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Coarctation of the Aorta with Patent Ductus Arteriosus in an Adult, a CT Angiographic Overview

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Abstract

Coarctation of the aorta is a rarely diagnosed pathology in adults. CT angiography is a necessary procedure, which explores the aorta. We report a rare case of a 38-year-old female patient presenting with aortic coarctation associated with a persistent ductus arteriosus. And we emphasize through this article the place of CT angiography in the exploration of aortic coarctation in adults and the detection of associated abnormalities.

Keywords: ***Aortic coarctation; Ductus arteriosus; Adult; CT angiography***

1. Introduction

Coarctation of the aorta accounts for 7% of congenital heart defects, although 90% of patients reach adulthood [1]. It is a localized constriction of the aorta which may be associated with other vascular malformations. It runs the risk of fatal complications such as heart failure, hypertension, dissection, and aortic aneurysm.

We report a case of aortic coarctation associated with a persistent ductus arteriosus in an adult patient. We emphasize through this article the interest of CT angiography in the exploration of aortic coarctation in adults.

2. Case Report

The patient is a 38-year-old woman, with treatment-resistant hypertension and chronic dyspnea. The cardiovascular examination objectified a left parasternal systolic murmur, a diastolic murmur at the aortic home, and absence of femoral pulses. Transthoracic Echocardiography showed a coarctation of the aorta without aortic valve abnormality, a maximum systolic speed of 4.4 m/s, and a persistent diastolic flow indicating the stenosis severity.

A slight left ventricular hypertrophy was associated with no apparent impact on the right ventricle. However, pulmonary arterial hypertension was shown in Echocardiography. A CT angiogram has been required for better vascular exploration.

This exploration was made by a Siemens scanner of 32 strips, according to the following protocol:

- The voltage of the tube was around 120 Kv; effective current was 300 mAs; collimation=0.75; pitch=1 and overlap=0.5.
- Topogram: thorax in the craniocaudal direction.
- Initial non-injected acquisition with apnea makes it possible to locate the various vascular structures, to visualize parietal calcifications and to look for deep or intra-mural hematomas.
- Contrast-enhanced acquisition with iodinated contrast agent: 350 mg/l using a venous access in the elbow, the dose was 1.5 ml/kg, with a flow rate of 5 ml/sec, pushing a 30 ml of physiological saline.
- Bolus-tracking with an ROI at the level of the ascending aorta and a trigger threshold of 120UH.
- Cardiac synchronization is required for the study of the ascending aorta.
- A second passage, succeeding the first helix after injection (arterial helix) was made.
- Maximum Intensity Projection (MIP) reconstructions provide angiography images which are comparable to that of digital arteriography on the three planes of space.
- The three-dimensional surface representations are necessary. These representations require careful threshold, and their interpretation must take into account native images and MIP images.
- Multi-planar reconstructions allow the study of the aortic wall, the precise quantification of the stenosis and the search for associated lesions using image processing software.

CT angiography results have shown a tight isthmic aortic coarctation of 65%, associated with a patent ductus arteriosus which was enhanced, showing communication between the pulmonary arterial trunk and the aortic arch (FIG. 1). We also remarked a standard tricuspid aortic valve (FIG. 2), a significant expansion of the pulmonary artery related to pulmonary arterial hypertension (FIG. 1 and 3). An anatomical variant of the supra-aortic trunk was associated as a common left carotid artery originating from the brachiocephalic artery (FIG. 4). Our patient underwent a repair surgery, consisting of a stenosis plastic enlargement with a suture of the arterial canal. The postoperative clinical courses, as well as echocardiography control, were favourable, with the persistence of less severe arterial hypertension balanced under treatment.

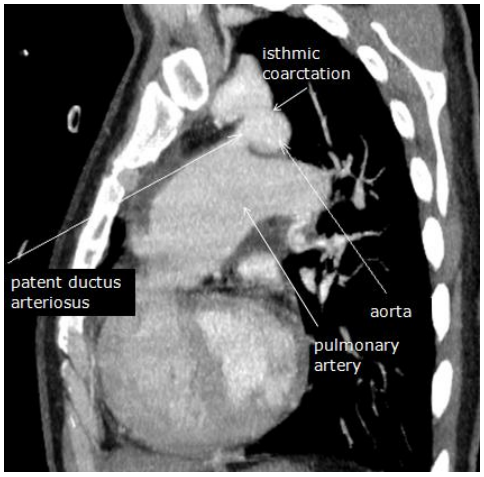

FIG. 1. **Sagittal reconstruction of CT angiography in the mediastinal window, with maximum intensity projection (MIP). Image shows aortic isthmus stenosis with the persistence of the arterial canal, making the pulmonary arterial trunk communicates with the aortic arch. There is a significant dilation of the pulmonary artery.**

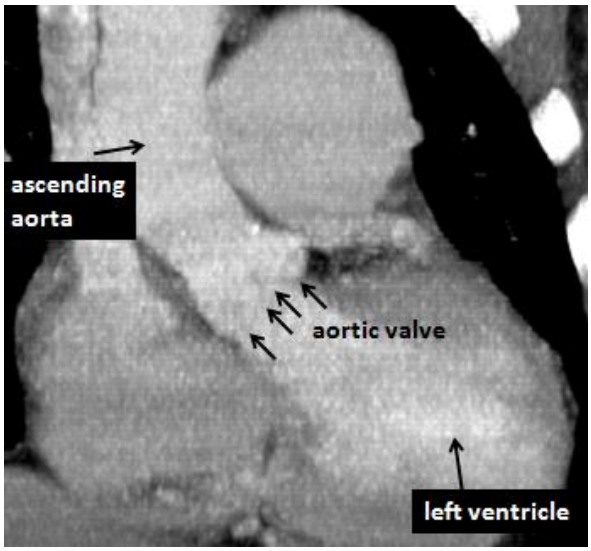

FIG. 2. **Coronal reconstruction of CT angiography, with maximum intensity projection (MIP), showing a normal aortic valve.**

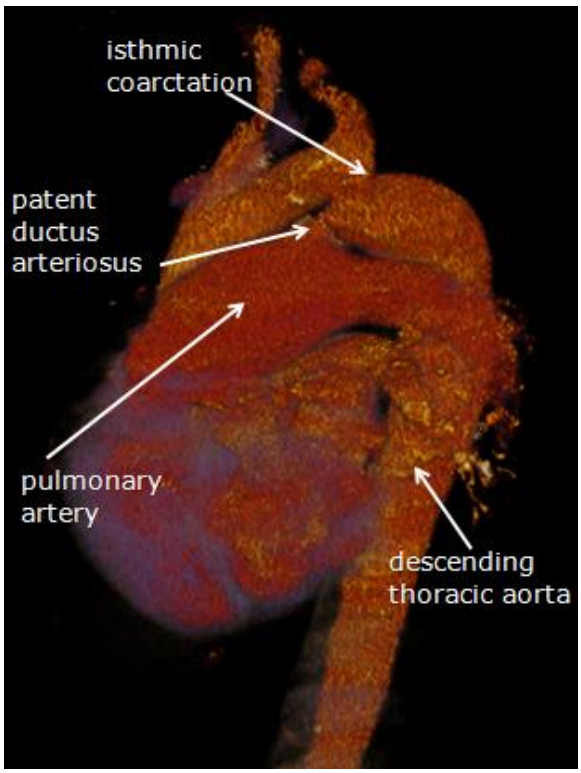

FIG. 3. **Reconstruction using the volume rendering technique (VRT). The image shows aortic coarctation with a persistent ductus arteriosus and pulmonary arterial dilation.**

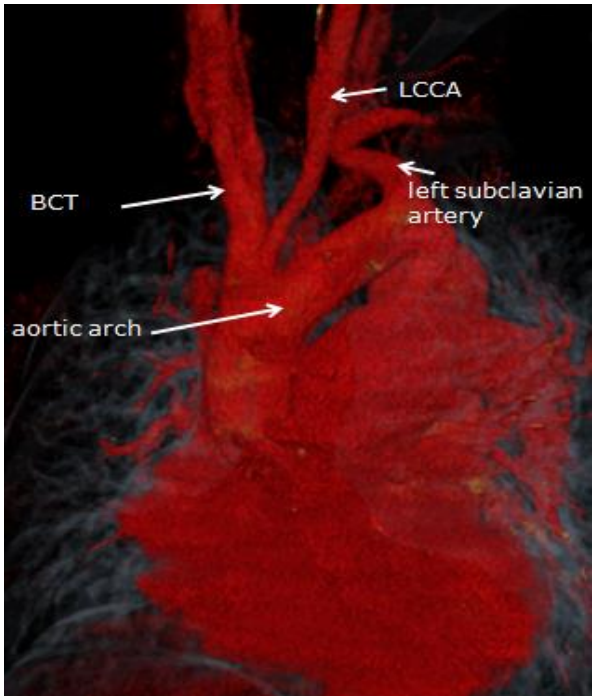

FIG. 4. **Reconstruction using the volume rendering technique (VRT): Anatomical variation of the left common carotid artery (LCCA) arising from the right brachiocephalic trunk (BCT).**

3. Discussion

Two theories have been described explaining the etiopathogenesis of congenital aortic coarctation: The first is related to the ductus arteriosus closure responsible for ductal tissue constriction; this latter encircles the distal portion of the aortic isthmus, which induces indentation of the aortic wall. The second theory is based on the necessity of sufficiently large blood flow for the development of vascular structures in utero [1,2]. During fetal life, blood ejected from the left ventricle supplies the cerebral circulation and that of the upper limbs. As for the right ventricle, it ensures the irrigation of the lower part of the body through the arterial canal. Between these two circulations, is the aortic isthmus, it receives a restricted blood flow, which explains its narrow caliber compared to other aortic segments. Any decrease in the flow ejected by the heart is, therefore, likely to induce hypoplasia of the isthmus, which may be responsible for aortic coarctation [1,2].

The main clinical sign encountered in adults is severe and treatment-resistant hypertension, especially in young adults. Other nonspecific symptoms have also been described as headache, tinnitus, chest pain and dyspnea [3].

The associated lesions most frequently encountered in adults are bicuspid valve disease encountered in 50% to 85% of patients with coarctation of the aorta, this abnormality was not found in our patient as well as aneurysm and dissection of the aorta. Mitral and coronary insufficiencies, anomalies at the origin of the supra-aortic trunks and aortic duplication are sometimes found [4]. The persistence of the ductus arteriosus is classically described in children in association with aortic coarctation. Rare cases are reported in the literature of persistent ductus arteriosus in adults, such as our patient. We note an abnormality in the birth of the supra-aortic trunks in our patient as a common left carotid artery originating from the arterial brachiocephalic trunk.

Cardiac MRI represents a non-invasive means of exploration, ensuring a morphological and functional study of the heart and large vessels. Analysis of vascular stenosis is based on contrast phase, which ensures the evaluation of shunts, regurgitation and derivations channels. It also offers a morphological study of the large vessels at different acquisition times. Late sequences allow the survey of parietal enhancement and ventricular fibrosis which reflects a progressive stage of cardiac stenosis [5]. MRI also performs a functional study of the heart. It surveys ventricular kinetic function on dynamic sequences and even the cardiac function by calculating the ventricular telediastolic and telesystolic volume [5].

Objectives targeted in the analysis of the aortic coarctation in adults can be summed up, in a preoperative context, to define the diagnosis of coarctation and to assess the degree of stenosis, collateral circulation and associated lesions. In the postoperative context, MRI is required to detect a residual shrinkage, a restenosis, and aneurysm [6].

The limits of MRI are not negligible, dominated by the limited spatial resolution compared to CT and the long duration of the examination. It adds the high cost of this exploration technique that presents a real obstacle for the majority of patients, particularly in developing countries.

As for CT angiography, it represents an irradiating but non-invasive means of exploration, unlike angiography. The calculations of the radiation mean effective dose comparing the angiography and computed tomography in adults indicate a higher dose in angiography (18 mSv vs. 10 mSv) [7]. Thus, CT angiography allows also to solve MRI constraints, offering optimal spatial resolution through thin sections and software dimensional and volume building.

The time required for completion of the review is concise, including the acquisition in spontaneous contrast and various vascular after the injection of the contrast material. It is also an inexpensive and easily accessible exam. As in our patient, CT provides with precision the multiple data essential for the preoperative assessment of the coarctation of the aorta in adults [4,8]. It makes it possible to look for residual postoperative narrowing, restenosis or aneurysm. The residual coarctation is defined by the ratio: isthmic diameter / diameter of the descending aorta <0.9. This ratio is less than 0.6 in the event of restenosis [4,8].

4. Conclusion

CT angiography is a crucial means for coarctation of the aorta in adults. Thanks to its non-invasive, available, rapid and inexpensive nature, it achieves various preoperative objectives that are expected by the vascular surgeon: Definite diagnosis, coarctation morphology study, stenosis degree and associated lesions. Thus, it detects postoperative complications as residual narrowing, restenosis and aneurysm.

5. Conflicts of Interest

There are no conflicts of interest.

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