X-ray for Cardio and Vascular Diseases

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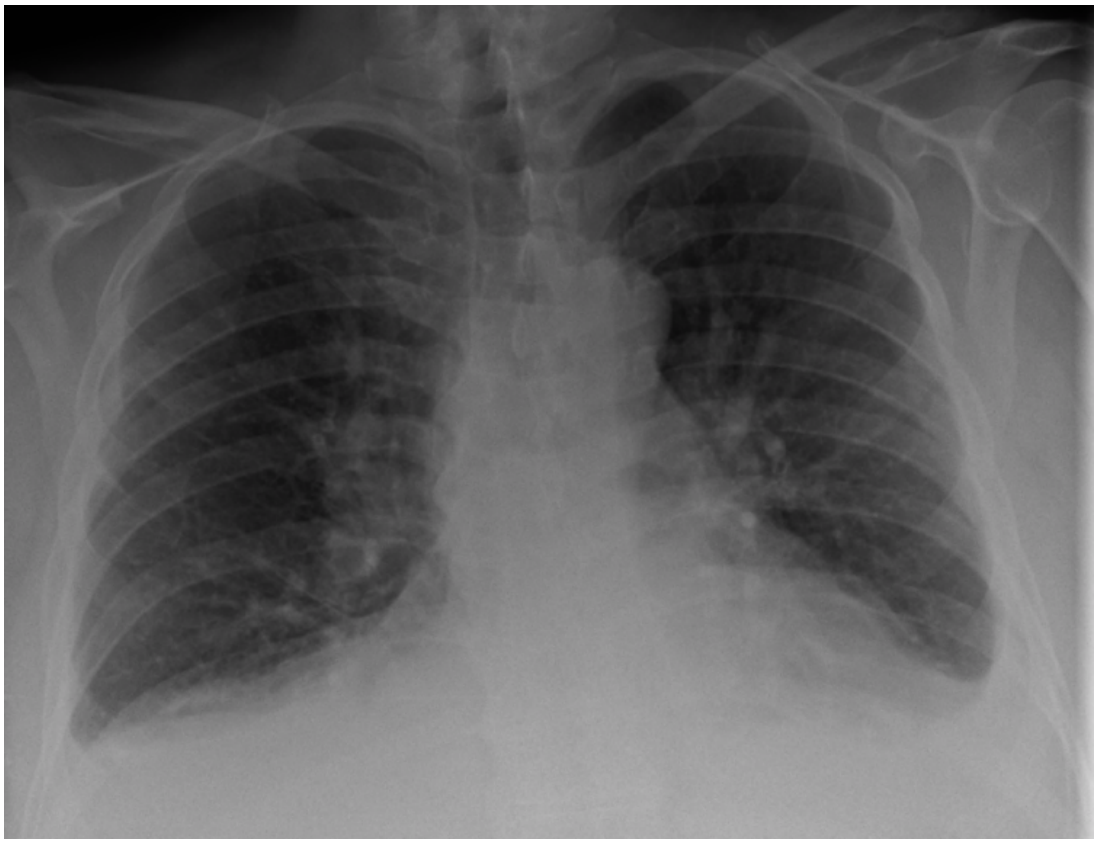
Cardiac and vascular pathologies can be rapidly diagnosed with radiographic techniques. X-ray, CT, and MRI are common methods used for diagnosis. X-rays provide a 2D image that is used in angiography and to detect other cardiac pathologies. CT scans use X-rays to generate a 3D image and are used to diagnose acute vascular events. MRI uses electromagnetic and radio waves to generate high-resolution 3D images and to determine the after-effects of vascular damage.



Overview

X-rays are part of the electromagnetic spectrum. An X-ray producing source sends the X-rays through the patient and onto a receiver, and the resulting image reflects the **different density of tissues** absorbing the X-rays.

Bones absorb more x-rays and have an opaque white color. Lungs are soft tissue and full of air; they appear dark because they do not absorb many X-rays. Tissues with the same density that are next to each other will appear as one continuous opacity and are not easily distinguishable from each other.

You should know how to interpret a plain film chest x-ray. Having a system is important

for spotting spot pathology quickly and effectively. There are many systems encompassing every aspect of an X-ray, but in clinical practice, it is best to use a quick method as you usually only have a few minutes to devote to each patient.

The quickest one is the **ABC method**. A stands for **airway,** where you look at the trachea and mediastinum. B is for **breathing,** to assess lung fields and pleura. C is **circulation,** referring to the heart and aorta. It is important to familiarize yourself with the common pathologies in each region.

Interpreting Technical Aspects of chest x-Ray

There are some standard outlines to get a proper chest radiograph. Rotation and inspiration are important technical factors in getting a perfect chest radiograph, as failure to get a proper standard of getting chest radiographs may result in misinterpretation and misdiagnosis.

Rotation: a satisfactory chest radiograph is free from rotation. It is confirmed by the fact that the medial ends of the clavicles are at equal distance from the spinous processes of the vertebral bodies. In the case of rotation, one side of the chest, one side of the radiograph will look darker than the other one. This can be falsely interpreted as pathological conditions, such as a pneumothorax or pulmonary embolism; the lighter side can be misinterpreted as a pleural effusion or airspace consolidation.

Inspiratory effort: It is also important that the patient makes a good inspiratory effort. This is confirmed by the visibility often ribs posteriorly in the mid-clavicular line in an anterior view chest x-ray. Poor inspiratory effort results in prominent pulmonary vessels, leading to a false diagnosis of cardiac failure.

Cardiac Pathologies

There are many cardiac pathologies that can be diagnosed with a simple chest X-ray.

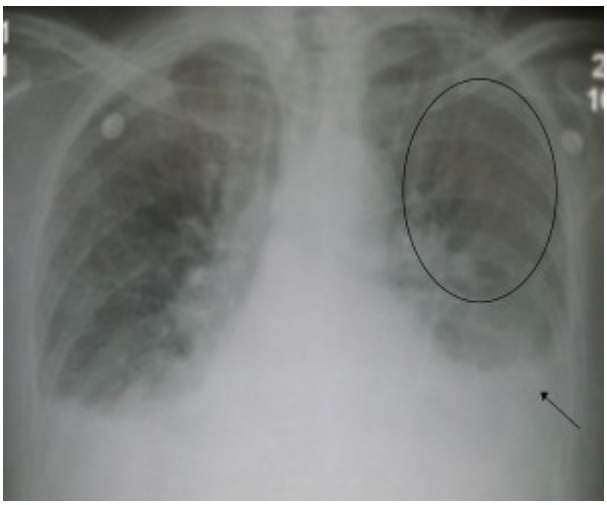


Image: “Acute pulmonary edema. Note enlarged heart size, apical vascular redistribution (circle), and small bilateral pleural effusions (arrow),” by James Heilman, MD. License: CC BY-SA 3.0

Heart failure is often broken up into two categories: left- and right-sided. **Left-sided heart failure** occurs when the left ventricle cannot pump enough blood to the body, causing blood to back up in the lungs. Symptoms include **pulmonary edema**, **orthopnea**, and **paroxysmal nocturnal dyspnea**. Patients can **cough up frothy pink**

sputum.

Right-sided heart failure occurs when the right ventricle cannot pump enough blood to the lungs, leading to **blood collecting in the liver and periphery**. Symptoms include **jugular venous distension**, **peripheral edema**, and **hepatomegaly**.

Diagnosis can be made with **plain film imaging,** which can show **central pulmonary venous congestion and cardiomegaly**. Cardiomegaly is determined on a PA plain film that measures the **ratio between the cardiac width and thoracic width;** it should be less than 0.5-0.6.

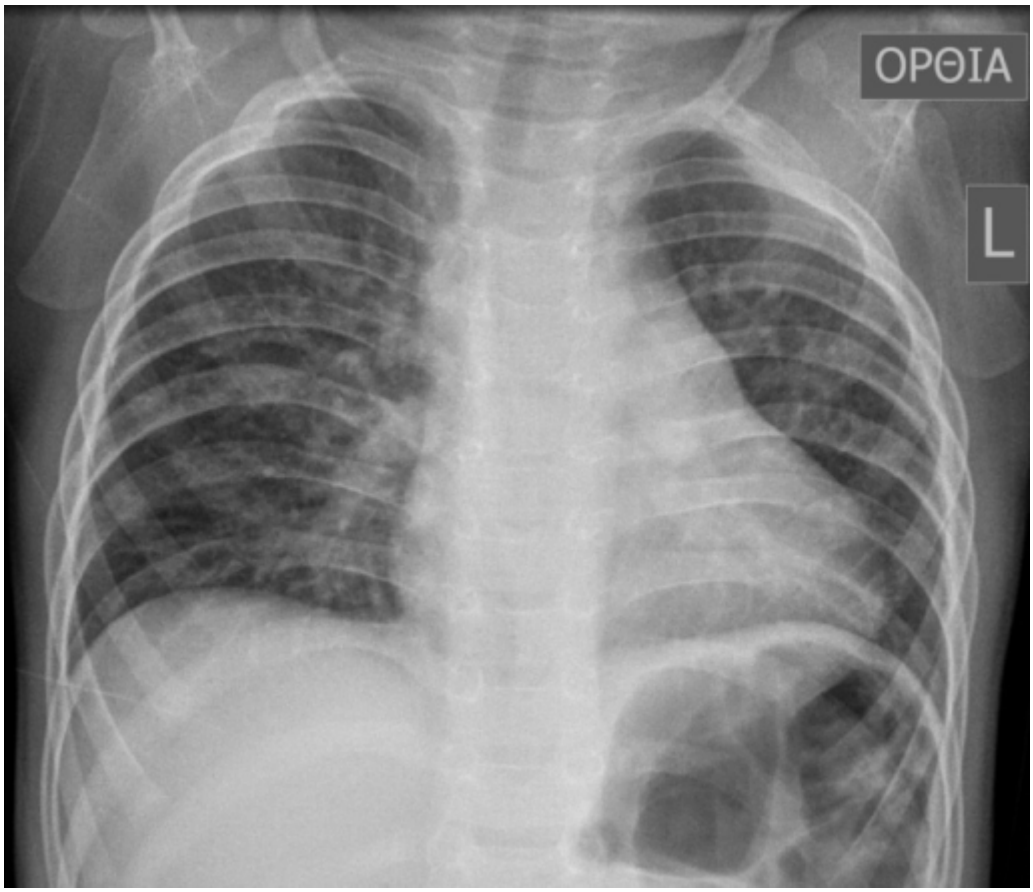


Image: Typical preoperative chest X-ray of a 16-month-old boy with tetralogy of Fallot. By: Clinical Case Reports. License: CC BY 4.0

In the pediatric population, the **tetralogy of Fallot** is a high-yield condition. It has four pathologies: **pulmonary stenosis**, **right ventricular hypertrophy**, **overriding aorta**, and **ventricular septal defect**. The heart may appear to have a boot shape on a chest X-ray.

Mediastinal widening is a finding on chest X-ray that will have a distinct pathology and can include **aortic aneurysm**, **aortic rupture**, and **esophageal rupture**. An infection with **anthrax** (bacillus anthracis), a gram-positive rod, can present this way.

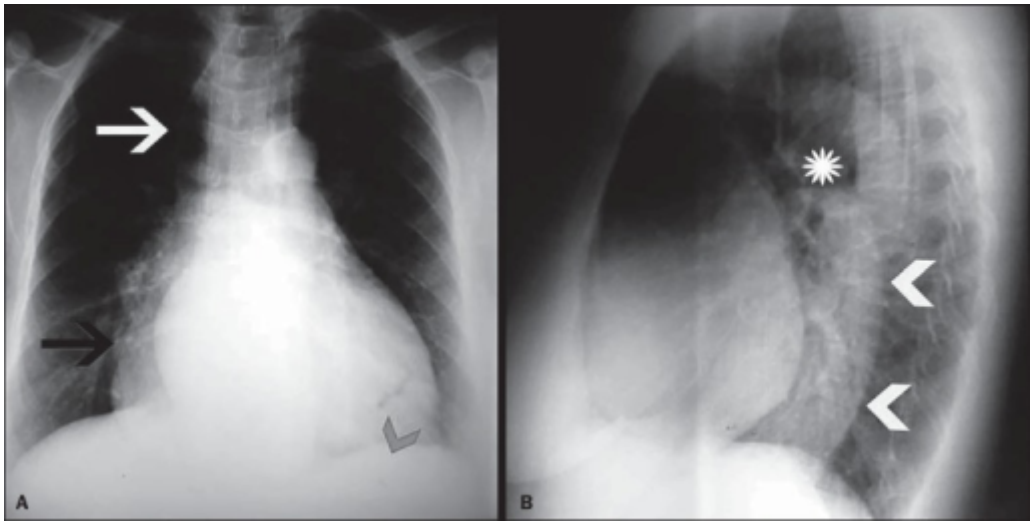


Image: Grade III megaesophagus. A: Posteroanterior X-ray showingright inferior mediastinal widening (black arrow) and right superiormediastinal widening, the latter simulating a pneumomediastinum due togas content inside of the esophagus (white arrow). Absence of thegastric air bubble (arrowhead). B: Lateral X-ray showing anair-fluid level (asterisk) and a retrocardiac mass (arrowheads). By: Radiologia Brasileira. License: CC BY 4.0

Vascular Pathologies

Many **vascular pathologies** can be seen using X-rays. One to be familiar with is **Monckeberg**, a disease where the media of arteries becomes calcified to the point where they can be seen on an X-ray. It is a sporadic and generally benign pathology.

Angiography is a technique where multiple X-rays are taken, and a **contrast** dye is injected to visualize the arteries. This procedure is usually done in the cath lab but can also be done in general operating rooms.

Fibromuscular dysplasia is a small to medium vessel angiopathy that affects younger women. It can lead to **cerebral vascular events** and **renal stenosis**. It is often seen on an X-ray as the **string of beads sign** in the renal arteries.

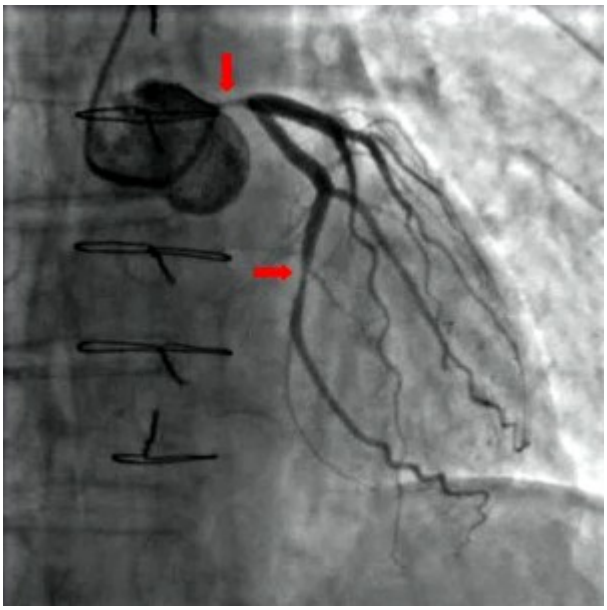


Image: “Coronary angiography of a critical sub-occlusion of the common trunk of the left coronary artery and the circumflex artery (see arrows),” by Kuebi. License: CC BY 2.0

Coronary angiography is the standard for assessing **coronary artery disease** and evaluating coronary blood flow. **Contrast** is used to visualize the coronary arteries and determine the amount of stenosis. It will be essential to know the anatomy and their locations on angiography.

Peripheral vascular disease (PVD) is a common disease resulting from **atherosclerosis.** It narrows the vascular lumen, leading to limb ischemia. PVD can lead to pain, limb impairment, and eventual loss of the affected limb. **Angiography** can be used to visualize the stenosis; at the same time, PVD can be treated with **balloon angioplasty**.

One concern with using contrast is its **detrimental effect on kidney function**. Patients with impaired kidney function should generally avoid contrast if possible. Recently, carbon dioxide has emerged as an alternative to contrast in patients with impaired kidney function. A skilled vascular surgeon can use this gas to visualize stenosis in a peripheral artery nearly as well as with contrast.

Computer tomography (CT) is a machine-based technique that shoots **multiple x-rays** at the patient while the x-ray source rapidly rotates around the patient to generate a 3D image. The image is divided into **slices** with a set width that can be adjusted depending upon what is being imaged. It is important to review the major anatomy that can be seen on a CT. When reviewing pathology and looking for a bleed, blood appears white due to the absorption of X-rays by the iron.

Coronary artery imaging with CT angiography is used to screen for coronary artery disease. It is considered acceptable, but it is seldom used without specific indications.

Abdominal aortic aneurysms are outpouchings through the media, which are visible as pulsatile masses in the abdomen to the left of the umbilicus. This is due to a loss of the vasa vasorum in that part of the abdominal aorta.

These aneurysms tend to occur in male smokers over 50 and are highly associated with atherosclerosis. Other causes include hypertension and Marfan syndrome. They are considered pathological, and treatment is necessary when the lumen reaches a diameter above 5.5 cm. **CTs** and **serial ultrasounds** can be used to monitor progression.

Thoracic aneurysms occur secondary to hypertension or Marfan syndrome. They are also seen in **tertiary syphilis**.

Image: " CT scan of an aortic dissection," by James Heilman, MD.

Aortic dissection occurs when there is a longitudinal tear within the lumen of the aorta. The way the tear occurs results in a false lumen where blood collects. This can result in **rupture** and lead to either **death from hypoperfusion** or **cardiac tamponade followed by obstructive shock**.

Symptoms often include a **tearing sensation** that radiates to the back and a **change in blood pressure between arms**. These symptoms are more common in hypertensive older patients and younger patients with Marfan syndrome. An x-ray would be a useful initial test that would show **mediastinal widening**.

Pulmonary embolism **(PE)** is a life-threatening **medical emergency** and must be treated quickly. PEs originate from **venous thrombosis** found in the extremities. Patients will present with acute onset shortness of breath, hypoxia, and chest pain. Management includes **anticoagulation** with heparin and **thrombolysis** with urokinase and streptokinase. A **CT pulmonary angiography** for suspected PE is the most sensitive and specific test.

Cerebral vascular events can be seen quickly with a **CT of the head**. Any patient that **loses consciousness** should have a head CT to rule out any threatening pathology.

Epidural hematomas appear as biconvex collections of blood outside of the dura due to a **ruptured middle meningeal artery**. The cavity fills rapidly and can lead to **brain herniation** with a CN III palsy (down- and out-gaze).

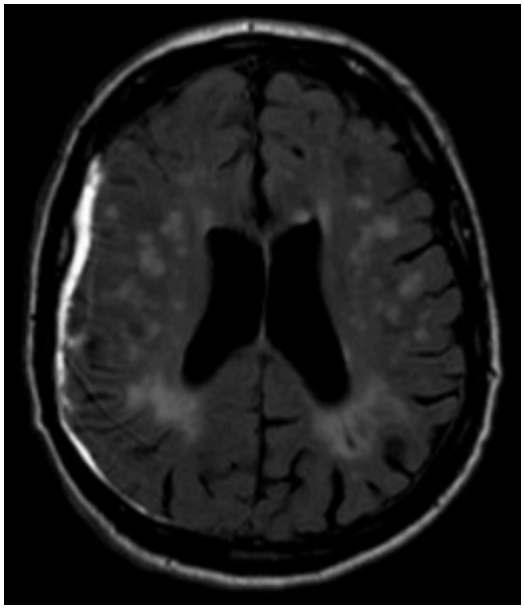


Image: “Subdural hematoma on MRI” by Hellerhoff.
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Subdural hematomas are concave collections of blood below the dura layer due to bridging vein rupture. It is usually seen in older populations due to **cerebral atrophy**. **Subarachnoid hemorrhages** occur due to ruptures of aneurysms in the brain. The most common is the berry, or saccular, that is often found in the anterior communicating artery of the circle of Willis but can be found at other branching points of arteries.

They can also be caused by **arteriovenous malformations**. Patients will present with what they often describe as “the worst headache of my life.” Berry aneurysms can also be seen on a **head CT** with **contrast** and treated with **clipping** or **coiling**.

Magnetic Resonance Imaging (MRI) uses a huge electromagnet that detects natural isotopes in the body and causes them to release radiofrequency energy. This energy is converted into high-resolution 3D images that can show many distinct pathologies.

The exam often takes a long time and requires the patient to remain still. It is commonly used **after vascular events** to visualize soft tissue damage. It is important to review the relevant anatomy easily visualized by MRI.

An MRI is the most likely option for examining an **arteriovenous malformation.** This is a typical vascular lesion characterized by arteries joining veins without capillaries, separating them. Capillaries usually dampen higher pressure from arteries, but in the case of AVMs, the veins experience higher blood pressures. AVMs usually affect young adults and carry a risk of rupture in a small percentage of patients. Hypertension can also increase the risk of rupture.

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Notes