Obscuration of the Aortic Knob in Coarctation of the Aorta

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SUMMARY
Obscuration of the superior margin of the aortic knob together with a widening of the mediastinal shadow to the left is a common sign of coarctation of the aorta. It is easily seen on the routine frontal chest film and may be the first detected evidence of the lesion. Although the appearance is not pathognomonic of a coarctation, it certainly indicates the need for further studies.

Diagnosis of a coarctation of the aorta can be made, in the majority of cases, from the roentgen study of the chest without resorting to catheterization or angiography. This is especially true if the diagnosis is considered on the basis of the clinical findings and the X-ray examination designed to demonstrate the rather characteristic abnor-

Figure 1
Effect of filming technique on appearance of the aortic knob. (Left) 6-ft posteroanterior chest film. The aortic knob is sharply delineated and its superior border forms a right angle where it meets the left border of the mediastinum. (Right) Portable chest film made on the same day, anteroposterior projection. The mediastinum appears widened, and the aortic knob can no longer be identified.
Coarctation of the aorta, supravalvular aortogram. (Left) Lateral view. The aorta is drawn forward at the level of the coarctation (arrow). The curve of the posterior aortic arch between the dilated left subclavian artery (LS) and the coarctation is flattened. There is considerable poststenotic dilatation of the aorta. (Right) Frontal projection. The left subclavian artery is dilated and displaced so that it forms the left lateral border of the mediastinum.

malities usually associated with this anomaly. However, in some instances, a hemodynamically significant coarctation may not be suspected because of the absence of clear-cut symptoms or physical findings. But even in these cases there is almost always a change in the appearance of the aorta. Obscuration of the superior aspect of the aortic knob is a common sign of coarctation and is of considerable importance because it is easily detected on the routine frontal film of the chest.

The aortic knob is not a discrete anatomical structure. The term is applied to a localized bulge on the left superior mediastinal contour that is formed by a portion of the aortic arch and is seen on a frontal roentgenogram of the chest. The distal portion of the aortic arch lies to the left of the trachea and esophagus, and curves posteriorly and downward to join the ascending aorta. Where the X-ray beam is tangential to this curve, the aorta is projected in cross section as a circle. This normally protrudes in part from the lateral border of the mediastinum. The medial and inferior margins of the circle blend with the shadow of the mediastinum and cannot be identified. The superior and lateral portions of the circle are silhouetted against air-containing lung and...
Obscuration of the aortic knob in coarctation of the aorta. In both cases, the superior aspect of the knob is not visible and blends with the shadow of the widened mediastinum. (Left) 27-year-old male with marked hypertension in the upper extremities. There is a double indentation on the esophagus caused by the aortic knob above the coarctation and the poststenotic dilatation below. There is no significant rib notching. (Right) 9-year-old male with coarctation and marked notching of the ribs.

Form the aortic knob (fig. 1L). The left subclavian artery arises from the aorta proximal to the knob and, therefore, lies medially, within the contour of the mediastinum. Normally, the left subclavian artery is not a border-forming structure.

In the common type of coarctation at the level of the ligamentum arteriosum, the curve of the distal aortic arch is distorted, and the relationship between the left subclavian artery and the aortic knob is changed. In most cases, the aorta is pulled forward and medially by the ligamentum so that the distal arch is drawn downward, flattening its curve (fig. 2L). In addition, the segment of the aorta between the left subclavian artery and the coarctation is often small in caliber and may be foreshortened. As a result, the true aortic knob tends to be smaller and less prominent than in the normal subject. Due to the change in the curve of the posterior arch, the origin of the subclavian artery is shifted downward and laterally so that this vessel comes into profile, widening the left border of the mediastinum (fig. 2R). In this position, it overlies and obscures the medial portion, or all, of the aortic knob (fig. 3).

Not uncommonly, the proximal portion of the left subclavian artery is dilated and produces a localized bulge on the mediastinal contour. Superficially, this can resemble a normal aortic knob (fig. 4). However, the subclavian artery ascends vertically, rather than curving into the mediastinum as does the aortic arch. Thus, the "knob" formed by the subclavian artery does not have a sharp superior border, but fades out gradually as it courses upward.
32-year-old female with Turner's syndrome and coarctation of the aorta. (Left) An indentation is seen on the lateral border of the descending aorta (arrow), characteristic of a coarctation. The aortic knob appears to be of normal size, but its superior margin does not curve to the mediastinum. There is a minor degree of notching of the fourth to the seventh posterior ribs. (Right) Supravalvular aortogram, frontal view, in the same patient. The "aortic knob" is actually formed by the dilated proximal portion of the left subclavian artery (LS).

**Differential Diagnosis**

Partial or complete obliteration of the aortic knob, on the frontal chest film, is not pathognomonic of coarctation and can result from any widening of the mediastinum adjacent to the aorta. Tumors involving the posterior portion of the superior mediastinum will often obscure the aortic knob. However, other evidences of a mass lesion are almost always present so that the appearance is unlike that of a coarctation. The same is true in most cases of mediastinal lymphadenopathy. The majority of the mediastinal nodes lie against the trachea and bronchi, anterior to the plane of the distal aortic arch. Even when these nodes are massively enlarged, the aortic knob can be visualized through their shadows because it is still outlined by air-containing lung. However, there are several nodes in the posterior mediastinum adjacent to the aorta. When they become enlarged, they fill in the angle between the aortic knob and the mediastinum and can mimic the appearance seen with a coarctation (fig. 5).

Apparent widening of the mediastinum and partial obscuration of the aortic knob can be
Hodgkin’s disease. Although the mediastinal contour is similar to that seen in coarctation, its shadow is exceedingly dense. A lateral film of the chest showed the anterior mediastinum to be involved as well as the posterior nodes, adjacent to the aortic arch.

the result of a pleuritis. Due to the inflammatory process, the pleura becomes thickened and the mediastinal and visceral layers become adherent, obliterating the small protrusions of the pleural space which normally conform to the curves of the borders of the mediastinal structures. This results in an ironing out of the mediastinal contour; the rather sharp angle between the knob and the mediastinum becomes a single continuous line and the upper border of the aortic knob is lost. Usually similar changes will be seen in other portions of the pleural cavity, establishing the diagnosis of a previous pleuritis.

A persistent left superior vena cava will produce a vertically oriented shadow, paralleling the mediastinum and overlying the aortic knob. This shadow is usually of lesser density than that of the subclavian artery in coarctation and, since the cava lies anterior to the lung root, it is anterior to the distal aortic arch and does not obliterate the silhouette of the knob (fig. 6).

When there is a large left-to-right shunt, the aorta is often small in caliber. The knob may not be seen in these cases because it does not protrude beyond the border of the mediastinum or because it is hidden by the dilated main pulmonary artery. However, the mediastinum is not widened, and there usually is a definite increase in the vascularity of the lungs, indicating the presence of a shunt.

Although obscuration of the aortic knob together with a widened mediastinal shadow is definitely abnormal when seen on a frontal film made in the posteroanterior projection,
the same appearance has little, if any, significance on an anteroposterior view such as on a portable chest film. When the patient's back is to the film, the shadow of the mediastinum is magnified and appears widened. The shorter the distance between the X-ray tube and the film, the greater is the magnification. The shadow of the aortic arch is projected upward and elongated, and the knob is often indistinct or hidden by the clavicle and upper ribs (fig. 1). This is accentuated if the X-ray tube is tilted towards the head of the patient.

Discussion

Of the various roentgen signs of coarctation of the aorta, notching of the posterior ribs, due to the collateral circulation through the intercostal arteries, is the most common (fig. 3R). It has been reported in about three-fourths of all patients with coarctation over the age of 2 years. However, the irregularities of the under-surfaces of the ribs may be relatively minor and easily overlooked unless specifically sought (fig. 4L). The internal mammary arteries are also dilated and tortuous, and produce a scalloping and thickening of the retrosternal soft tissue shadow. This is best seen in the lateral view and cannot be detected in the frontal projection.

A rather specific sign of coarctation, often seen on the frontal chest film, is a discontinuity in the lateral contour of the descending aorta just beneath the knob (fig. 4L). This is usually due to the indrawing of the coarcted segment by the ligamentum arteriosum but, in some cases, it represents the junction of the dilated left subclavian artery with the aorta. This area often lies behind the heart, and the aortic shadow will not be seen unless the technique of filming is sufficient to penetrate the cardiac silhouette.

Once the possibility of a coarctation is considered, additional films should be made in the frontal and left anterior oblique projections with the esophagus filled with barium. Poststenotic dilatation of the aorta is very common and produces an impression on the posterolateral aspect of the esophagus below that of the aortic knob (figs. 3L and 4L). This can usually be seen in the frontal projection but is better visualized in the left anterior oblique view. The oblique view is also the best for demonstration of the indentation on the outer contour of the aorta at the level of the coarctation. Obscuration of the aortic knob is of no value as a sign of coarctation in infants and young children. The left subclavian artery is generally not significantly dilated and does not lie as far laterally in this age group as in older patients. In addition, the superior mediastinum is often widened by the thymus gland. Actually, none of the extracardiac signs of coarctation are of much value in patients below the age of 2 years.

References

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