

Updating

CORONARY ANATOMY WITH MULTIDETECTOR COMPUTED TOMOGRAPHY ANGIOGRAPHY*

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Abstract

Multidetector computed tomography has been progressively used for evaluation of coronary artery disease, so the knowledge about the anatomy of coronary arteries and veins is of fundamental importance.

Keywords: Coronary artery; Anatomy; Angiography; Multidetector computed tomography.

INTRODUCTION

The techniques for coronary calcium detection and scoring, and the coronary angiography by computed tomography have been increasingly used⁽¹⁻⁴⁾. An adequate evaluation requires knowledge of arterial and venous coronary anatomy (Figures 1 and 2).

MATERIALS AND METHODS

Coronary multidetector computed tomography (MDCT) images were acquired by means of a 16 detector-row Mx 8000 IDT (Philips; Holland) device. Angiographic images were acquired

during apnea and synchronized with electrocardiogram (ECG), with retrospective reconstruction at 10% of the RR interval. Technical parameters are shown in Table 1.

Cardiac axis

Coronary artery images are acquired in half axial projection. The heart is studied in its oblique plane since the cardiac axis is not perpendicular to the MDCT device gantry (Figure 3). With this configuration, the ostia of the left coronary trunk (TCE) and right coronary artery (ACD) are localized at the same distance from the aortic valve when measured along the axis of the ascending aorta. However, on MDCT, these vessels typically are seen at different levels (Figures 4A and 4B).

Coronary arterial circulation

Left coronary trunk – The left coronary trunk originates in the left aortic sinus (Figure 5) and passes behind the pulmonary trunk. Normally, it has a horizontal course or a slightly caudocranial course, dividing into anterior descending artery (ADA) and circumflex artery (ACx) (Figures 6A and 6B). Occasionally, the left coronary trunk presents a trifurcation, originating the diagonal branch (ramus diagonalis) that extends laterally towards the anterior descending artery (Figures 7A and 7B).

Anterior descending artery and branches – The anterior descending artery initially passes behind the pulmonary trunk, after coursing between this vessel and the left atrial auricula to reach the interventricular sulcus. When arteries are evaluated from the cardiac basis towards its apex, the anterior descending artery usually is the first coronary artery to be identified, followed by the left coronary trunk.

The anterior descending artery originates the septal and diagonal branches. Diagonal branches are more easily identified by MDCT coronary angiography (Figures 8A and 8B).

Circumflex artery and branches – The circumflex artery, immediately after arising from the left coronary trunk division, courses posteriorly to pass under the left atrial auricula and reach the left atrioventricular sulcus (Figures 9A and 9B). A short segment of the circumflex artery is typically seen at the same level of the left coronary trunk division (Figure 7A).

The circumflex artery usually originates three marginal obtuse branches, the first of them being the greatest one. This branch is frequently identified at MDCT (Figure 7B).

Right coronary artery and branches – The right coronary artery (ACD) originates from the right coronary sinus (Figure 10A). It initially passes between the exit passage of the right ventricle and the right auricula and continues through the right atrioventricular sulcus (Figure

10B). The initial portion of the right coronary artery (15–25 mm) follows in a horizontal course, therefore is usually identified in longitudinal slices (Figure 10A). The final portion of the proximal segment and the whole middle portion of the right coronary artery are transversally sliced during its course through the right atrioventricular sulcus (Figure 10B). The distal portion of the right coronary artery originates after the marginal branch emergence and passes horizontally along the heart diaphragmatic surface where it can be identified in longitudinal slices (Figure 11A).

Generally, the right coronary artery branches identified at MDCT are the conus branch, the anterior ventricular branch (Figure 10B), the marginal branch and the posterior descending artery (Figure 11A), that originates from the dominant RCA in 85% of individuals. Beside the middle cardiac vein (posterior interventricular vein), the posterior descending artery has an anterior course in the posterior interventricular sulcus (Figure 11A).

After originating the posterior descending artery, the dominant right coronary artery continues over the *crux cordis* (a point on the diaphragmatic cardiac surface where the left and right atrioventricular and posterior interventricular sulci come together) into the left atrioventricular sulcus where it ends, originating the posterior ventricular branch (Figure 11B). The conus, anterior ventricular and marginal branches present a limited therapeutic value in the atherosclerotic coronary disease.

Coronary venous circulation

The greater part of the venous blood is drained through the veins that follow the arteries. The cardiac veins end in the coronary sinus, a large vein that drains into the right atrium. The remaining blood of the coronary circulation is collected from the myocardium through small veins which drain directly into the four cardiac chambers.

Great cardiac vein (v. cordis magna) – It begins at the apex of the heart and ascends along the anterior interventricular sulcus, along the anterior descending artery. It then curves to the left in the atrioventricular sulcus (coronary) to course along the circumflex artery (Figure 6A). The great cardiac vein opens into the left extremity of and receives the oblique vein of left atrium.

Coronary sinus – The coronary sinus curves to the right into the atrioventricular sulcus and, generally is partially covered by muscular fibers from the left atrium. It ends in the posterior wall of the right atrium (Figure 11C) between the opening of the inferior vena cava and the atrioventricular aperture and receives the middle and small cardiac veins.

Middle cardiac vein and small cardiac vein (v. cordis parva) – The middle cardiac vein passes through the posterior interventricular sulcus (Figure 11A) and the small cardiac vein runs in the atrioventricular sulcus, along the right coronary artery.

Posterior vein of the left ventricle – The posterior vein of the left ventricle drains the lateral face of the left ventricle and enters into the coronary sinus immediately after its formation.

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ANATOMIA CORONÁRIA COM ANGIOGRAFIA

Tabela e Figuras

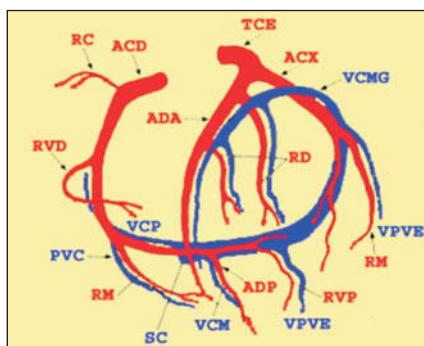


Figure 1. Coronary arteries and veins. Arterial system. The left coronary arterial tree consists of the left coronary trunk (TCE), anterior descending artery (ADA), circumflex artery (ACX), diagonal branches (RD) and marginal branches (RM). The right coronary arterial tree consists of the right coronary artery (RC), conus branch (RVD), marginal branch (RM), posterior descending artery (ADP) and posterior ventricular branch (RVP). Venous system. Consisting of coronary sinus (SC), great cardiac vein (v. cordis magna – VCMG), middle cardiac vein (v. cordis media – VCM), small cardiac vein (v. cordis parva – VCP), posterior veins of the left ventricle (VPVE) and small cardiac veins (PVC).

Table 1 Technical parameters applied in coronary angiography images acquisition.

Mx8000 IDT16 device			
Collimation	16 × 0.75	Amperage	500 mAs/slice
Slice thickness	0.8 mm	Filter	Cardiac
Increment	0.4 mm	Contrast	
Scan time	21 a 26 s	Volume	100 ml
Rotation time	0.42 s	Iodine concentration	350 mg/ml
Pitch	0.238 (média)	Injection speed	4 ml/s
Field-of-view	180 a 230 mm	Bolus tracking	
Matrix	512	Limit (threshold)	140 UH
Voltage	120 kV	Positioning	Ascending aorta

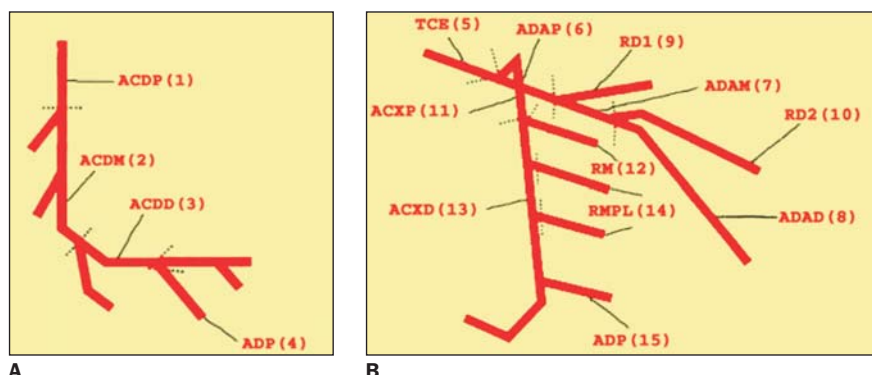


Figure 2. Coronary segments in compliance with the classification of the American Heart Association. Subdivision of arteries into 15 segments. Segments 1 to 4 correspond to the right coronary artery (proximal – ACDP, middle – ACDM, and distal – ACDD) and posterior descending artery – ADP; segment 5 corresponds to the left coronary trunk (TCE); segments 6 to 10 correspond to the anterior descending artery (proximal – ADAP, middle – ADAM, distal – ADAD; and first – RD1, and second – RD2 diagonal branches); segments 11 to 15 correspond to the circumflex artery (proximal – ACXP, distal – ACXD; and marginal – RM, and postero-lateral marginal – RMPL branches).

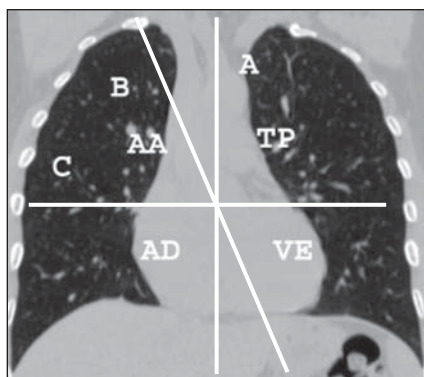


Figure 3. Heart positioning in the thoracic cavity. Coronal reconstruction showing body and cardiac axis. In the half-axial projection the body axis (A) is perpendicular to the tomograph gantry (C). The cardiac axis (B) in the thoracic cavity is obliquely oriented. Therefore, images acquired at MDCT are oblique slices of the heart. (AA, ascending aorta; TP, pulmonary trunk; VE, left ventricle; AD, right atrium).

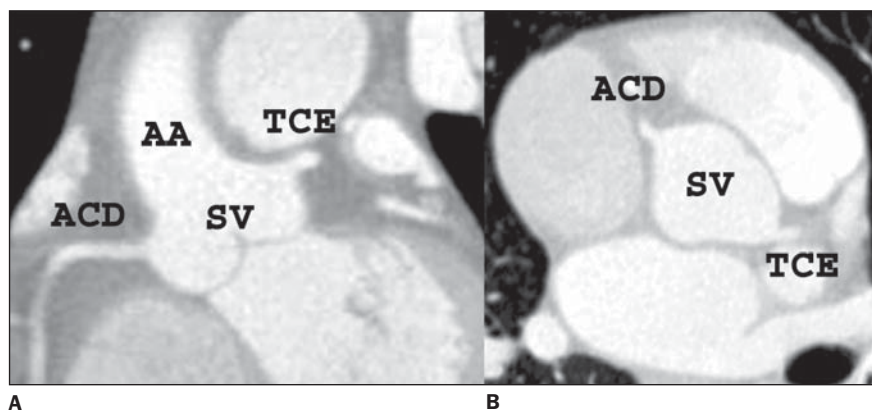


Figure 4. Reformatations in coronal (A) and oblique axial (B) orientations at the level of left coronary trunk (TCE) and right coronary artery (ACD) emergence, showing that right coronary artery is identified superiorly in relation to the left coronary trunk (coronal plane), considering the long body axis. (AA, ascending aorta; SV, Valsalva sinus).

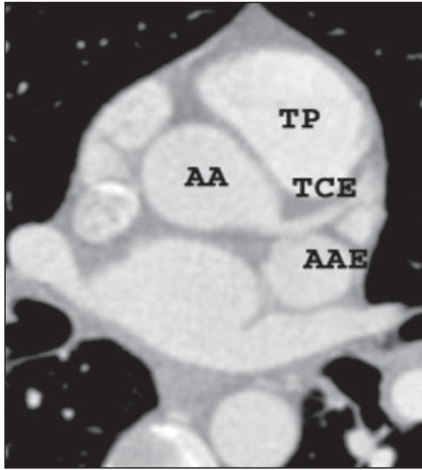


Figure 5. Axial and oblique reformations showing left coronary trunk arising from the aortic sinus, with a course between the pulmonary trunk anteriorly localized, and the left atrial auricle, posteriorly localized. (TP, pulmonary trunk; AAE, left atrial auricle).

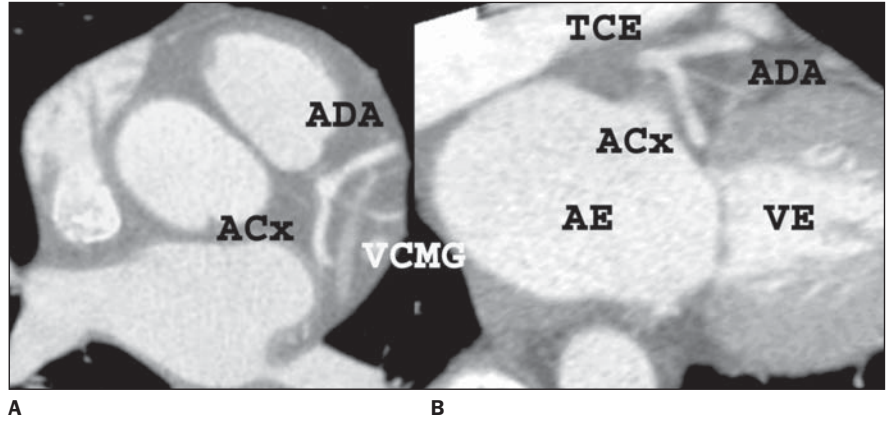


Figure 6. Axial and oblique reformations showing left coronary trunk (TCE) bifurcation into anterior descending artery (ADA) and circumflex artery (ACx). Note the course of the circumflex artery in the left atrioventricular sulcus. (VCMG, great cardiac vein; AE, left atrium; VE, left ventricle).

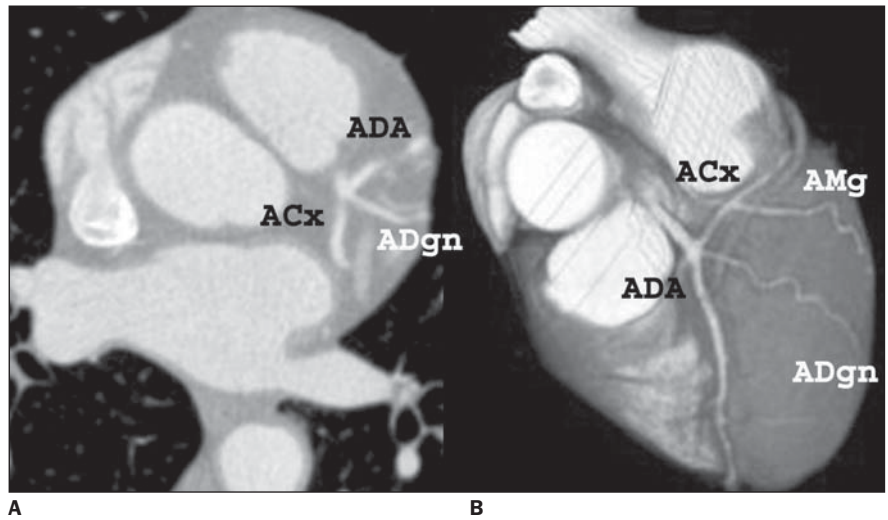


Figure 7. Axial and oblique (A) and 3D volume rendering (B) reformations demonstrating diagonal artery (ADgn) originating from the left coronary trunk (TCE) between anterior descending artery (ADA) and circumflex artery (ACx). (AMg, marginal artery).

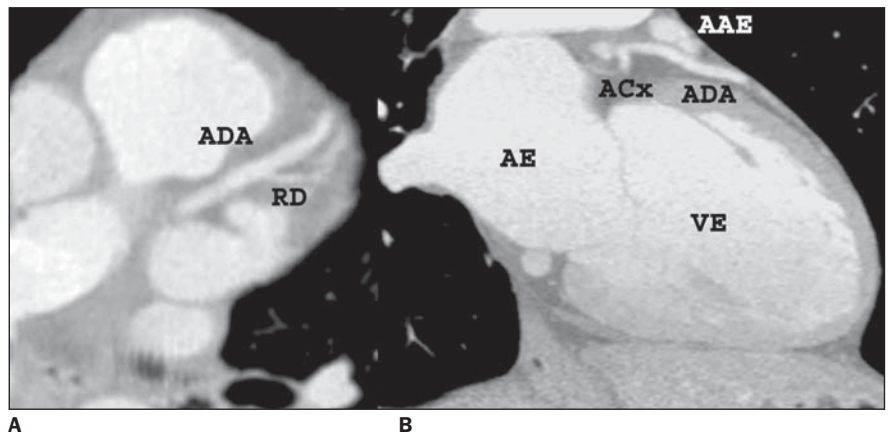


Figure 8. Oblique axial (A) and sagittal (B) reformations showing anterior descending artery (ADA) proximal and middle portions localized in the anterior interventricular sulcus. The first diagonal branch origin is observed. (RD, diagonal branch; AAE, left atrial auricle; VE, left ventricle; AE, left atrium).

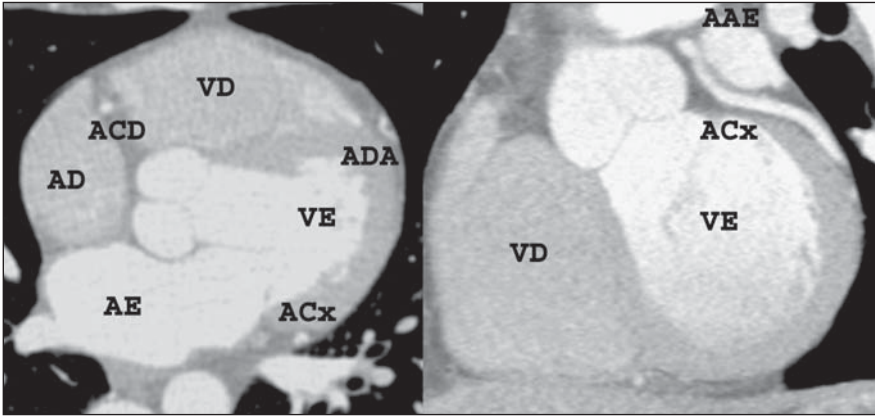


Figure 9. Axial slice (A) shows the circumflex artery (ACx) in the left atrioventricular sulcus, at the level of the first marginal branch origin, the anterior descending artery (ADA) in the anterior interventricular sulcus, at the level of the first diagonal branch origin, and the right coronary artery (ACD) in the right atrioventricular sulcus. Oblique coronal reformation (B) demonstrates the circumflex artery (ACx) in the left atrioventricular sulcus. (VE, left ventricle; VD, right ventricle; AD, right atrium; AAE, left atrial auricle).

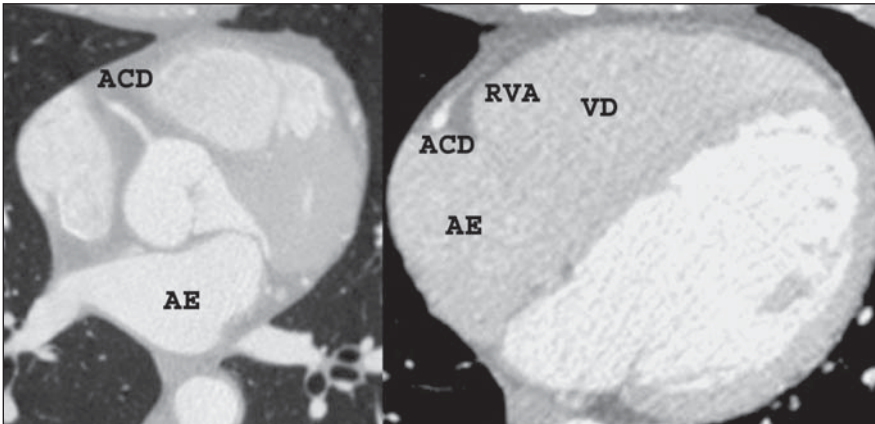


Figure 10. Axial slices showing the right coronary artery (ACD) arising from the right aortic sinus. The right coronary artery runs in the right atrioventricular sulcus and the anterior ventricular branch (RVA) origin is noted.

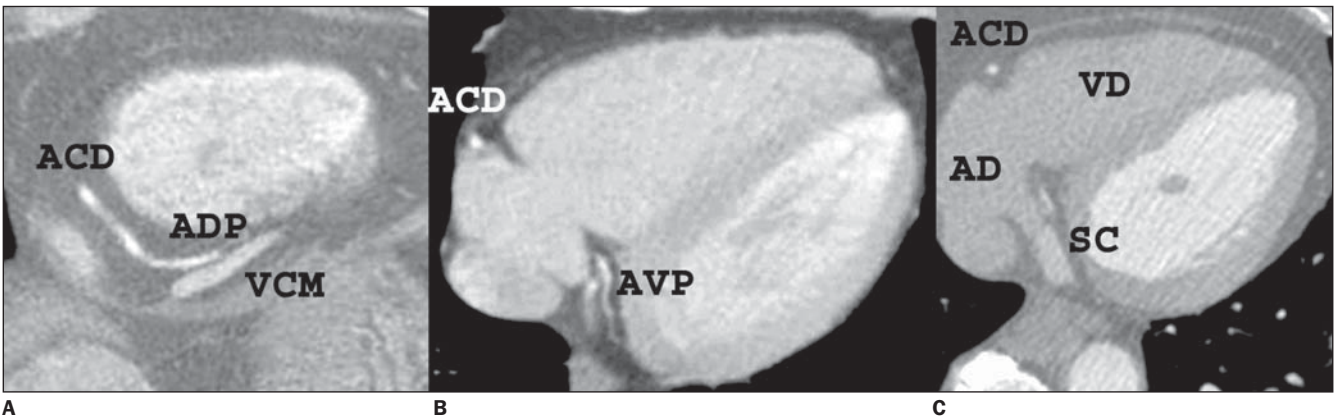


Figure 11. More inferior axial slices evidencing the distal portion of the right coronary artery (ACD) bifurcating into posterior descending and posterior ventricular arteries. (ADP, posterior descending artery; AVP, posterior ventricular artery; VCM, middle cardiac vein; SC, coronary sinus).