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Anomalous origin of right coronary artery: Magnetic resonance angiography and viability study ☆

Sophie Mavrogeni [a,*], Kostas Spargias [a] Stefanos Karagiannis [a], Panagiotis Kariofilis [a], Dimosthenis D. Cokkinos [b], Marouso Douskou [c], Dennis V. Cokkinos [a]

[a] *Onassis Cardiac Surgery Center, Athens, Greece*
[b] *Hippokration Hospital, Athens, Greece*
[c] *Bioiatriki MRI Unit, Athens, Greece*

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Abstract

Objective: To detect origin and course and to evaluate viability in patients with anomalous RCA.
Design: 3D coronary MR angiography and viability study using gadolinium-enhanced magnetic resonance imaging (Gd-MRI) was performed.
Setting: A tertiary hospital center.
Patients: Four patients, selected from the catheter lab, were studied.
Results: Anomalous RCA from the left sinus of Valsalva was identified in all patients. Inferior myocardial infarction was documented in three patients.
Conclusions: Magnetic resonance imaging can non-invasively identify anomalous RCA and perform viability study in the same examination.

Keywords: Anomalous RCA; Coronary MRA; Viability

1. Introduction

An uncommon but important cause of sudden death is the anomalous origin of the coronary arteries [1,2]. The incidence is between 0.3–1.0% of the population [3–6]. This may be underestimated, as many asymptomatic individuals remain unrecognized. Approximately 60% of coronary artery anomalies involve an isolated circumflex artery, and the remaining 40% involve the right and left coronary arteries [7,8]. In 0.03–0.17% of patients undergoing angiography, the right coronary arises from the left sinus of Valsava as a separate vessel or as a branch of a single coronary artery [9–11]. In a large number of patients the vessel coursed immediately anteriorly between the aortic root and the right ventricular outflow tract (RVOT) to enter the right atrioventricular groove. This variant can be associated with sudden cardiac death in up to 30% of patients [12].

The precise knowledge of origin and course is essential for patient treatment. The initial diagnostic approach is usually conventional coronary angiography. However, even with multiple projections, the identification of the proximal course of the vessel can be problematic [13–18].

Although other noninvasive imaging techniques (transesophageal echocardiography and computed tomography) have been successfully used, coronary magnetic resonance angiography (MRA) has been proposed as a valuable noninvasive tool for investigation of patients suspected of having anomalous coronary arteries [19–25]. There are many studies using either 2D or 3D MRA to determine

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* Corresponding author. 50 Esperou Street, 175-61 P.Faliro, Athens, Greece. Tel./fax: +30 210 98 82 797.
E-mail address: soma@aias.gr (S. Mavrogeni).

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anomalous coronary arteries [26–30]. Recently, applying inversion recovery sequences, magnetic resonance imaging has the potential to perform scar detection, using delayed images after gadolinium injection [31–33]. This approach, in combination with coronary MRA, can give an integrated imaging of these patients.

The purpose of our study was to detect coronary artery origin and course in a group of patients with anomalous RCA using 3D coronary MR angiography and at the same time to evaluate viability using gadolinium enhanced magnetic resonance imaging (Gd-MRI).

2. Materials and methods

2.1. Study population

Between 2000 and 2005, 4 patients (2 men and 2 women, aged 40–45 years) with anomalous origin of RCA were examined by MRI for assessment of the origin and proximal course of RCA. In all of them, conventional coronary angiography, because of unstable angina or history of recent myocardial infarction, was performed. Patients were free of risk factors for coronary artery disease.

All underwent RCA angioplasty with stent implantation. No patient had contraindications to MR imaging. The study was approved by local hospital ethics committee and informed written consent was obtained from all patients.

A more detailed clinical history is following.

Patient 1 She was admitted because she had an acute inferior myocardial infarction 4 days ago. She was thrombolysed and she had recurrent angina. Maximum CPK was 340 mlU/ml and CK-MB 50 mlU/ml. She was catheterized immediately and angioplasty with stent implantation was performed in a 95% lesion of the anomalous RCA coming from left sinus of Valsalva.

Patient 2 He had a history of inferior myocardial infarction with maximum CPK 268 mlU/ml and CPK -MB 38 mlU/ml. He was catheterized a week after the infarction due to chest pain. An anomalous RCA coming from the left sinus of Valsalva was identified and an angioplasty with stent implantation was performed in a 90% obstructive lesion of RCA.

Patient 3 She was admitted due to unstable angina. She had negative cardiac enzymes. A 90% lesion in an anomalous RCA coming from the left sinus of Valsalva was identified and an angioplasty with stent implantation was performed.

Patient 4 Urgent admittance due to unsuccessfully thrombolysed acute inferior myocardial infarction and infarction of right ventricle. Maximum CPK was 718 mlU/ml and CPK-MB 50 mlU/ml. He was catheterized immediately and an anomalous RCA coming from the left sinus of Valsalva with a 99% obstructive lesion was identified. An acute angioplasty with stent implantation was performed.

All patients had an uneventful recovery and they were discharged with clopidogrel, ACE inhibitors, nitrates and b-blocker. They remained asymptomatic during the follow-up until now.

2.2. Imaging methods

2.2.1. Magnetic resonance angiography

Coronary MRA was performed using a 1.5 T Philips Intera CV MR scanner (Philips Medical Systems, Best, The Netherlands). A commercial, five-element, cardiac phased array receiver coil was used for signal acquisition. All patients were examined with four ECG electrodes on the anterior left hemithorax and during free breathing. To compensate for respiratory motion artifacts, a prospective 2D real time navigator beam was properly placed on the patients' right hemidiaphragm for slice tracking and end-expiratory gating. The R wave of the ECG was used as a trigger for data acquisition and all images were acquired in mid-diastole [34].

Two different imaging sequences were used to obtain images with "white blood" and "black blood" contrast of the coronaries. The "white blood" sequence used was a 3D, segmented k-space, gradient-echo sequence (TE=2.1 ms, TR=7.5 ms, flip angle=30°, reconstructed slice thickness=1.5 mm, in-plane image resolution=0.7 mm × 1.0 mm) employing a T2-weighted preparation pre-pulse and a frequency selective fat-saturation pre-pulse. For the left coronary artery system, a transverse volume was scanned centered on the origin of the left main coronary artery. Using this plane, both right and left coronary arteries were identified coming from the left sinus of Valsalva. The "black blood" sequence used was a M2D, dual Inversion Recovery (IR) Turbo Spin Echo sequence (TE=28 ms, echo train length=25, TR=2 cardiac cycles, slice thickness=3 mm, slice overlap=1.5 mm, in-plane image resolution=0.7 mm × 1.0 mm), with a linear *k*-space acquisition scheme [35]. One set of overlapping 2D sections was acquired for both the right coronary artery and one the left coronary system. Anatomical positioning for each set was identical to that of the corresponding volume scanned with the "white blood" sequence. This was ensured through a system software parameter, which enables locking of the geometrical parameters (angulations and offsets) of a sequence to the values used in the last executed sequence. Therefore, the "white blood" sequence for the right coronary artery was first run, followed by the corresponding "black blood" sequence. The "white blood" volume for the left coronary system was then scanned and the same volume was finally acquired with the "black blood" sequence.

Source images obtained with the two sequences were used to derive multi-planar reconstructions (MPR) along the