Radiologic Appearance of the Azygos Vein in Cardiovascular Disease

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SUMMARY
Although the usual appearances of the azygos arch on plain chest radiographs are well known, there are less common radiographic presentations which may be misconstrued as mediastinal nodes or masses. The size of the anterior azygos arch measured perpendicular to the right main bronchus should not exceed 7 mm. In the rare case of congenital aneurysmal dilatation of the azygos arch, its size may be much greater and can be confused with a mediastinal mass. Enlargement of the azygos vein can also result from increased pressure in the right ventricle or as the result of increased flow through the azygos system. Increased flow can result from congenital abnormalities or from caval obstruction.

The arch of the azygos vein can be visualized in a large percentage of plain PA radiographs of the chest and is occasionally seen on lateral films. Frequently, its normal appearance is confused with mediastinal nodes or masses. The azygos arch, and sometimes the ascending portion of the vein, can be enlarged in a wide variety of cardiovascular abnormalities.

Normal Azygos Vein
The azygos vein represents the cephalad continuation of the right ascending lumbar vein (fig. 1). Following its passage through the aortic hiatus of the diaphragm, it is joined by the hemiazygos vein at the level of T₈ or T₉. The vessel then continues cephalad in front of the vertebral bodies to the level of T₄ or T₅ where it curves forward and to the right, passing over the right lung root, to enter the superior vena cava. The anterior portion of the azygos arch, near its junction with the superior cava, is projected on end and can be on frontal chest films recognized readily as a round or oval shadow lying immediately lateral to the right main bronchus and just above the right upper lobe bronchus (fig. 2). Occasionally, the lateral border of the posterior portion of the azygos arch lies in contact with the right lung and can be seen on overpenetrated films or tomograms as a vertically oriented, elliptical shadow within the mediastinum, to the right of the midline (fig. 2). The left margin of the posterior arch lies against the posterolateral aspect of the esophagus and commonly produces imprint on the barium-filled esophagus in the frontal (fig. 2) and right anterior oblique views. This should not be confused with a mediastinal node or mass.

Prominent Azygos Vein
The size of the azygos arch is variable but the maximum diameter of the normal vein as measured on an erect frontal chest film is no greater than 6–7 mm. In pregnancy, the arch may dilate to a diameter of 15 mm, presumably secondary to hypervolemia.

Dilatation of the azygos vein may occur on a congenital basis, or secondary to increased right heart pressure or as the result of increased blood flow.

Aneurysmal Dilatation of the Azygos Arch
Rarely, the azygos arch may be as large as 2–3 cm in diameter without associated disease. This is commonly considered to be a congenital abnormality. There are no reported cases of rupture of such a

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dilated vein and, apparently, the condition is entirely benign. Occasionally, patients have been operated upon under the assumption that the dilated vein represented a mediastinal tumor. The differential diagnosis usually can be made if the possibility of aneurysmal dilatation of the azygos is considered. Decrease in the size of the shadow or flattening of its lateral aspect during a Valsalva maneuver proves the lesion to be vascular. The same holds true if the lesion is demonstrated to be larger when the patient is recumbent than when he is erect.

Enlargement Secondary to Increased Right Heart Pressure

The azygos vein may dilate whenever the pressure in the right atrium and superior vena cava is increased, regardless of whether this is due to a lesion on the left side of the heart, in the pulmonary circulation, or the right side of the heart. It is not uncommon with left ventricular failure. However, we have seen many instances of rather marked pulmonary venous hypertension and pulmonary edema in which the azygos vein did not appear to be dilated. An azygos arch of normal size, therefore, does not necessarily indicate that the right heart pressures are normal.

The azygos vein also dilates in a wide variety of conditions producing increased precapillary pulmonary resistance. This observation may be particularly helpful in the diagnosis of constrictive pericarditis, which almost always presents nonspecific
Figure 2

Normal azygos vein, frontal view. (Left) AP tomogram. (Middle) AP azygogram. (Right) AP tomogram with barium in the esophagus. The anterior portion of the azygos arch, near its entrance into the superior vena cava, is projected as an oval density (white arrow) along the right side of the mediastinum. The posterior arch of the azygos (double black arrow) is outlined by the air-containing right lung. This portion of the vein also normally indents the right lateral aspect of the esophagus (black arrow). The azygogram was performed by means of a femoral vein catheter advanced through the inferior cava, right atrium, superior cava (C) and selectively positioned in the mouth of the azygos vein.
Dilatation of the azygos vein secondary to right heart hypertension. Two weeks later, following resolution of the emboli and reduction of the right heart pressures, the shadows of the superior cava and azygos vein appear normal.

Similarly, dilatation of the azygos arch may be of considerable help in the differential diagnosis between a major pulmonary embolus and an acute myocardial infarction. In the absence of signs of congestive failure, an abnormal prominence of the azygos vein suggests the presence of acute cor pulmonale and strongly favors the diagnosis of thromboembolism (figs. 3, 4). It should be kept in mind that the standards for the size of the normal azygos arch were derived from erect, 6-ft films and are not applicable to portable films or those made with the patient supine. In the latter instances, the shadow of the azygos arch is magnified and there are no existing standards for the size of the arch on supine radiographs.

**Enlargement due to Increased Flow**

Frequently, it is possible on the basis of plain radiographs, to distinguish the prominent azygos

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**Figure 3**

*Dilatation of the azygos vein secondary to right heart hypertension. The initial frontal chest film shows considerable dilatation of the superior vena cava (arrow) and the azygos arch (A). A pulmonary arteriogram at this time showed occlusions of multiple pulmonary arteries by emboli. The right ventricular and atrial pressures were elevated. P = main pulmonary artery; Ao = aortic knob.*

**Figure 4**

*Dilatation of the azygos vein secondary to right heart hypertension. Two weeks later, following resolution of the emboli and reduction of the right heart pressures, the shadows of the superior cava and azygos vein appear normal.*
Figure 5

Azygos continuation of the inferior vena cava and dextrocardia. Because of the increased blood flow through the azygos, both the ascending portion of the vein (arrow) and its arch (double arrows) are dilated. As the ascending vein dilates, it becomes visible on frontal films as it projects beyond the border of the vertebrae. (Left) Frontal tomogram. (Right) Frontal chest film following injection of contrast material into the lower inferior vena cava. T = trachea; R = right main bronchus; L = left main bronchus.
Acquired dilatation of the azygous vein. Injection of contrast material into a left antecubital vein shows the collateral venous pathways in the chest which communicate, through the intercostal veins, with the hemiazygous vein. Similar pathways were present on the right side. The dilated ascending portion of the azygous vein can be identified (arrows) as it grooves the right lung.

Figure 6
Acquired dilatation of the azygous vein. (Left) Frontal chest film of a hydrocephalic child following insertion of a Spitz-Holter valve (arrow) into the superior vena cava. The normal azygous vein is completely hidden within the mediastinal shadow. (Right) The valve was subsequently removed because of thrombosis of the superior cava and innominate vein. The azygous arch (double arrow) is markedly dilated as it now is carrying all the venous blood from the head and the upper extremities.

Figure 7
Acquired dilatation of the azygous vein. Injection of contrast material into a left antecubital vein shows the collateral venous pathways in the chest which communicate, through the intercostal veins, with the hemiazygous vein. Similar pathways were present on the right side. The dilated ascending portion of the azygous vein can be identified (arrows) as it grooves the right lung.
which the aortic arch and the gastric air bubble were on different sides of the body rather than on the same side as is normal. Azygos continuation of the inferior vena cava was present in all. This anomaly may be isolated but more often is associated with other congenital cardiac defects and is a common component of the syndromes of polysplenia and asplenia.

Dilatation of the azygos system due to increased flow can also be an acquired abnormality when obstruction of systemic venous return leads to divergence of blood flow into the azygos or hemiazygos veins.

When the superior vena cava is obstructed, the venous return from the head and upper extremities follows alternate pathways through the chest wall, and ultimately drains into the azygos vein. This additional blood flow is added to the normal azygos flow and, as a result, the vein dilates. The dilated azygos channels may produce abnormal posterior mediastinal contours unilaterally or bilaterally (figs. 6, 7). A similar sequence of events can result from obstruction or ligation of the inferior vena cava. The altered mediastinal contours may be smooth or lobulated and sometimes can achieve impressive size apparently solely because of the volume of diverted blood flow.

Obstruction of the portal venous system or of the hepatic veins (Budd-Chiari syndrome) may also result in divergence of blood through the azygos system with dilatation of the azygos vein and arch.10

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