Dilatation and Pulsation of the Left Subclavian Artery in the Roentgen-Ray Diagnosis of Coarctation of the Aorta
Roentgenkymographic Studies in Thirteen Cases

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Postero-anterior chest roentgenograms in 17 of 20 patients with coarctation of the aorta showed widening of the left upper mediastinal shadow attributed to dilatation of the left subclavian artery; pulsations of this vessel were evident in 12 of 13 cases with roentgenkymograms. In 3 of the latter cases rib notching was absent or equivocal. The subclavian pulsations may be observed fluoroscopically. Recognition of dilatation and pulsation of the left subclavian artery may provide roentgenologic corroboration of a diagnosis of coarctation of the aorta even in the absence of rib notching.

ENLARGEMENT of the left subclavian artery is a well recognized and almost constant anatomic feature of coarctation of the aorta when the constriction is distal to the origin of that artery. The resultant widening of the left upper mediastinal shadow above the level of the aortic arch has been mentioned occasionally in the literature as a roentgen-ray finding in certain cases.1, 6, 10, 11 Recently Gladnikoff and his associates9, 10 have thrown new emphasis on this finding; Gladnikoff states: "The only changes which are pathognomonic are:

1. Widening of the left subclavian artery, visible as (a) an S-curved outline of the left border of the superior mediastinum, (b) an impression upon the oesophagus, (c) an indentation of the left border of the posterior mediastinum, (d) a modification of the impression of the aortic arch upon the oesophagus.

2. The discrepancy between the increased pulsations in the left subclavian artery and the decreased pulsations in the adjacent part of the descending aorta."

Laubry and Heim de Balsac7 had earlier described the diminution of pulsations of the descending aorta as compared with the ascending aorta, recorded in the roentgenkymogram.

Recently the study of patients with coarctation of the aorta at the University of Minnesota Hospitals prior to surgical treatment has provided an opportunity to evaluate these roentgen-ray features in a considerable number of subjects over a relatively short period of time. Our material consists of 20 patients, 13 with roentgenkymograms in the posteroanterior projection; (4 patients from other hospitals are included because their roentgen-ray studies included kymograms). Examination of the roentgenograms in this series of patients provided convincing evidence of the diagnostic importance of the left subclavian artery shadow. Some degree of enlargement of the left upper mediastinal shadow was recognizable in the great majority of the cases. In all but one of the roentgenkymograms, abnormal pulsations of arterial type were distinctly visible on the left above the aortic arch. Marked scoliosis due to old tuberculosis of the spine may well have prevented visualization of the pulsations in the one patient in whom they could not be recognized in the kymogram.

The ages of the patients ranged from 7 to 72 years; a report of the patient aged 72 years appears elsewhere.8 By decades the patients were distributed as follows:

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>1 patient</td>
</tr>
<tr>
<td>10-20</td>
<td>6 patients</td>
</tr>
<tr>
<td>20-30</td>
<td>7 patients</td>
</tr>
<tr>
<td>30-40</td>
<td>3 patients</td>
</tr>
<tr>
<td>40-50</td>
<td>2 patients</td>
</tr>
<tr>
<td>70-80</td>
<td>1 patient</td>
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In 9 of the patients the diagnosis was verified at surgical exploration (in 7 by Dr. Richard L. Varco and in 2 by Dr. Ivan D. Baronofsky). Three further cases not explored were confirmed at autopsy. All cases exhibited the classic clinical findings of coarctation of the aorta.
Seventeen of the 20 patients showed enlargement of the left upper mediastinal shadow. In almost all instances the shadow was flat, with the border approximately 1 cm. beyond the left margins of the vertebral bodies (fig. 1). The density of the left upper mediastinum was usually noticeably greater than that on the right; vertebral detail was less visible as a result. In only one patient was the arterial dilatation of aneurysmal character; this patient was a man 37 years of age with the clinical findings of coarctation of the aorta, but no rib notching; there was no anatomic confirmation of the aortic arch level is very important in rendering the aortic knob inconspicuous in those patients who do not have an associated extensive hypoplasia of the aortic arch (fig. 1).

Several patients showed dilatation of the ascending aorta; this was most pronounced in one patient with well-marked aortic regurgitation, attributed to a probable bicuspid aortic valve (fig. 3).

Twelve of the thirteen roentgenkymograms showed vascular pulsations on the left above the level of the aortic arch. This area normally lacks pulsations (fig. 2). In one patient with evidence of pulsation in the kymogram there was no recognizable left subclavian shadow in the plain film.

It is of greatest interest that in 3 patients showing the pulsating left upper mediastinal shadow there was absent or equivocal evidence of rib notching. In each of these 3 patients the abnormal pulsation was observed fluoroscopically as well. Since 2 of these patients were studied recently, it seems not improbable that such pulsations may have been overlooked during fluoroscopy in earlier cases when we were

![Fig. 1.—Enlarged left subclavian artery shadow (arrows) in 3 patients with coarctation of the aorta. Aortic knob inconspicuous. a, The patient was a man 21 years of age. This patient had surgical resection of the coarctation. b, The patient was a man 20 years of age. This patient died from subarachnoid hemorrhage. At autopsy, coarctation was found at the usual site with poststenotic dilatation of the aorta; the left subclavian artery was greatly enlarged. c, The patient was a man 25 years of age. He had surgical resection of the coarctation.](http://circ.ahajournals.org/doi/fig/10.1161/01.cir.29.3.295.f1)
less aware of its significance; in the third patient there was aneurysmal dilatation of the left subclavian artery.

Figure 2.—Normal appearance of aortic knob and left upper mediastinum in roentgenogram (a) and roentgenkymogram (b). The patient was a woman 30 years of age. There was absence of pulsations on the left above the aortic knob.

Figure 3.—Coarctation of the aorta. The patient was a man 20 years of age. He had aortic regurgitation, probable bicuspid aortic valve, dilated ascending aorta, and enlarged, pulsating left subclavian artery.

Figure 4 illustrates one of the cases with supra-aortic pulsations and absence of rib notching; the preoperative diagnoses of coarctation of the aorta involving the origin of the left subclavian artery and patent ductus arteriosus were confirmed on surgical exploration by Dr. Richard L. Varco. Pulsation of the brachiocephalic vessels was the only roentgen-ray indication of coarctation. The pulsations on the
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Fig. 4.—Coarctation of the aorta; patent ductus arteriosus. The patient was a boy 7 years of age. There was a widened brachiocephalic vessel shadow (left common carotid) pulsating as shown in kymogram (b); the pulsations were obvious fluoroscopically. Clinically there was absence of the left radial pulse and signs of patent ductus and coarctation. Roentgenologically the heart appeared large; the trunk and branches of the pulmonary artery were very large; the aortic arch was small. There was no rib notching. On surgical exploration, coarctation was found beginning proximal to the origin of the left subclavian artery; the left common carotid was greatly enlarged; there was a large patent ductus arising proximal to the coarctation.

Fig. 5.—Coarctation in a 45 year old man. The aortic knob was prominent owing to ectasia. There was minimal widening of left brachiocephalic vessel shadow (a); pulsations were shown in the kymogram (b). (Roentgenograms courtesy of Dr. Harold O. Peterson.)

left in this instance were presumably due to the left common carotid since the left radial pulse was unobtainable, the left subclavian

arising in the area of coarctation. In the patient reported by Schatzki and Hallerman¹⁰ there was a pulsating mass in the left upper media-
sternum and a pulsus parvus et tardus in the left arm; these authors postulated coarctation proximal to the origin of the left subclavian artery and aneurysmal dilatation of the other brachiocephalic vessels.

In our third patient, a boy of 10 years with equivocal rib-notching, there was pulsation of the left subclavian artery and left ventricular hypertrophy permitting roentgen-ray confirmation of the diagnosis of coarctation; at operation a pin-point lumen at the site of well localized isthmus stenosis of the aorta was found.

The kymographic findings in coarctation with respect to the brachiocephalic vessels are in sharp contrast to those encountered in a review of fifty unselected kymograms of patients with other cardiovascular conditions. Included in this “control” group were examples of conditions with high pulse pressure, such as aortic regurgitation and patent ductus arteriosus; the only instance of pulsation of the left brachiocephalic vessel shadow occurred with aneurysmal dilatation of one of these vessels in a patient with hypertension but no evidence of coarctation of the aorta.

In the kymograms of 2 patients with coarctation, pulsations of the descending aorta were of normal amplitude. In most of the others the outline of the descending aorta could not be made out in the kymogram.

A notch in the dorsal vascular contour near the termination of the aortic arch was visualized in a few of our patients with coarctation in the left anterior oblique view. Study of our cases and of published angiocardiograms indicates that this notch may represent either the site of coarctation or the junction of the dilated left subclavian artery and the aortic arch above the level of the coarctation.

Conclusions

The advent of surgical treatment for coarctation of the aorta makes its early diagnosis of great practical importance. Rib notching, generally accepted as the pathognomonic roentgen-ray sign may occur late and occasionally not at all; minimal indentations of the ribs may be without significance. Dilatation of the left subclavian artery is frequently recognizable in the posteroanterior chest roentgenogram in coarctation of the aorta; regularly in this condition pulsations of this vessel may be recorded in the roentgenkymogram and they may also be recognizable fluoroscopically. Recognition of these signs may provide roentgen-ray evidence for a diagnosis of coarctation of the aorta even in the absence of rib notching.

The widening of the left upper mediastinal shadow by the enlarged left subclavian artery contributes to the characteristic decreased roentgen-ray visibility of the aortic knob in this condition.

In the occasional instances of coarctation of the aorta proximal to the origin of the left subclavian artery, enlargement and pulsations of the left common carotid may be evident roentgenologically. An example of this is included in the present report.

REFERENCES

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