Enlargement of the Cardiac Silhouette on Chest X-ray

The chest X-ray is a cheap, feasible, screening tool for cardiac and respiratory diseases in neonates, children, and adults. The heart shadow on the chest X-ray 'cardiac silhouette' occupies half of the anteroposterior chest X-ray film in normal individuals. Therefore, the examination and evaluation of the cardiac silhouette on the conventional X-ray have received interest from radiologists and pediatricians. The main aim of examining the cardiac silhouette is to determine the heart’s size, the identification of the different contours of the heart, and the categorization of the pulmonary vascularity.

Systemic Approach to Chest X-ray

Chest X-ray can be used to screen for abnormalities in heart size, the presence or absence of one or more of the heart chambers and the status of pulmonary vascularity. Intracardiac lesions cannot be visualized on the chest X-ray.

When examining the heart using the chest X-ray, at least two views should be obtained. An anteroposterior and a lateral view are adequate for the 3D visualization of the heart.
While examining the chest X-ray, one should pay attention to:

1. The quality of the image and check for adequate exposure, lack of rotation, adequate penetration, and adequate expansion of the lungs
2. The size and shape of the heart
3. The status of pulmonary vascular markings
4. Parenchymal lung abnormalities
5. Pleural pathologies

A chest X-ray can often have more than one pathology. Therefore, one should try to systemically interpret the chest X-ray instead of jumping to conclusions based on the most obvious pathology.

**The size of the heart on a chest X-ray is determined by:**

- Size of the cardiac chambers
- Cardiac wall thickness
- Pericardial space
- Pericardium

Therefore, an enlargement in any of these components is expected to present as cardiomegaly on the chest X-ray which is depicted by a cardiothoracic ratio of >0.5.

To tell apart between the different causes of cardiomegaly on the chest X-ray, one should pay more attention to the shape of the enlarged heart. For instance, cardiomegaly in an adult with a prominent aortic arch is most likely due to left ventricular hypertrophy which can be caused by systemic hypertension or aortic stenosis.

![Cardiomegaly Image](Image: “Cardiomegaly” by James Heilman, MD. License: CC BY-SA 3.0)

Patients with heart failure can present with an enlarged cardiac shadow on the chest X-ray due to left ventricular dilatation, pulmonary edema, and pleural effusions.

**Artifactual Causes of Cardiac Enlargement**

<table>
<thead>
<tr>
<th>Cause</th>
<th>Reason</th>
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<tbody>
<tr>
<td>Rotation</td>
<td>Distorts the appearance of the heart</td>
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<tr>
<td>Suboptimal inspiration</td>
<td>Diaphragm moves upwards and compresses the heart</td>
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Effects of Specific Cardiac Pathologies on Cardiac Silhouette

Atrial Septal Defects on the Chest X-ray

Atrial septal defects are characterized by the presence of an **opening between the two atria**. Blood will flow from the left to the right atrium. Increased pulmonary blood flow ensues. The chest X-ray will **show increased pulmonary vascular markings in addition to an enlarged cardiac silhouette.**

![ASD Chest X-Ray](https://commons.wikimedia.org/wiki/File:ASD_Chest_X-Ray.jpg)

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Ventricular Septal Defects on the Chest X-ray

Like atrial septal defects, pulmonary blood flow is expected to increase in ventricular septal defects. **Increased pulmonary vascular markings** will appear on the chest X-ray. **Left atrial and left ventricular dilation are common** findings. The lateral view might reveal posterior deviation of the esophagus due to left atrial enlargement.
Coarctation of the Aorta on the Chest X-ray

The chest X-ray in a neonate with coarctation of the aorta is usually normal. If left untreated, severe coarctation of the aorta might result in left ventricular hypertrophy and an enlarged cardiac silhouette. Rib notching due to deformation of the inferior surface of the ribs is a sign of severe coarctation of the aorta.

Patent Ductus Arteriosus on the Chest X-ray

Pulmonary blood flow is expected to increase and can manifest as increased pulmonary vasculature on the chest X-ray. Left atrial and left ventricular enlargement are common. Posterior deviation of the esophagus on the lateral view chest X-ray can be seen and is caused by the enlargement of the left atrium.

Tetralogy of Fallot on the Chest X-ray

Tetralogy of Fallot is a cause of a small rather than a large cardiac silhouette. Sometimes, pulmonary stenosis can cause an enlargement in the right ventricle. Right ventricular enlargement manifests as uplifting of the cardiac apex. The small pulmonary arteries narrowed mediastinum, and uplifting of the cardiac apex give the heart the shape of a boot. This radiographic feature, known as Coeur en sabot, is quite specific for the tetralogy of Fallot. Diminished pulmonary vascular markings due to decreased
Atrioventricular Canal Defect on the Chest X-ray

Atrioventricular canal defects are characterized by the presence of atrial septal defects, ventricular septal defects, and an abnormal atrioventricular valve. The four chambers of the heart are expected to become enlarged. Increased pulmonary vascular markings are seen on the chest X-ray.

Pulmonary Valve Stenosis on the Chest X-ray

Blood-flow through the stenosed valve causes pulmonary artery dilation. Dilation of the main pulmonary artery manifests as a prominence of the pulmonary artery segment which is found in the mid-left border of the cardiac silhouette. If left untreated, the patient might develop right ventricular hypertrophy and/or enlargement. Enlargement of the right ventricle presents with a fullness of the lower retrosternal portion of the cardiac silhouette on the lateral view of the chest X-ray.

Aortic Valve Stenosis on the Chest X-ray

Like pulmonary stenosis, blood flow through the stenosed aortic valve will be jet-like and will cause dilation of the ascending aorta. Therefore, fullness and prominence of the aorta in the mid-region of the right heart border is expected on the chest X-ray. Left ventricular enlargement with lateral displacement of the cardiac apex can be seen in cases of untreated aortic stenosis. Congestive heart failure with pulmonary edema and pleural effusions are found on the chest X-ray of patients with a prolonged history of untreated severe aortic stenosis.

Tricuspid Atresia on the Chest X-ray

Patients with tricuspid atresia must have a patent ductus arteriosus or systemic-to-pulmonary arterial collaterals to survive. Therefore, increased pulmonary blood flow
is a common finding in this condition. The cardiac silhouette in tricuspid atresia is small or normal.

**Truncus Arteriosus on the Chest X-ray**

Patients with truncus arteriosus have a **single great vessel instead of two major vessels** arising from the heart, i.e., they do not have a pulmonary artery and an aorta. This main truncus manifests as a narrow mediastinum on the chest X-ray. Patients with this congenital anomaly usually have **DiGeorge syndrome**. DiGeorge syndrome is characterized by the **absence of the thymus gland**. The absence of the thymus gland further contributes to the narrowed mediastinum on the chest X-ray.

**Total Anomalous Pulmonary Venous Return on the Chest X-ray**

Patients with total anomalous pulmonary venous return have the **pulmonary veins draining in a vertical vein that is connected to the innominate vein**. This abnormal venous configuration results in a dilated vertical vein, innominate vein, and an enlarged superior vena cava.

The dilation of these three major veins results in a round image that is above the cardiac silhouette. This image is **known as a snowman appearance** and is characteristic of total anomalous pulmonary venous return. Pulmonary venous congestion is seen.

**Acquired Cardiac Pathologies and the Chest X-ray**

**Systemic hypertension** can result in left ventricular hypertrophy which can manifest as an enlarged cardiac silhouette with downward and lateral displacement of the cardiac apex. **Acquired aortic stenosis** usually results in an image that is similar to systemic hypertension, but can also present a radiograph suggestive of congestive heart failure.

Patients with a **large myocardial infarction** can present with acute pulmonary edema and a normal or an enlarged cardiac silhouette depending on the presence or absence of left ventricular hypertrophy.

**Pericardial effusions and pericardial or cardiac tumors** can also present with an enlarged cardiac silhouette on the chest X-ray.

**References**


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