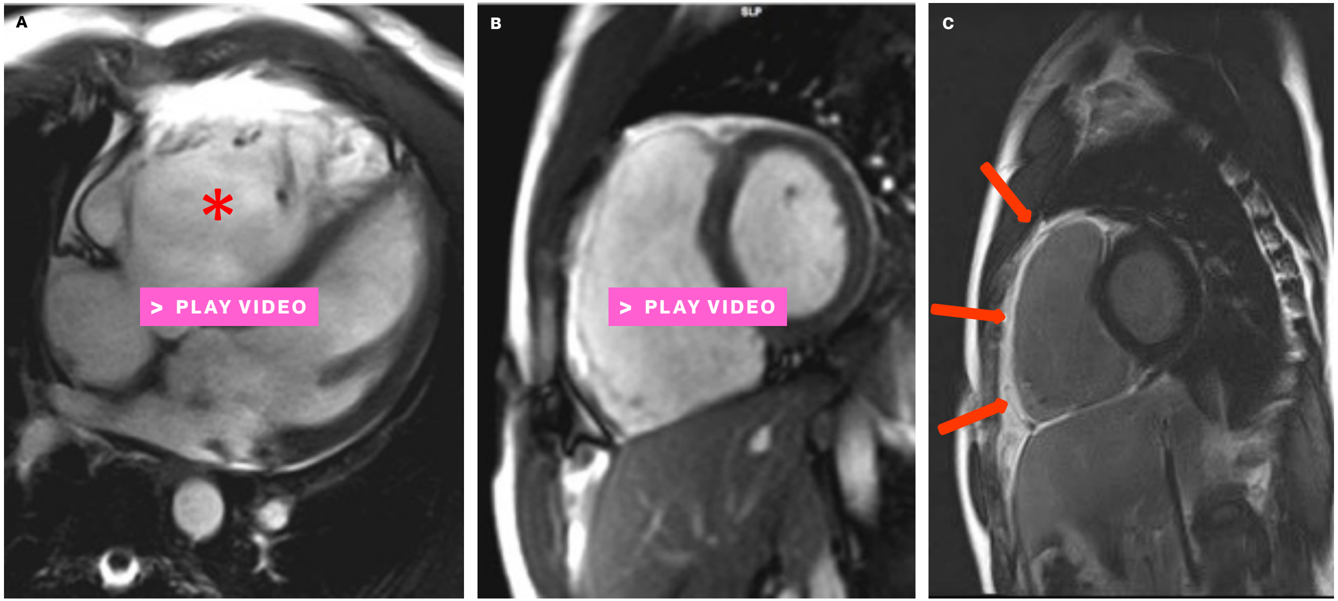


FIGURE 35

Cine-MRI (**A** and **B**) showing right ventricular dilatation (**asterisk**, Right ventricle (**asterisk**) end-dyastolic volume/body surface area:

171.8 mL/m² normal values for the same age and sex group : 67-111) with decreased Ejection Fraction (EF: 14%). Motility is clearly reduced.

C. LGE sequence showing diffuse pathological parietal enhancement of the right ventricular wall, due to fatty infiltration and fibrosis typical of arrhytmogenic right ventricular dysplasia (ARVD).

/ Pericardial Disease

CHAPTER OUTLINE:

/ Pericardial Disease

Pericardial effusion results from accumulation of more than 50 mL in the pericardial sac, it is a common finding in a wide spectrum of pathologies.

- Chest X-ray can detect effusion only when pericardial fluid is more than 200 mL, and will be seen as a globular, enlarged cardiac silhouette (water bottle configuration)
- Echocardiography is accurate in describing the amount of effusion, that will appear as hypoechoic material between the two layers of pericardium, and will also give information on the haemodynamic effect on the heart of such effusion. Echocardiography is also useful to plan and guide pericardiocentesis
- Detection of effusion at CT is very easy when you see material with the density of water surrounding the heart. CT can also very often give insights on the cause of effusion
- Effusion at MRI will be easily recognised as hyperintense material surrounding the heart on T2 sequences

Pericarditis can be seen as a thickening of the pericardium, that will be enhanced by the uptake of contrast

- CT and MRI are the only two modalities able to reliably identify pericarditis

Cardiac tamponade is caused by a rapidly developing pericardial effusion that compromises the functionality of the heart

- Echocardiography is the most important modality in this clinical scenario, as it allows for localisation of the effusion, assessment of the heart function and guidance of the pericardiocentesis

<∞> REFERENCES

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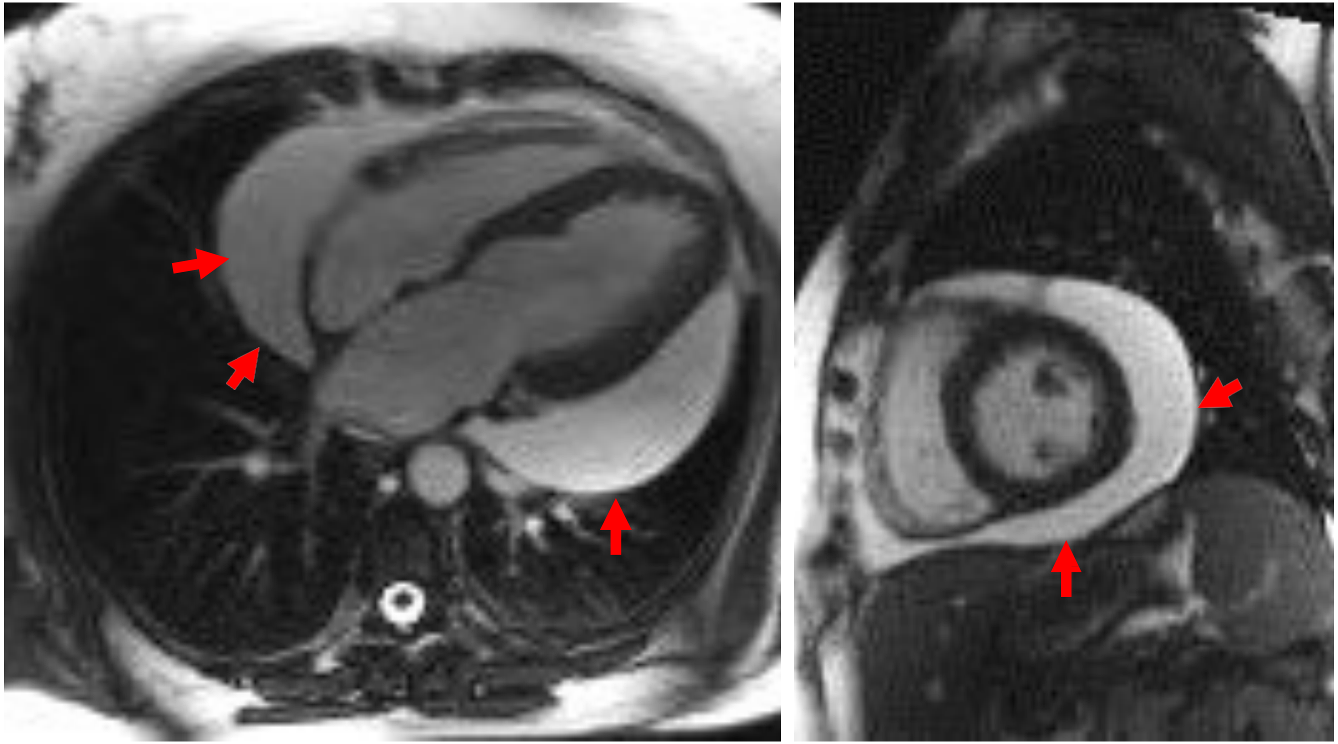

FIGURE 36

Cardiac MRI showing profuse circumferential pericardial effusion (**arrows**) in a patient with systemic lupus erythematosus (SLE).

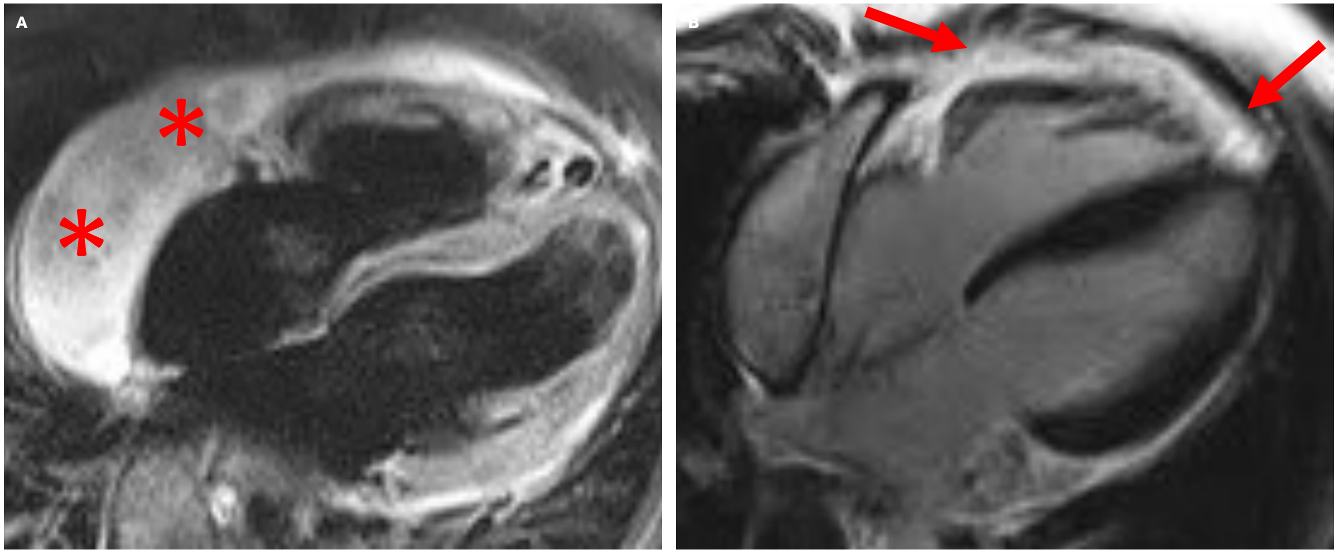

FIGURE 37

Cardiac MRI in a patient with pericarditis: **A**) T2 fat saturated sequence showing massive pericardial effusion (**asterisks**). **B**) LGE sequence showing enhancement of pericardial layers (**arrows**).

Congenital Heart Disease

CHAPTER OUTLINE:

/ Congenital Heart Disease (CHD)

Congenital Heart Diseases are alterations in cardiac structures that are present at birth.

There are several congenital defects, mostly involving cardiac wall, heart valves or large blood vessels, with different clinical presentations, ranging from an asymptomatic picture to severe Heart Failure (HF).

They can be isolated, but more often there is an association with other congenital anomalies, in a syndromic clinical picture.

They can be distinguished on the basis of clinical features in Cyanotic and Acyanotic CHD, but the most useful classification is the physiopathological one, which comprehends:

- CHD with increased pulmonary blood flow
- CHD with reduced or normal pulmonary blood flow
- CHD with reduced systemic flow

The most common CHD is the biscuspid aortic valve, followed by Interventricular Septum Defect and Interatrial Septum Defect.

The first step in evaluation of CHD is echocardiography, but it often detects just indirect signs of CHD, such as altered Qp/Qs values and/or cardiac chamber enlargement, and the suspicion of CHD has to be confirmed by a second-level modality, such as MRI.

MRI is the best modality in evaluating cardiac defects (with morphological sequences) and how they affect cardiac function(cine-MR). It is also useful in the follow-up of patients who underwent surgical correction of CHD.

<∞> REFERENCES

Br J Radiol. (2011) 84, S258–S268

Diagnostic and Interventional Imaging (2016) Volume 97, Issue 5, Pages 505-512

- **ACYANOTIC**
  - **With increased pulmonary blood flow**
    - Right Hypertrophy
      - Interatrial Defects
    - Left Hypertrophy
      - Interventricolar Defects
      - Patent Ductus Arteriosus
  - **Without increased pulmonary blood flow**
    - Right Hypertrophy
      - Pulmonary Stenosis
    - Left Hypertrophy
      - Aortic Stenosis
      - Coarctation of the Aorta
- **CYANOTIC**
  - **With increased pulmonary blood flow**
    - Right Hypertrophy
      - Transposition of Great Vessels
      - Total Anomalous Pulmonary Venous Drainage
      - Hypoplastic Left Heart Syndrome
    - Left Hypertrophy
      - Single Ventricle
  - **Without increased pulmonary blood flow**
    - Right Hypertrophy
      - Tetralogy of Fallot
      - Ebstein Anomaly
    - Left Hypertrophy
      - Tricuspid Atresia

Cardiac Imaging

CHAPTER OUTLINE:

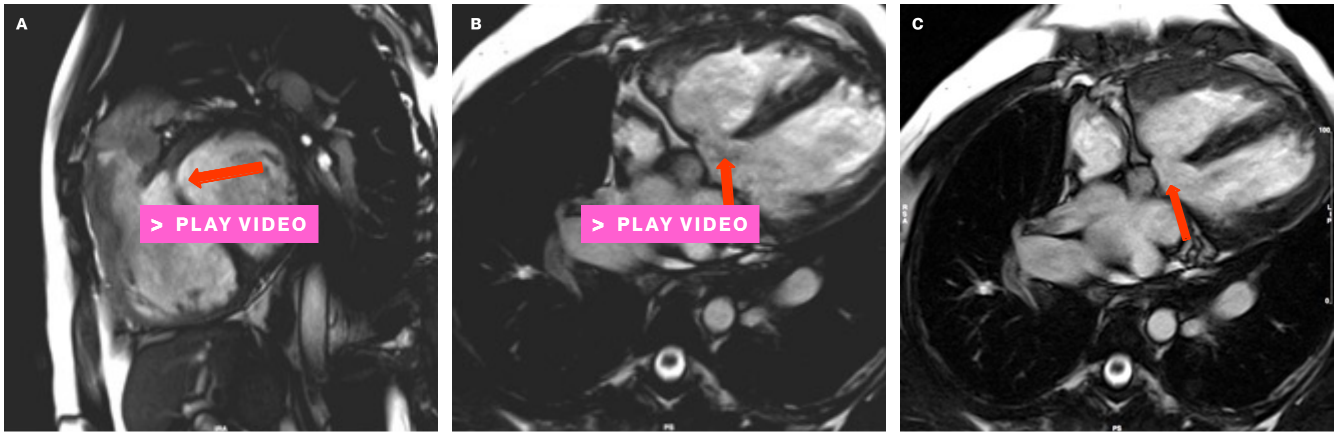

FIGURE 38

Cardiac MR images in short-axis (**A**) and four chambers (**B** and **C**) views, showing a large interventricular septum defect (**arrows**).

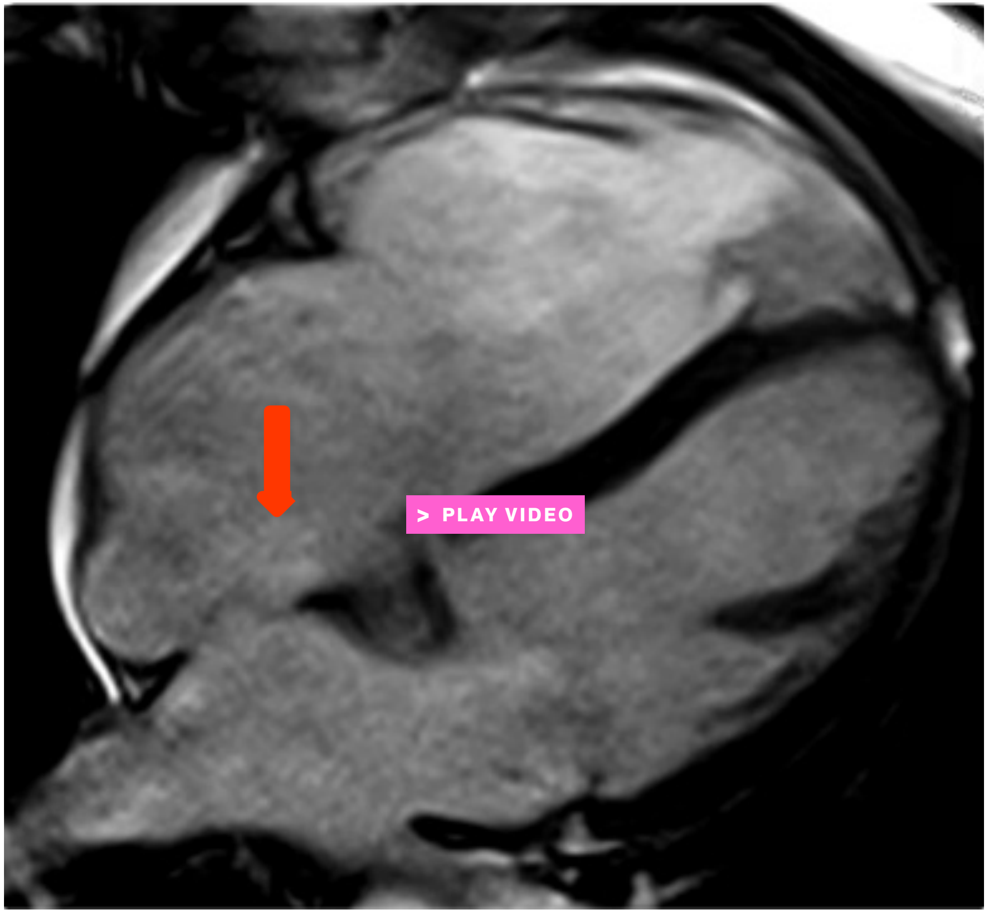

FIGURE 39

Cardiac MRI, in a four chamber view, showing a large interatrial septum defect (**Red arrow** points at the jet phenomenon due to blood turbulence on the cine series caused by the defect).

Cardiac Masses

Cardiac Imaging

CHAPTER OUTLINE:

/ Cardiac Masses

Cardiac masses can be divided in tumour and non-tumour ones. The most common finding is non-tumour masses, which comprehend thrombi and misinterpretation of normal variants of cardiac structures.

Tumours can be distinguished in **primary** cardiac tumours and cardiac **metastases**, which are more common. Primary cardiac tumours are exceedingly rare, usually originating from mesenchymal tissue and mostly benign.

The most common benign cardiac tumour is **myxoma**, although the most common malignant tumour is cardiac angiosarcoma. Non-mesenchymal tumours comprehend teratoma (which can be benign or malignant) and lymphoma.

Cardiac masses are usually first detected at echocardiography, but cardiac CT and MRI can reveal some characteristics useful in distinguishing tumour from non-tumour masses and benign from malignant tumours. These findings mostly comprehend location, size, margins, tissue composition, the presence of a feeding artery, calcification or pericardial effusion.

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Korean J Radiol. (2009) 10, 164–175. AJR Am J Roentgenol. (2011) 197(5), W837–W841

Curr Cardiovasc Imaging Rep. (2014) 7(8), 9281

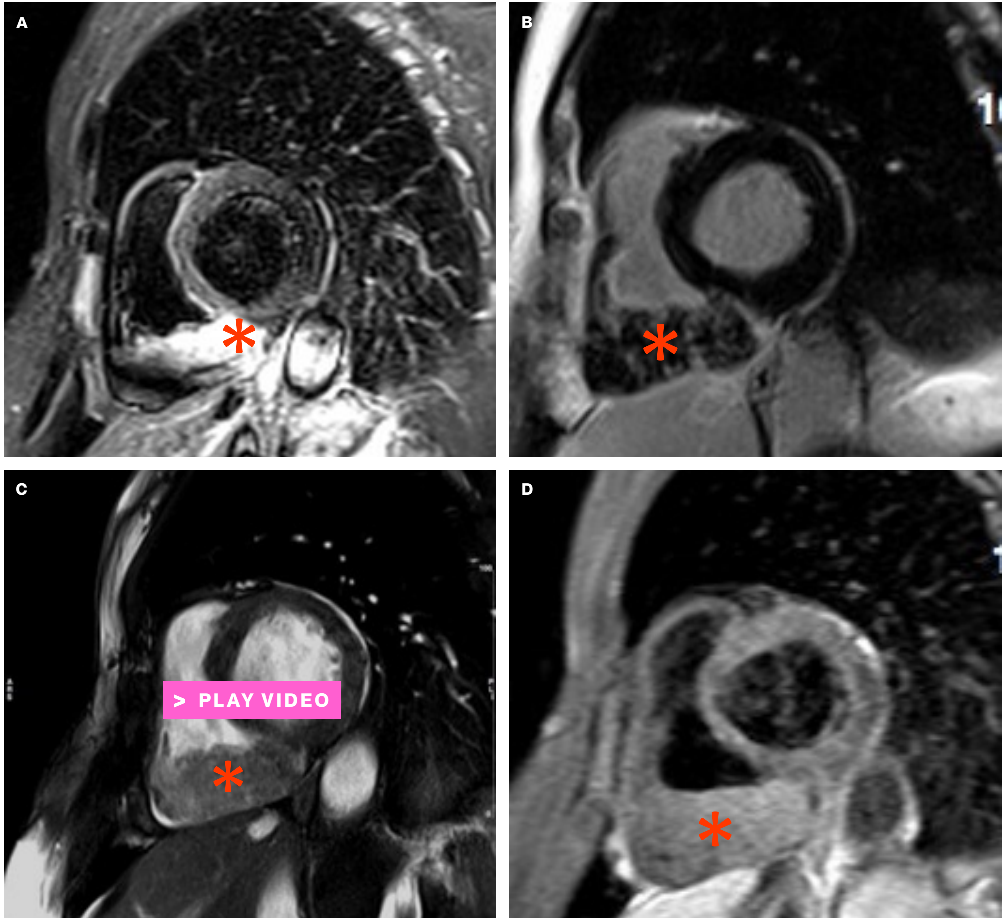


FIGURE 40

STIR (T2 fat suppressed) (**A**) LGE (**B**) cine-MR (**C**) and T1 (**D**) images in short axis view, showing a large cardiac metastasis (**asterisk**) in a patient with known melanoma.

CHAPTER OUTLINE:

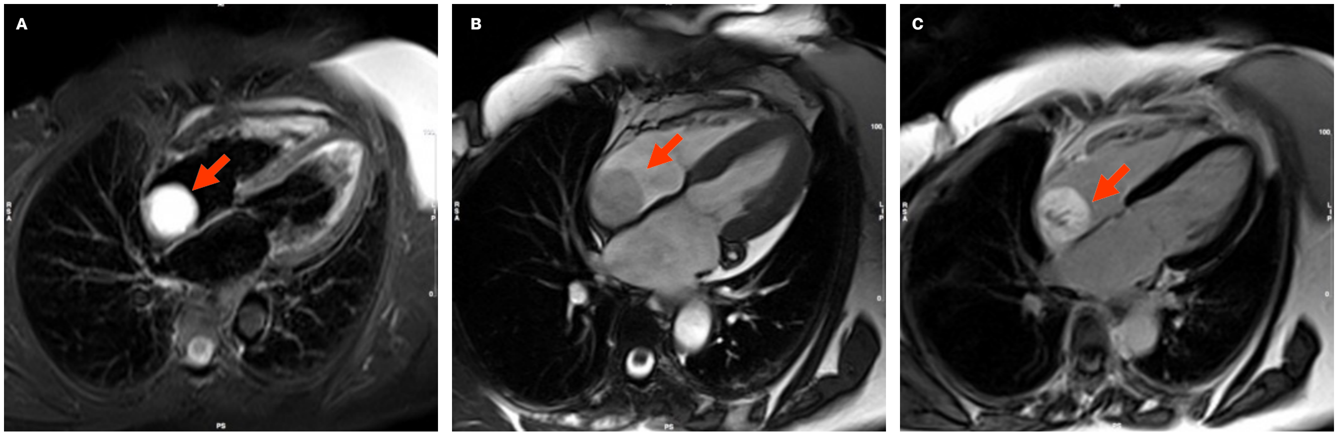


FIGURE 41

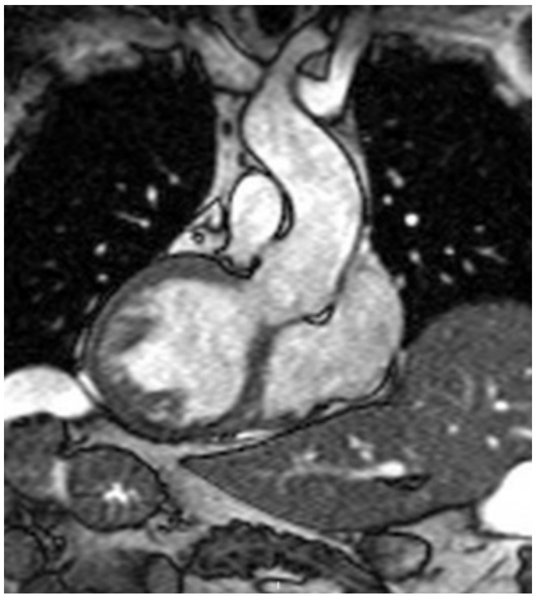
STIR (**A**), cine-MR (**B**) and LGE(**C**) images of a 4 chamber view showing a typical appearance of right atria myxoma (**arrows**).

/ Test Your Knowledge

/ Test Your Knowledge

<?> QUESTION

1 Which anomaly do you see on this MRI-image?

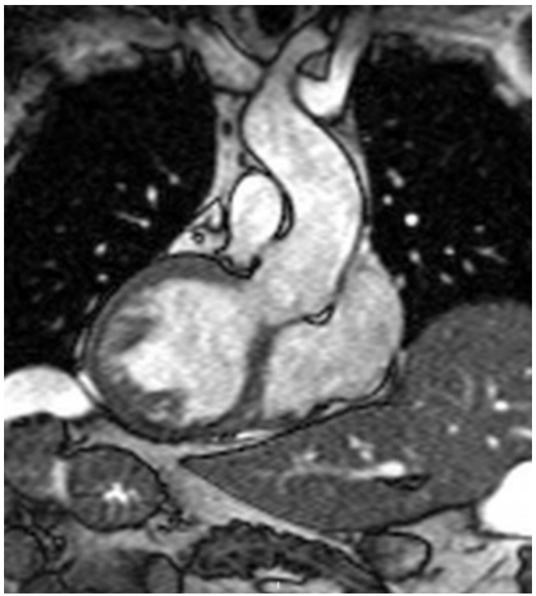


CHAPTER OUTLINE:

/ Test Your Knowledge

<?> ANSWER

1 Which anomaly do you see on this MRI-image?

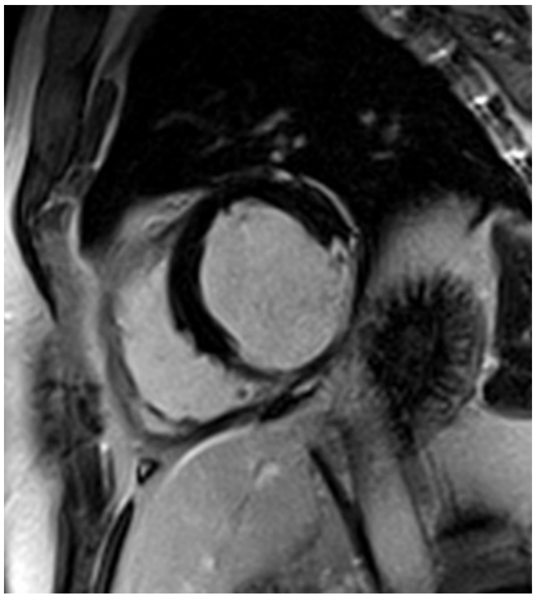


This is a case of situs inversus, as you can see by looking at the position of the different organs and at the directions towards which the heart is pointing.

/ Test Your Knowledge

<?> QUESTION

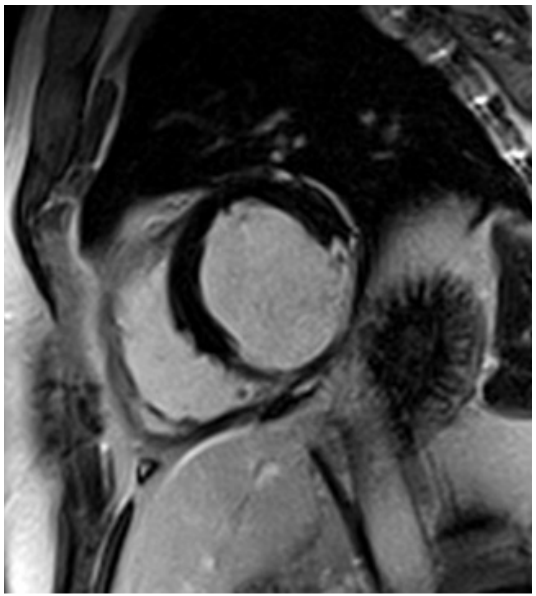
2 How would you describe this cardiac MRI image?



/ Test Your Knowledge

<?> ANSWER

2 How would you describe this cardiac MRI image?



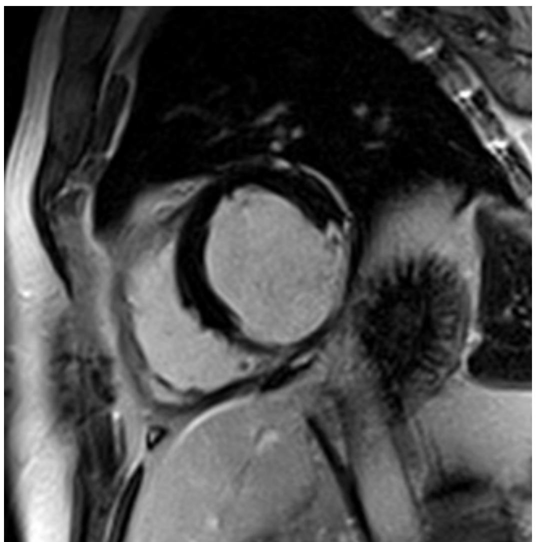
This is an LGE sequence, short axis view. The inferior wall of the left ventricle is markedly thinned, while the remaining segments seem unaffected.

CHAPTER OUTLINE:

/ Test Your Knowledge

<?> QUESTION

3 Can you give an aetiopathological explanation of these findings? Which is the most likely cause?



CHAPTER OUTLINE:

/ Test Your Knowledge

<?> ANSWER

3 Can you give an aetiopathological explanation of these findings? Which is the most likely cause?

This is the result of long-term remodelling of an area of myocardium subjected to ischaemia and, subsequently, to fibrosis. The most likely cause is a previous myocardial infarction.

/ Test Your Knowledge

<?> QUESTION

4 Can you guess which coronary artery was involved?

/ Test Your Knowledge

<?> ANSWER

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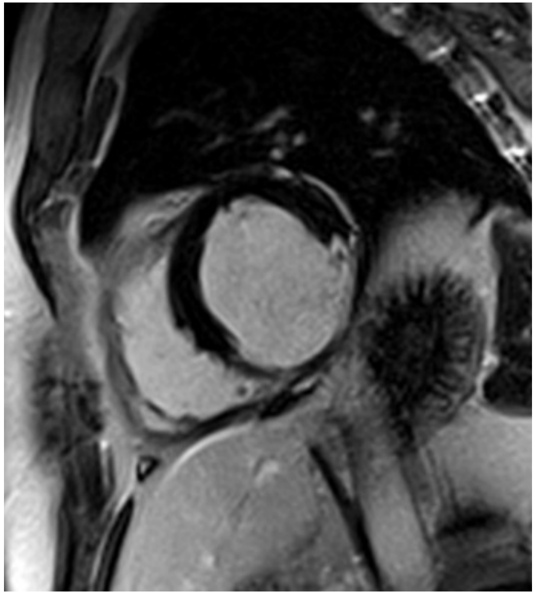

It was the right coronary artery, which typically perfuses the inferior and inferoseptal walls of the left ventricle.

/ Test Your Knowledge

<?> QUESTION

5

A 50-year-old male arrives to the attention of his family doctor because of a complain of stable angina and exertional dyspnoea. He doesn’t smoke, but is overweight and has a family history of major cardiovascular events. The physician prescribes an ECG stress test, but the results are inconclusive. Which is the best next step?

/ Test Your Knowledge

<?> ANSWER

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A 50-year-old male arrives to the attention of his family doctor because of a complain of stable angina and exertional dyspnoea. He doesn't smoke, but is overweight and has a family history of major cardiovascular events. The physician prescribes an ECG stress test, but the results are inconclusive. Which is the best next step?

Given the young age of the patient and the inconclusive ECG stress test, the best next step is to perform a coronary CT angiogram.

/ Test Your Knowledge

<?> QUESTION

6 Here is the major finding of this exam, can you describe it? Do you think it may be the cause of symptoms?

/ Test Your Knowledge

<?> ANSWER

6 Here is the major finding of this exam, can you describe it? Do you think it may be the cause of symptoms?

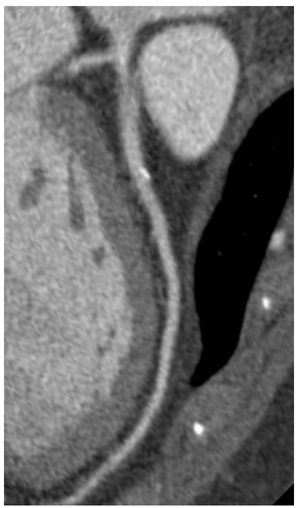
This is an atherosclerotic plaque in the left anterior descending artery. The plaque is mixed and causes severe stenosis of the lumen (70%). The patient is at risk and should undergo invasive coronary angiography for further characterisation and possibly treatment of the stenosis.

/ Test Your Knowledge

<?> QUESTION

7

A 32-year-old male arrives to the Emergency Department complaining of acute, compressive, chest pain radiating to the left arm. The LV function is depressed at echocardiography. The main clinical suspicion is acute myocardial infarction, but the ECG only shows non-specific anomalies of ventricular repolarisation. This finding, together with the young age of the patient, convince the physicians to perform a Triple-rule-out CT scan. The only pathological finding can be seen here, affecting the left anterior descending coronary artery, can you spot it?



/ Test Your Knowledge

CHAPTER OUTLINE:

<?> ANSWER

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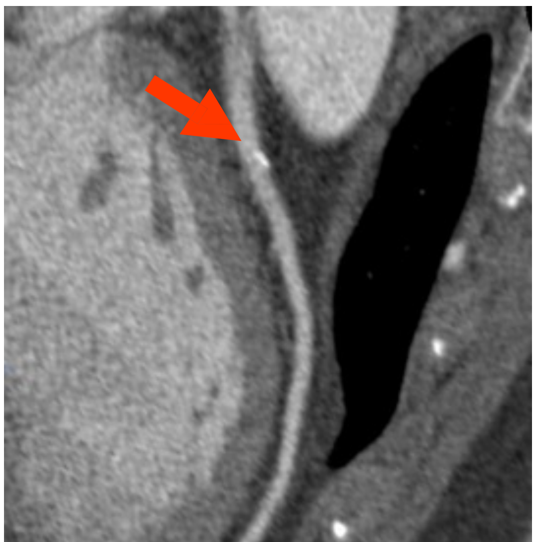
There is a small calcified plaque on the left anterior descending artery.

/ Test Your Knowledge

<?> QUESTION

8 The only abnormality seen on CT angiography was a small calcified plaque of the left anterior descending artery. Could it be responsible for the clinical presentation of chest pain?



/ Test Your Knowledge

<?> ANSWER

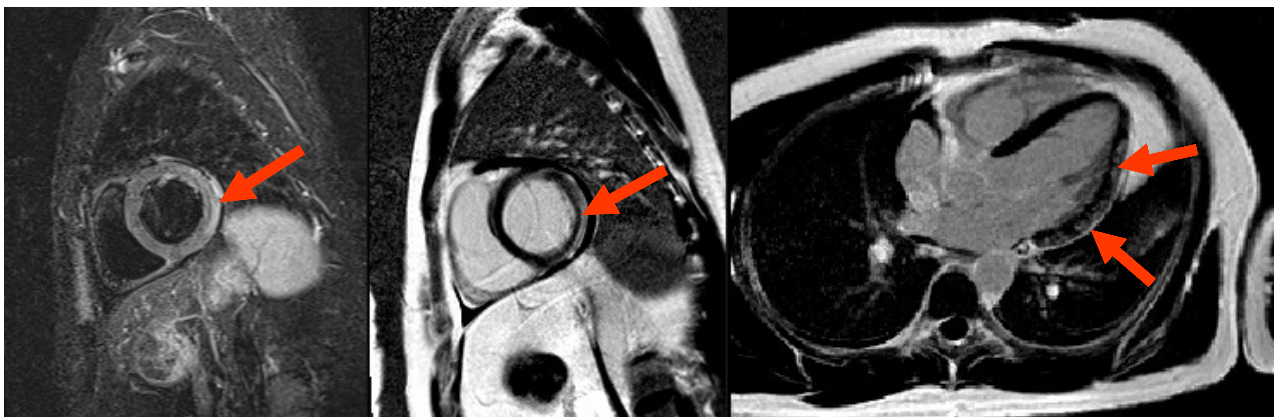
8 The only abnormality seen on CT angiography was a small calcified plaque of the left anterior descending artery. Could it be responsible for the clinical presentation of chest pain?

The small calcified plaque is very unlikely to be responsible for the patient's symptoms.

/ Test Your Knowledge

<?> QUESTION

9 The acute symptomatology subsides, but the heart function remains depressed. The patient undergoes cardiac MRI 6 days after the acute episode. Here are some selected images from the MRI exam. What are the main findings?



/ Test Your Knowledge

<?> ANSWER

9 The acute symptomatology subsides, but the heart function remains depressed. The patient undergoes cardiac MRI 6 days after the acute episode. Here are some selected images from the MRI exam. What are the main findings?

The STIR image (left) shows myocardial oedema in the inferolateral wall. LGE images (centre and right) show subepicardial enhancement, which has a patchy distribution. These findings are most likely consistent with myocarditis.