

# Anatomy of the left main coronary artery of particular relevance to ablation of left atrial and outflow tract arrhythmias



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**BACKGROUND** Left main coronary artery (LMCA) damage is a rare but catastrophic complication of cardiac ablation procedures.

**OBJECTIVE** The purpose of this study was to describe the anatomic relationships of the LMCA to its adjacent structures using analysis of computed tomographic coronary angiograms (CTCA).

**METHODS** We studied 100 patients (55 males, age  $51 \pm 10$  years) who were investigated for chest pain with CTCA. The relationships between the LMCA and adjacent structures were described by analysis of 2-dimensional images and 3-dimensional reconstructions.

**RESULTS** The LMCA coursed within 5 mm of the anterior left atrial endocardium and/or base of left atrial appendage in 49% (within 2 mm in 17%) and from the pulmonary artery in 90% (within 2 mm in 43%). The LMCA was within 5 mm of the right ventricular outflow tract in 1%. In 4% the LMCA coursed inferiorly, remaining within 5 mm of the left aortic sinus of Valsalva at a vertical distance  $> 5$  mm from the inferior margin of the LMCA ostium.

**CONCLUSION** The LMCA is often intimately related to the anterior left atrium, left atrial appendage base, and pulmonary artery and occasionally to the inferior part of the left aortic sinus of Valsalva and thus is exposed to the risk of injury during ablation in these areas. The LMCA is rarely close to the right ventricular outflow tract.

**KEYWORDS** Left main coronary artery; Anatomy; Radiofrequency ablation; Complications

**ABBREVIATIONS** **AF** = atrial fibrillation; **CA** = coronary artery; **CTCA** = computed tomographic coronary angiogram; **Cx** = circumflex coronary artery; **LA** = left atrium; **LAA** = left atrial appendage; **LAD** = left anterior descending coronary artery; **LASV** = left aortic sinus of Valsalva; **LMCA** = left main coronary artery; **PA** = pulmonary artery; **PSV** = pulmonary sinus of Valsalva; **RF** = radiofrequency; **RVOT** = right ventricular outflow tract; **STJ** = sinutubular junction; **VRR** = volume-rendered reconstruction.

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## Introduction

Injury to the left main coronary artery (LMCA) during catheter ablation of cardiac arrhythmias is a catastrophic complication that usually presents acutely as a life-threatening emergency.<sup>1–4</sup> Because tissue necrosis can occur within 5 mm of radiofrequency (RF) energy application,<sup>5</sup> an intimate knowledge of the anatomy of the LMCA is essential to optimize the safety of these procedures. However, there is a dearth of information regarding the relationship of the LMCA to the anterior left atrium (LA) and appendage (LAA), right ventricular outflow tract (RVOT) and pulmonary artery (PA), and inferior part of the left aortic sinus of Valsalva (LASV), structures that are commonly targeted during catheter ablation of atrial and ventricular arrhythmias. In this study, we characterize the anatomic relationship of the LMCA to these structures.

## Methods

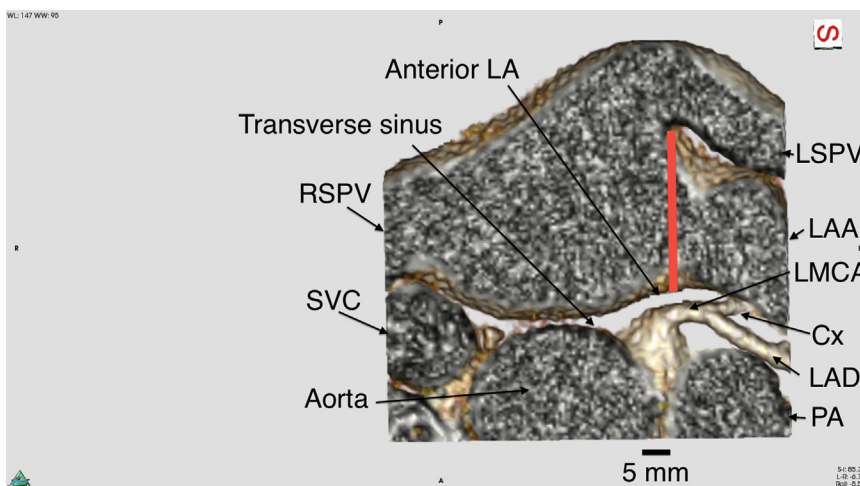
### Patients

We analyzed the computed tomographic coronary angiograms (CTCA) of 105 consecutive outpatients with suspected coronary artery (CA) disease. One patient with a CA anomaly was excluded, as were 4 others with suboptimal scan quality, leaving 100 patients who compose the study population.

### Image acquisition and reconstruction

Patients took metoprolol 50 mg PO 12 hours and 2 hours before CTCA using a 64-slice CT scanner (Discovery CT 750 HD, GE Healthcare, Waukesha WI) using prospective ECG gating with images acquired at 75% of the R-R interval during a single breath-hold with slice thickness of 0.625 mm from arch of aorta to below the inferior surface of heart. A bolus of up to 100 mL iohexol 350 was injected intravenously at 6 mL/s, followed by 26 mL saline flush after a timing bolus. Images were reconstructed and analyzed using an OsiriX open-source DICOM viewer (OsiriX, Pixmeo, Geneva, Switzerland).

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**Figure 1** Three-dimensional volume-rendered reconstruction viewed from the superior aspect showing the close relationship of the left main coronary artery (LMCA) to anterior left atrium (LA) and left atrial appendage (LAA) base, which are demarcated by the vertical red line. Cx = circumflex coronary artery; LAD = left anterior descending coronary artery; LSPV = left superior pulmonary vein; PA = pulmonary artery; RSPV = right superior pulmonary vein; SVC = superior vena cava.

**Definitions**

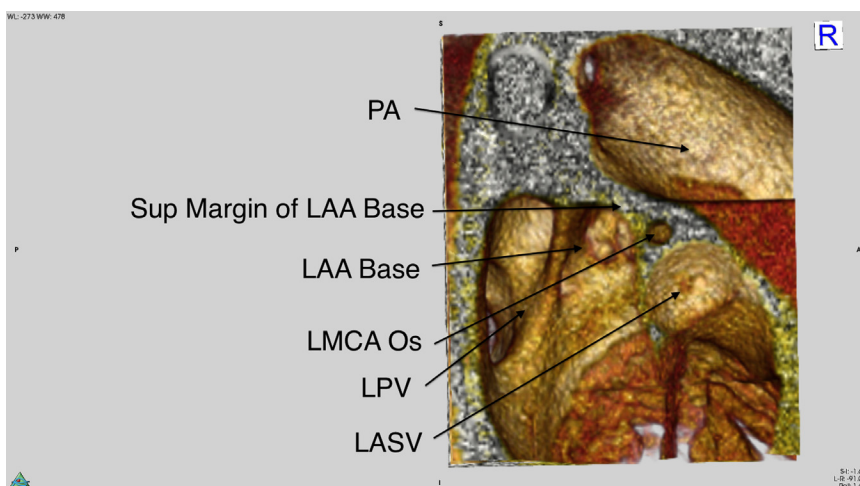
Structures were described according to their attitudinal position.<sup>6</sup> The junction of the RVOT and PA was defined as an imaginary line joining the nadir of the three PA sinuses (left, right, and posterior) of Valsalva (PSV) ([Online Supplemental Video 1](#)). The sinutubular junction (STJ) of the PA was defined as an imaginary line encircling the PA at the superior margin of the PSVs. The LAA base was defined as that part of the anterior LA lateral to an imaginary line extending anteriorly from the isthmus between the left superior pulmonary vein and LAA to the anterior LA wall ([Figure 1](#)). The tubular part of the LAA was defined as that part of the LAA containing pectinate muscle.

**Measurements**

Digital calipers were used to measure structures of interest in 2-dimensional orthogonal planes and in 3-dimensional

volume-rendered reconstructions (VRR). Care was taken to avoid foreshortening error resulting in underestimation of distances between structures measured in VRR. All 100 scans were examined, and those in which any portion of the LMCA was <5 mm from the LA and/or LAA base were identified because the LMCA in these patients would be within the radius of necrosis of an RF source in the LA or LAA base.<sup>5</sup> In these patients, VRRs were segmented to better demonstrate the relationship of the LMCA to the anterior LA and LAA base ([Figure 1](#)). The following measurements were obtained: minimum distance from any part of LMCA to endocardium of LA or LAA base; distance from LMCA ostium to nearest part of LA or LAA base; length of LMCA < 5 mm from LA or LAA base; and position of LMCA in relation to superior margin of LAA base ([Figure 2](#)).

Separate segmentations demonstrated the relationship between the LMCA and the RVOT and PA in all 100 patients ([Figure 3](#)). The following measurements were



**Figure 2** Endocardial surface of the left atrium viewed from the right showing the left main coronary artery (LMCA) ostium just inferior to the superior margin of the left atrial appendage (LAA) base. LASV = left aortic sinus of Valsalva; LPV = left pulmonary veins; PA = pulmonary artery.

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