

A Case of R-II-B Type Single Coronary Artery Evaluated by Multi-Detector Computed Tomography and Coronary Angiography

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Abstract

Multi-Detector Computed Tomography (MDCT) has been used to detect coronary lesions in a number of earlier studies. Here, we describe a rare case of congenital anomaly of the coronary artery, i.e., the R-II-B subtype (Lipton classification) of single coronary artery (SCA). A 61 year old man with angina was referred to our hospital. Assessment by coronary angiography (CAG) suggested SCA. The R-II-B subtype was confirmed by MDCT. Coronary artery bypass grafting (CABG) was then performed, and success of the grafting was evaluated by post-CABG MDCT.

This subtype of SCA has been reported to be associated with high risk of cardiac sudden death because the aberrant vessel, which passes between the aorta and the main pulmonary artery, is readily compressed by these arteries. This subtype of SCA is also very rare: there is only one previously reported case in which MDCT was used for diagnosis. Ours is the first case of this subtype in which MDCT together with CAG was used for evaluation both pre- and post-CABG. Our results show that MDCT may be useful not only prior to CABG for risk stratification in patients with anomalous coronary arteries but also after CABG for evaluation.

Keywords: Congenital heart disease; Single coronary artery; Ischemic heart disease; Multi-detector computed tomography; Coronary angiography

Introduction

Isolated Single Coronary Artery (SCA) is a rare congenital coronary anomaly. The incidence of SCA is only 0.014% in the general population undergoing diagnostic cardiac catheterization [1]. Most of these anomalous vessels are not clinically important. It has been recognized for more than three decades, however, that some patients are at high risk for sudden cardiac death: namely, those in whom the aberrant vessel passes between the aorta and the main pulmonary artery, because an aberrant vessel of this type is readily compressed by the surrounding large arteries. The risk is even greater when the vessel supplies the area of the left coronary artery distribution [2]. In such cases, coronary artery anomalies are potentially life-threatening.

Recently, the use of MDCT for the detection of coronary anomalies is becoming more common [3,4]. This case report demonstrates the role that MDCT can play not only in detection but also in risk assessment of rare coronary anomalies both before and after surgical treatment.

Case

A 61-year-old man with a history of dyspnea and chest discomfort on exertion was referred to our hospital because of abnormal Electrocardiogram (ECG). He had no history of syncope or arrhythmia in adolescence but had begun experiencing shortness of breath on exertion approximately three years before presentation. His ECG showed a negative T wave in leads II, III, aVF, and V6. He was also dyslipidemic and hypertensive with a family history of coronary artery disease. His echocardiogram showed akinetic inferior left ventricular wall with an ejection fraction of 51%, suggesting a previous myocardial infarction. No congenital cardiac abnormality was detected by echocardiogram.

Coronary Angiography (CAG) was then performed to evaluate coronary artery stenosis using the Judkins technique in standard projections. This revealed a single coronary artery originating from the right sinus of Valsalva (Figure 1). The left main coronary artery was bifurcated from the right coronary artery. No other coronary artery was detected by means of aortography. We also found that the left anterior descending artery had 90% stenosis and that the left circumflex artery was hypoplastic.

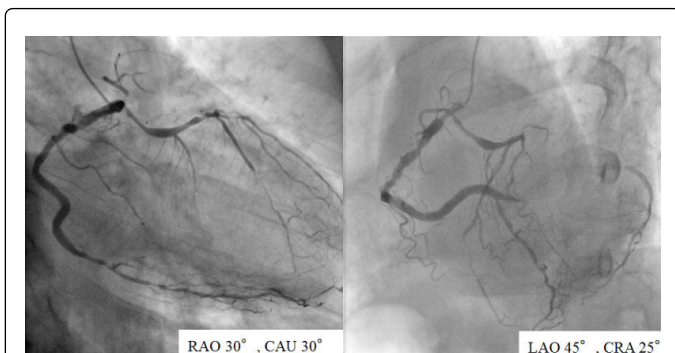


Figure 1: Conventional coronary angiography demonstrates that the single coronary artery originates from the right sinus of Valsalva. RAO view (a), LAO view (b). LAO: Left Anterior Oblique; RAO: Right Anterior Oblique.

In addition, the right coronary artery had diffuse stenosis, including a lesion proximal to the bifurcation to the Left Coronary Artery (LCA).

We then performed MDCT in order to understand the exact anatomical course of the anomalous branch as well as to determine the origin and course of the LCA for the purpose of risk assessment. MDCT was performed using a prospective gating axial scan protocol on a 320-MDCT scanner [TSX-301A/2A (Aquilion ONE); Toshiba Medical Systems Corporation].

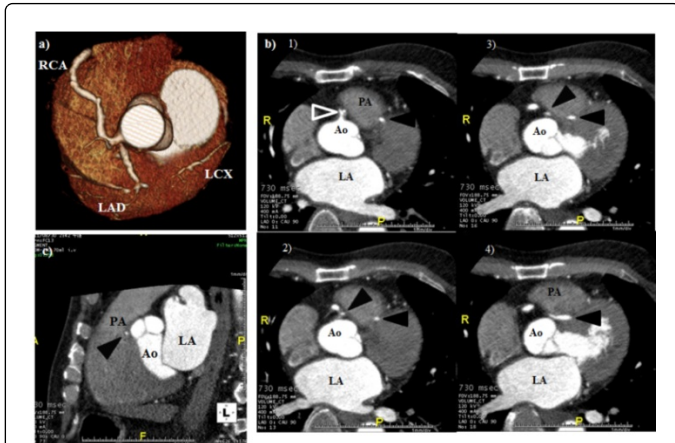


Figure 2: Multidetector computed tomography image shows that the single coronary artery originates from the right sinus of Valsalva. Volume rendering image (a), Transverse CT scan (b), Sagittal CT scan (c). The left main coronary artery (black arrow) originating from the RCA (white arrow) was coursed between the aorta and the pulmonary trunk. RCA, right coronary artery; LAD, left anterior descending coronary artery; LCX: Left Circumflex Coronary Artery; PA: Pulmonary Artery; Ao: Aorta; LA: Left Atrium.

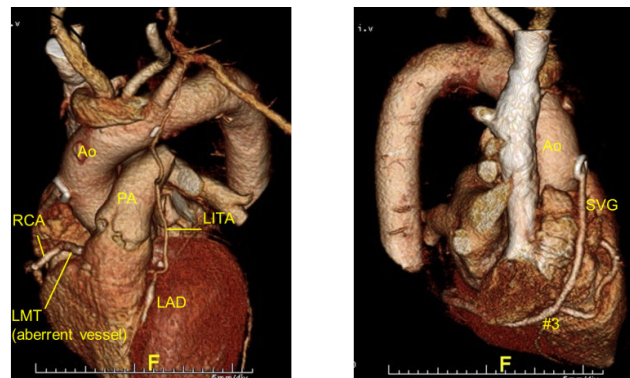


Figure 3: Multidetector computed tomography image shows successful grafting after CABG. Grafting is from left internal thoracic artery (LITA) to left anterior descending artery (LAD) (a), and from saphenous vein graft (SVG) to right coronary artery segment 3 and segment 4 atrioventricular branch (AV) (b). Images show that both LITA and saphenous vein graft have good patency.

The following scan protocol was used for MDCT angiography: 120 kV tube voltage, 400 mA tube current, and 350 ms gantry rotation time. For the CT scan, 70 mL of contrast agent (Iohexol 350) was injected through an intravenous catheter at a rate of 4.9 ml/sec. The injection was followed immediately by a 20 mL saline flush and the bolus tracking procedure was performed. An effective dose of 6.9 mSv was calculated using $0.014 \times \text{DLP}$ (dose-length product). Images were reconstructed with a slice thickness of 0.75 mm and 0.25 mm increment using iterative reconstruction. Volume rendering images were obtained using Aquarius iNtuition viewer (Terarecon, CA, USA).

We then confirmed that the left coronary ostium was absent. The left main coronary artery, originating from the RCA, was coursed between the aorta and the pulmonary trunk to the anterior myocardial wall, indicating that this was the R-II-B subtype according to the Lipton classification of angiographic types of SCA (Figure 2).

After these tests were completed, the patient underwent CABG in which the left internal thoracic artery was grafted to the left anterior descending artery and the saphenous vein was grafted to the right coronary artery segment 3 and segment 4 atrioventricular branch. After CABG, MDCT was performed again, enabling us to evaluate the graft patency and assess the relationship of the anomalous branch to the grafted vessels without risking the major complications that are associated with CAG. We were able to confirm easily that the graft patency and orientation were acceptable, and that the bypass distal to the aberrant vessel had been successful (Figure 3).

Discussion

Lipton et al. classified SCA into types according to ostial location, anatomical distribution, and the course of the transverse branch [5]. Ostial location is designated as 'R' or 'L' when the ostium is in the right (R) or left (L) sinus of Valsalva, respectively. The anatomical distribution is designated as Group I, II, or III. Group I has the right or left coronary arteries in their normal courses, with the distal part of each connected to the other. In Group II, anomalies arise beginning in the proximal part of the normal right or left coronary artery, and cross the base of the heart before assuming the normal position of the

inherent coronary artery. Group II is further divided into three subgroups (A, B, and P), according to the relationship between the anomalous coronary artery and the aorta and pulmonary artery. The letters 'A', 'B' and 'P' refer to 'anterior', 'between' and 'posterior' positioning, respectively. Any SCA case that does not belong to Group I or II is designated as Group III.

The present case was thus classified as the R-II-B subtype of SCA. This is a very rare anomaly, with a reported incidence of approximately 0.004% [3,4]. The risk of sudden cardiac arrest is greater in this subtype than in others because the proximal segment of the anomalous coronary artery courses between the aorta and the pulmonary artery, so that compression of the anomalous coronary artery between the aorta and pulmonary trunk can occur, especially during exercise [6]. It has also been reported that sudden cardiac death may occur with SCA because of severe atherosclerosis of the coronary artery. The acute angle of take-off and the presence of only one ostium providing for the whole heart may induce an abnormally high coronary flow rate, causing severe atherosclerotic coronary artery disease through endothelial injury [7].

Diagnosis of SCA has been made using conventional CAG as well as Multi-Detector Computed Tomography (MDCT) and Coronary Magnetic Resonance Angiography (CMRA). Canbay et al. have reported three cases of SCA (types L-I, R-I and R-II-B) that were diagnosed using CAG [8]. Ichikawa et al. reported that MDCT revealed anomalous origin of the RCA in 15 of 3,212 patients [3]. More recently, another report has described several types of SCA, including one case of the R-II-B subtype, as assessed by means of MDCT [9]. Unfortunately, however, in that study no CAG or MDCT was performed after CABG for evaluation [9]. As far as we know, therefore, ours is the first report of an R-II-B subtype SCA assessed using MDCT imaging along with CAG both before and after CABG. We used these imaging techniques prior to CABG to determine the exact anatomical course of the anomalous branch as well as the origin and course of the LCA for the purpose of risk assessment, and after CABG to evaluate the relationship of the anomalous branch with the grafted vessels.

Prior to recent technical advances in MDCT and CMRA, it was very difficult to obtain an exact anatomical assessment of an SCA. The advantage of CMRA over MDCT is that CMRA does not use ionizing radiation or injection of a contrast agent to image the coronary arteries. MDCT, in contrast, requires radiation doses that are associated with cancer in adults and particularly in children. Yet MDCT is much more effective than CMRA for visualizing coronary calcifications; it also has higher sensitivity and specificity for coronary stenosis. Furthermore, CMRA is performed only in certain hospitals because it requires a long procedural time and its performance remains technically more challenging than that of MDCT.

As demonstrated in the current study, MDCT may be useful for estimating the risk of coronary event in patients with SCA. MDCT also allowed us to identify the precise course of this SCA case, specifically, to determine that it passed between the ascending aorta and the pulmonary artery. Detailed evaluation of the relationship between SCA and the other structures of the heart and measurement of coronary plaque volume can also be achieved using MDCT. Thus, when SCA is diagnosed by routine CAG, as it was in this case, MDCT is strongly recommended as a means of risk stratification and an aid in developing a therapeutic strategy for coronary artery disease.

Conclusion

We treated a case of the rare SCA subtype R-II-B as determined using MDCT. MDCT may be useful not only for diagnostic purposes but also for risk stratification as well as post-CABG evaluation.

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