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Case report

ECG-gated multislice computed tomography angiography as a comprehensive non-invasive imaging tool in patient with aortic coarctation

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Abstract. We describe a case of a 52-year-old-woman with aortic coarctation demonstrated by means of 40-slice MSCT angiography. Based on the information extracted from MSCT it was possible to display the anatomical configuration of the disease, the thoraco-abdominal collateral pathways. The best therapeutic approach was established on the basis of MSCT findings. MSCT is a reliable and comprehensive tool for the assessment of adult patients with aortic coarctation. (www.actabiomedica.it)

Key words: Multislice Computed Tomography Angiography, ECG-Gated Scan, Aortic Coarctation, Collateral Vascularization, Collaterals.

Introduction

Aortic Coarctation (AC) is a congenital obstructive anomaly of the aortic lumen (M:F=5:1). There are two different AC: juvenile (JT) and adult type (AT).

In JT the stenosis typically involves the aortic isthmus, from the origin of the left subclavian artery to the insertion of the ductus. It is associated with other heart anomalies: ventricular septal defect, bicuspid aortic valve, stenosis of the left subclavian artery, aberrant right subclavian artery, and aneurysms of the ascending aorta, intercostal arteries, and circle of Willis. The prognosis is very poor.

The AT has a better prognosis than the JT. The aortic isthmus (between the left subclavian artery and the ductus, usually below its insertion) is the vascular segment most commonly involved. For this reason AT is also called post-ductal coartaction and it is not associated with significant heart anomalies and/or cyanosis (1).

The stenosis of the descending aorta is about 95%, and 50% of the blood flow arises from the post-stenotic aorta (2) throughout the collateral pathways anastomizing pre-coartaction circle with post-coartaction circle.

There are three main collateral systems:

1. subclavian arteries - internal mammary arteries - epigastric arteries;
2. subclavian arteries - scapular arteries - intercostal arteries;
3. subclavian arteries-superior intercostal arteries - intrathoracic intercostal arteries.

Echocardiography and conventional angiography represent the imaging modalities commonly used in patients with suspected or known AC. Clinical investigations, including measurement of the systolic blood pressure gradient between the upper and lower extremity, chest radiography, and color-Doppler echocardiography may not provide accurate information of stenosis or aneurysm of the thoracic aorta (3, 4).

In the recent years several non-invasive modalities were introduced for the angiographic assessment of large and small vessels (i.e. Magnetic Resonance Imaging - MRI and Computed Tomography - CT).

The latest developments of CT (i.e. Multislice CT – MSCT) in the field of coronary imaging has attracted the interest of cardiovascular communities under several different perspectives (5).

The increased potential of MSCT has improved the performance of this technology also in large vessel imaging especially when applied to larger scan ranges, for instance a complete thoraco-abdominal CT angiography.

Case Report

A 52 year old woman was referred to our Istitution for asthenia and pain at the lower extremities for three months. Physical examination revealed asymmetric peripheral pulse. Upper extremities and lower extremities blood pressure were 180/95 mm Hg and 90/60 mm Hg, respectively. Echocardiography showed the dilatation of aortic root and the hypertrophy of left ventricle walls and septum. Furthermore, it is showed dilatation of aortic arch and right subclavian arteries. An AC was strongly suspected.

A 40-channel MSCT angiography (Brilliance 40, Philips Medical Systems, Cleveland, Ohio) using an ECG-gated retrospective technique was performed to assess the grade and morphology of AC and eventually to plan the endovascular treatment. The scan parameters were: collimation 40x0.625 mm, rotation time 420 msec, pitch 0.4, Kv 120, mAs 500, table speed 23.8 mm/sec, scan length 640,8 mm, and scan time 28,39 sec. The heart rate registered during the MSCT angiography scan was 75 beats/minute. An automated injector (Stellant, MedRAD, Pittsburgh, USA) was used to administer 130 ml of iodinated contrast material (iomeprol, Iomeron 400, Bracco, Milan, Italy) through a 18 Gauge catheter placed in a superficial vein of the right arm at a flow rate of 4 ml/sec with bolus tracking technique (Triggering threshold: +90 HU). The MSCT angiography allowed the assessment of coronary trees and demonstrated the morphology of the high grade aortic coarctation and the extensive collateral circulation (Fig. 1-5).

The best therapeutic approach was established on the basis of MSCT findings and the patient was treated surgically.

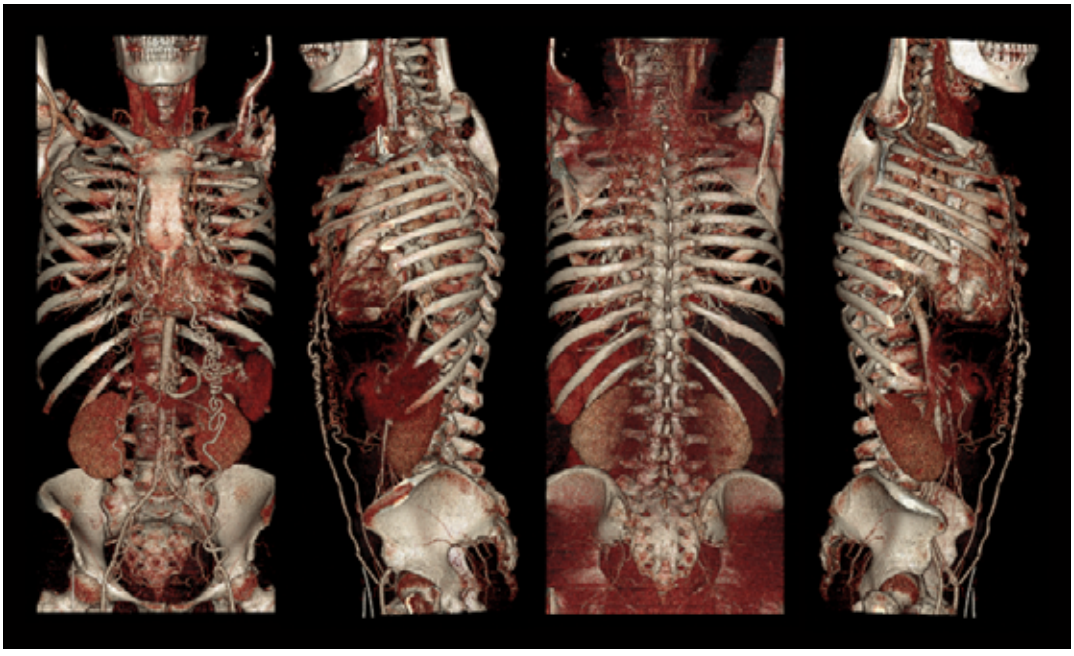

Figure 1. Frontal, left lateral, posterior, and right lateral Volume Rendering images show enlarged intercostals arteries, descending scapular arteries, internal mammary arteries, and abdominal epigastric arteries. The descending thoracic is characterized by a small diameter, as well the abdominal aorta.

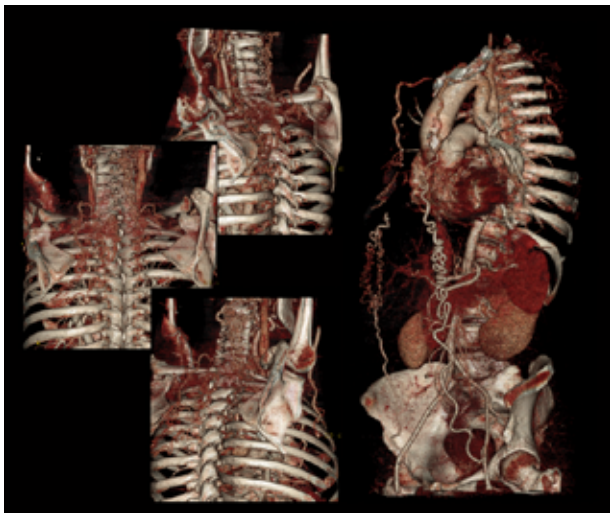

Figure 2. Posterior-right Volume Rendering images clearly display enlarged thoracoacromial and descending scapular arteries, and a dilatation of the internal carotid artery. After thoracic cage removal, an aortic post-ductal coarctation at the aortic isthmus below the left subclavian artery is observed. A dilatation of the ascending aorta is associated. The enlarged internal mammary arteries arise from the subclavian arteries and connect both with the external iliac arteries via the superior and inferior abdominal epigastric arteries. The thoracoacromial and descending scapular arteries arise from the subclavian arteries and supply the post-stenotic descending thoracic aorta with retrograde flow via the intercostal arteries.

Figure 3. Volume Rendering images show aortic narrowing below the left subclavian artery. Elongation and dilatation of the left subclavian artery are visible. The obstruction of blood flow through the aortic arch provokes the development of collateral vessels to supply blood to the tissues below the obstruction (e.g. internal mammary arteries and intercostals arteries).

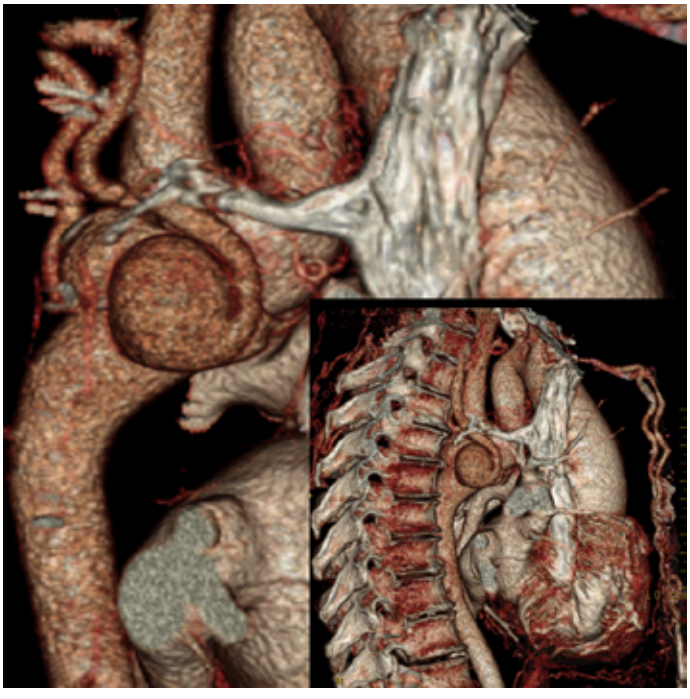

Figure 4. Aneurysms of an intercostal posterior artery which supplies the descending aorta. A collateral pathway connect the subclavian artery with the post-coarctation descending thoracic aorta via the vertebral artery, the anterior spinal artery, and the intercostal arteries.

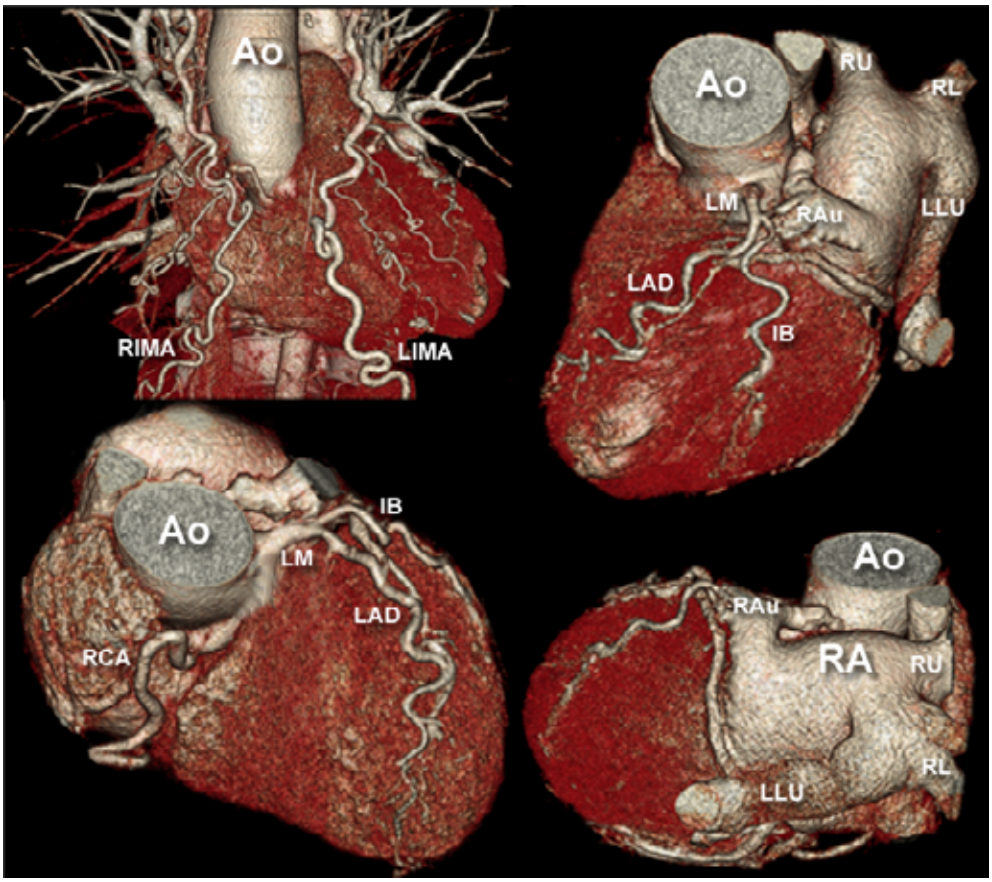

Figure 5. Volume Rendering images in different views displaying the coronary trees, tortuous and ectasic RIMA and LIMA, and the anomalous of pulmonary veins.

Discussion

Treatment of aortic coarctation with balloon angioplasty or surgery is usually performed on the basis of typical clinical and echocardiographic findings without reliance on further non-invasive imaging techniques.

Volumetric approach by using MSCT scanner allows to detect the presence of a suspected aortic diseases and aortic coarctation. MSCT imaging reconstructions (Maximum Intensity Projection, Multiplanar Reconstruction, and Volume Rendering Images) detect both the stenosis and the collateral pathways in few seconds. Three-dimensional reconstruction approaches allow to produce images adequate for diagnosis and treatment without the use of conventional catheter angiography. Using cardiac ECG-gating acquisition protocol, it is possible to assess coronary artery tree and visualize patent ductus, or small cardiac malformations with a good diagnostic accuracy within the same scan protocol (6, 7).

MSCT is an optimal non-invasive angiographic tools for surgery follow-up and for the selection of patients to send to conventional coronary angiography evaluation, and/or, eventually, other surgical treatments (8).

MSCT angiography can be considered as an optimal non-invasive technique for the assessment of aortic coarctation, collateral pathways, and cardiac abnormalities (7). Moreover, this new non-invasive imaging allows to perform a careful follow-up in patients surgically treated and detect the presence

of complications (8). A concern remains regarding the X-ray dose required. Further developments are expected to improve this aspect as well.

Abbreviations: Ao: Ascending Aorta; RIMA: Right Internal Mammary Artery; LIMA: Left Internal Mammary Artery; LM: Left Main; LAD: Left Anterior Descending Coronary Artery; RCA: Right Coronary Artery; IB: Intermediate Branch; RAu: Right Auricola; RU: Right Upper Vein; RL: Right Lower Vein; LLU: Left Lower and Upper Veins.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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