# Introduction

**Coronary artery disease** is a leading cause of morbidity and mortality in the world. The ability to non invasively evaluate the coronary arteries has been limited by their small size and constant motion. ***(Donnino et al., 2009).***

Invasive coronary angiography, despite the associated risks, remains the gold standard for the diagnosis of obstructive coronary artery disease. ***(Miller et al., 2008).***

Over the years, advances in multi-detector computed tomographic (CT) technology resulted in a continuous quality improvement of non invasive CT coronary angiography. ***(Baumuller et al., 2009).***

Coronary CT angiography has been increasingly used in the diagnosis of coronary artery disease due to rapid technological developments, which are reflected in the improved spatial and temporal resolution of the images.***(Sun et al., 2012).***

Dual-source computed tomography (DSCT) represents one of the latest improvements in CT technology and is characterized by a doubling of the temporal resolution while maintaining the spatial resolution of the previous 64-section CT scanner. With dual-source CT, coronary arteries could be imaged in a diagnostic manner even in patients with higher heart rates, while providing a high accuracy. ***(Baumuller et al., 2009).***

DSCT has been designed primarily to increase the temporal resolution of the CT system. With the two tubes and two detectors mounted at orthogonal orientations in the gantry the transmission data required for the reconstruction of one image slab can be acquired in half the time needed by a conventional spiral CT system. The main purpose of this technological development is to make cardiac imaging, and especially coronary CT angiography, robust enough to obtain diagnostic images at any heart rate and to discard beta blocker utilization for CT coronary angiography from general clinical practice. ***(Johnson et al., 2006).***

In addition, DSCT offers the possibility for simultaneous data acquisition with different X-ray energies, which may permit improved tissue differentiation. One tube is operated at 80 kV tube voltage, while the other tube is operated at 140 kV. ***(Achenbach et al., 2008).***

The dose reduction compared to today's 64-slice CT scanners will help the technology gain further and broader acceptance for regular clinical use. The combined benefits of higher temporal resolution, faster volume coverage, and lower dose may prove useful in pediatric cardiac CT applications. Due to the high temporal resolution and the ability of dual-energy acquisition, new applications are coming within reach, such as the evaluation of regional cardiac function, myocardial perfusion, and blood volume as well as the differentiation and quantification of arterial plaques. ***(Ohnesorge, 2007).***

# Aim of the work

To evaluate the role of dual source CT coronary angiography as a non invasive imaging tool in assessment of coronary arterial tree in cases with coronary artery disease.

# Anatomy

The coronary arteries are conductive vessels running through the epicardial surface of the heart, embedded in adipose tissue, and showing short segments of mild penetration into the myocardial tissue. ***(Petracca, 2006)*.**

As indicated by its name (from the latin *corona*: wreath), coronary arteries are distributed over the heart as a crown-shape network, showing anastomotic communications between its different branches, particularly at the level of the base and the apex of the left ventricle. (Figures 1.1 & 1.2). ***(Petracca, 2006)*.**

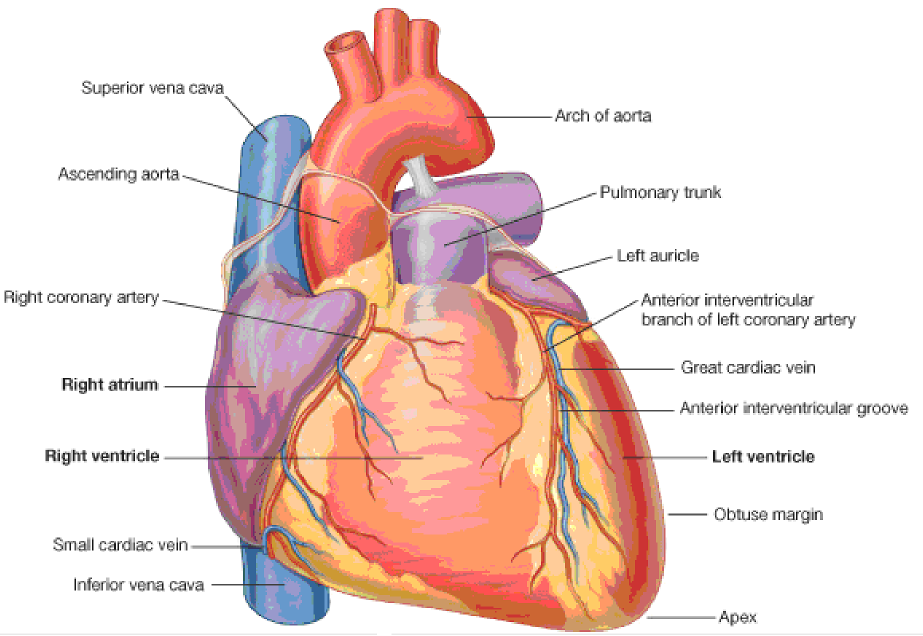


**Fig. (1.1).** Anterior Surface of The Heart. ***(Drake el al., 2007)***

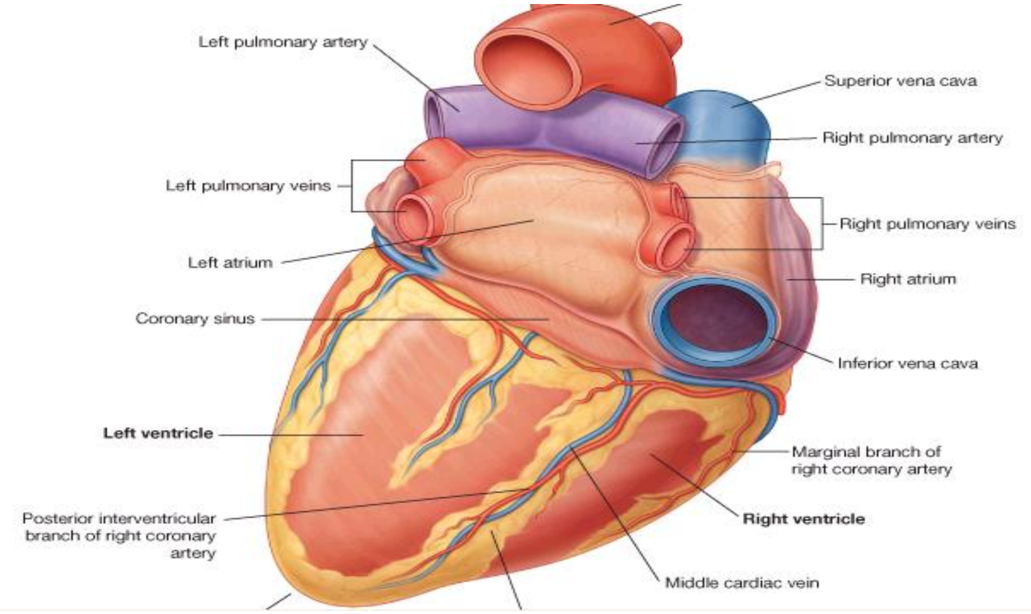


**Fig. (1.2).** Diaphragmatic Surface of The Heart. ***(Drake el al., 2007)***

In the normal situation, the coronary arteries arise from the proximal aorta. The right and left coronary arteries arise from the right and left sinus of Valsalva, respectively. The noncoronary sinus of Valsalva is usually the posterior one. (Figure 1.3). ***(Dewey and Kroft, 2009)*.**

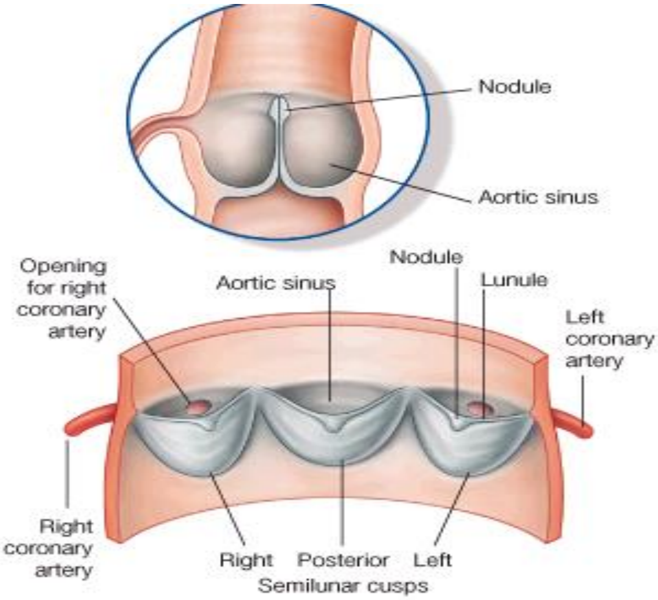


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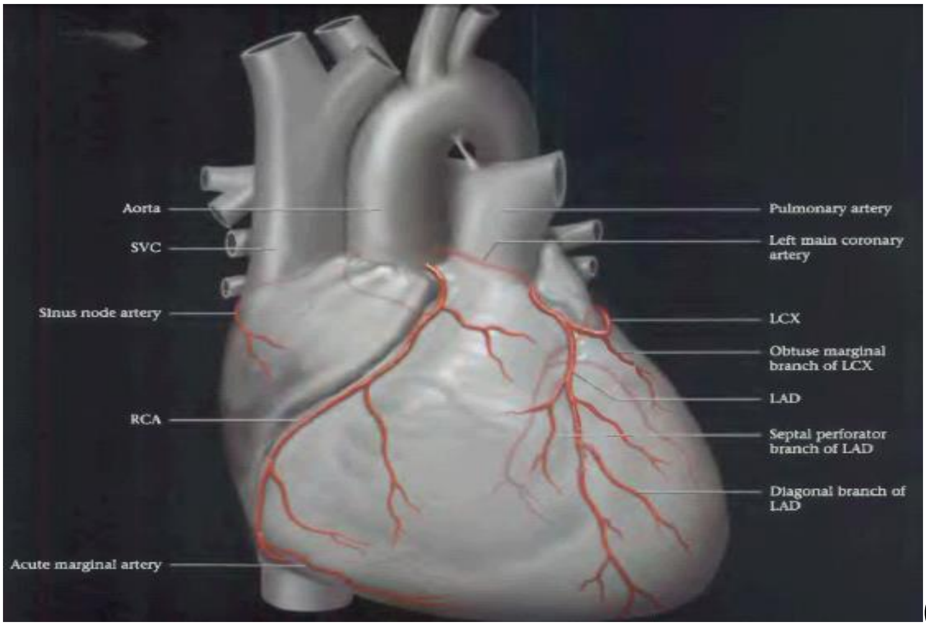
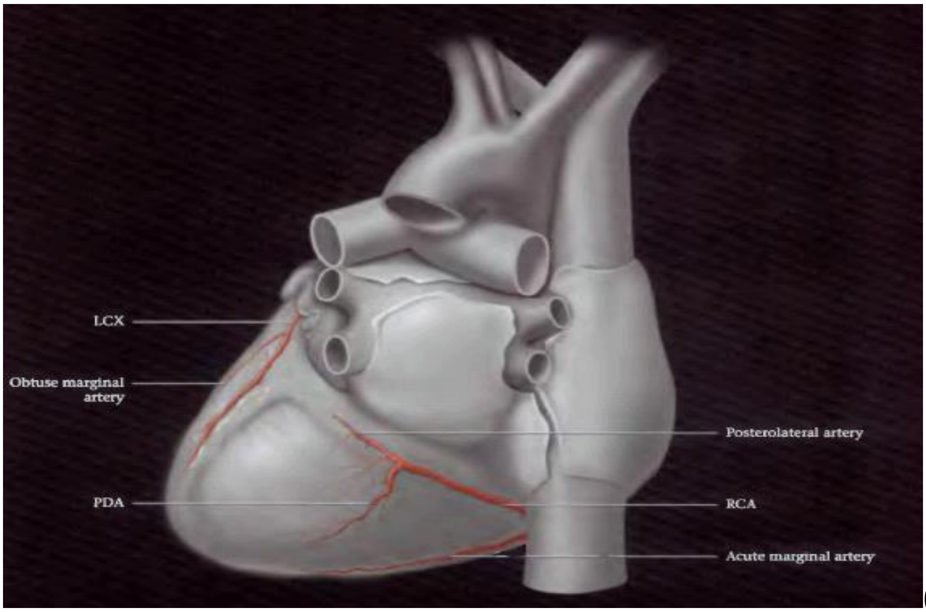
**Fig. (1.3).** Anterior View of Aortic Valve**. *(Drake el al., 2007).***

The main coronary artery segments run in the left and right atrioventricular grooves between the atria and ventricles, and then perpendicularly in the anterior and posterior interventricular grooves between the left and right ventricles . The coronary arteries and their side branches vary greatly in terms of their presence or absence and their size, shape, and length. (Figure 1.4). ***(Dewey and Kroft, 2009).***




(a)




(b)

**Fig. (1.4).** Anterior (a) and Posterior (b) Views of Coronary Arteries. ***(Shaaban, 2006).***

# LCA Anatomy

The LCA normally emerges from the left coronary sinus as the left main (LM) coronary artery . The LM coronary artery is short (5–10 mm), passes to the left of and posterior to the pulmonary trunk, and bifurcates into the left anterior descending (LAD) and LCx arteries . Occasionally, the LM coronary artery trifurcates into the LAD artery, the LCx artery, and the ramus intermedius artery. (Figures 1.5 & 1.6) ***(Kini et al., 2007).***

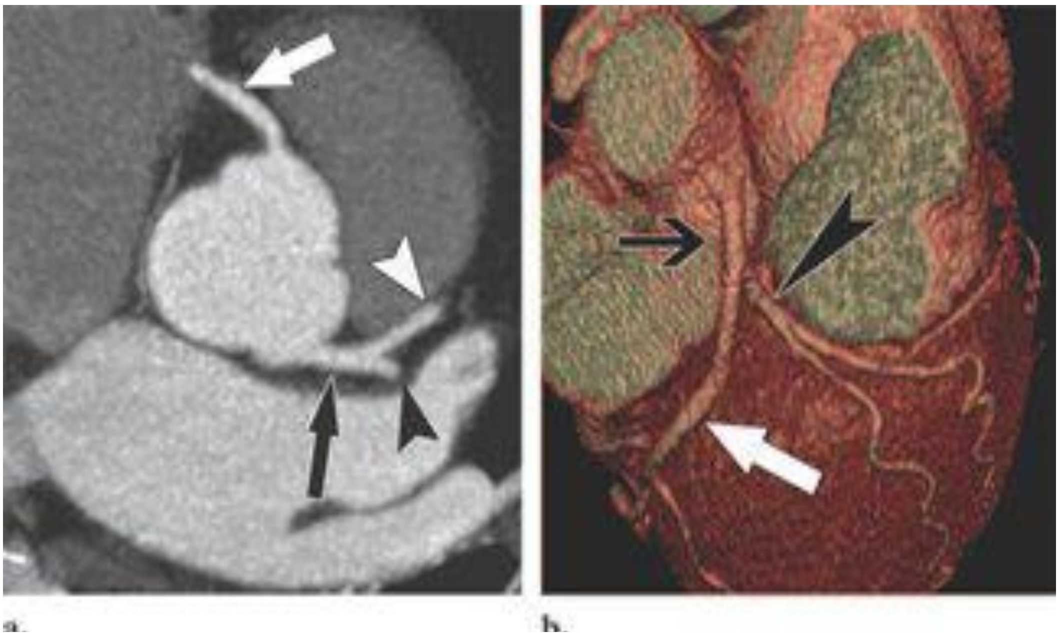



**Fig. (1.5).** (a) Axial MPR image displays the origin of the coronary arteries from the aorta. The LCA (black arrow) bifurcates into (LAD) artery (white arrowhead) and (LCx) artery (black arrowhead).White arrow indicates the right coronary artery (RCA). (b) VR image shows the LCA (black arrow) arising from the aorta and bifurcating into the proximal LCx artery (arrowhead) and the proximal LAD artery (white arrow).***(Brien et al., 2007)***.

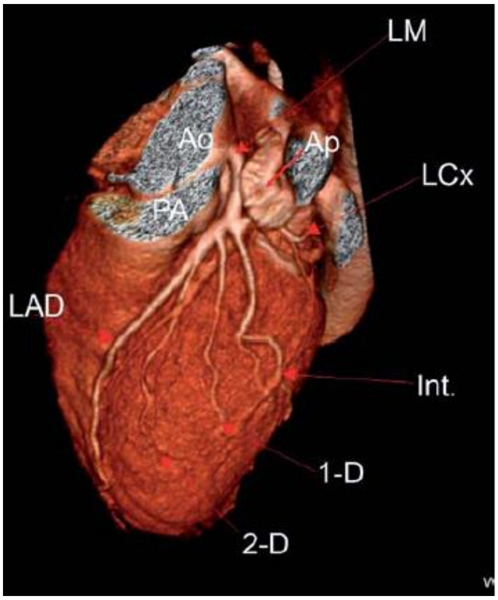



**Fig. (1.6).** Anatomical relationships of left main (LM) coronary artery. Ao: aorta; Ap: left atrial appendage; Int.: intermediate artery; LAD: left anterior descending; LCx: circumflex artery; PA: pulmonary artery; 1D and 2D: first and second diagonal branches of the LAD. ***(Petracca, 2006)*.**

# Left anterior descending (LAD):

The LAD runs on to the left of the pulmonary artery and continues in the anterior interventricular sulcus to the apex of the heart. (Figure 1.7) ***(Malagò et al., 2011)*.**

The LAD artery provides two main groups of branches: first, the septal branches, which supply the anterior two-thirds of the septum; and, second, the diagonal branches which lie on the lateral aspect of the left ventricle. ***(De Feyter and Krestin, 2008)*.**

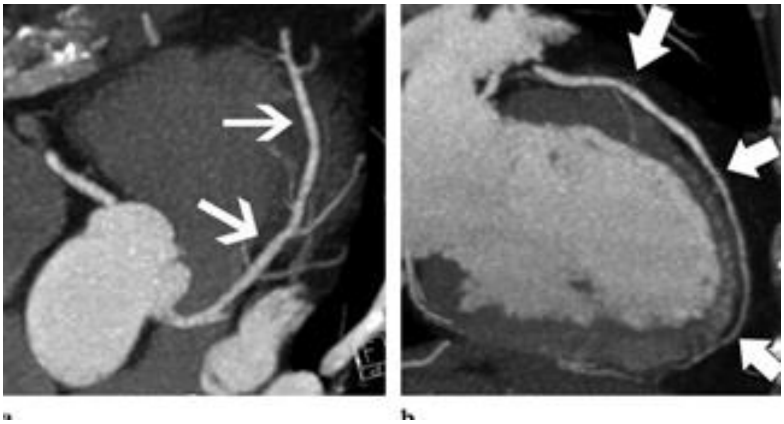



**Fig (1.7).** Oblique axial (a)and vertical long-axis (b)MPR images show the normal LAD artery (arrows) coursing in the interventricular groove toward the LV apex. ***(Brien et al., 2007).***

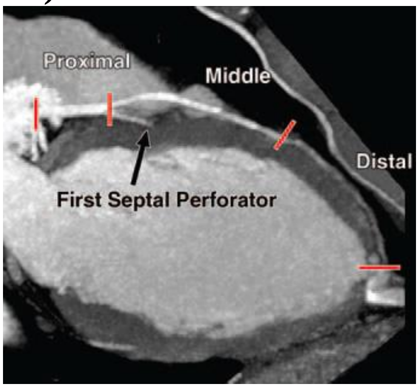



**Fig. (1.8).** Segmentation, shown by lines, of left anterior descending (LAD) artery. Oblique long-axis reformatted CT image shows lines dividing LAD artery into three segments. Proximal segment runs from origin of LAD to origin of first septal perforator. Middle segment runs from first septal perforator halfway to apex. Distal segment runs from this point to apex itself. ***(Young et al., 2011).***

The end of the LAD surrounding the apex of the heart and supply the lower portion of the left ventricle, except when the RCA is large and its distal branches reach the apex. As the normal variant of the left descending artery, the LAD can split in two main vessels, both running on the epicardial fat of the anterior interventricular septum (double LAD). ***(Malagò et al., 2011).***

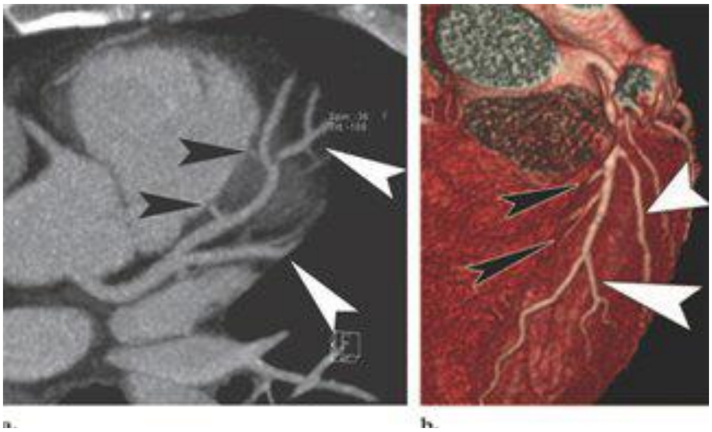


**Fig. (1.9).** Oblique axial MPR (a) and VR (b) images show the septal branches (black arrowheads) and diagonal branches (white arrow-heads) of the LAD artery. The septal branches quickly reach and penetrate the myocardium, whereas the diagonal branches course laterally to the LV free. ***(Brien et al., 2007).***

## The LAD gives some branches along its Course

### Left conal artery :

With an origin in the proximal LAD, it communicates with the right conal artery, with which it constitutes the "arterial ring of Vieussens," along with the *vasa vasorum* of the aorta and pulmonary artery. ***(Petracca, 2006)*.**

### Right anterior ventricular branches:

Usually irrelevant in number and diameter, as the right ventricle is almost exclusively irrigated through the right coronary artery. ***(Petracca, 2006)*.**

## <u>Left anterior ventricular branches</u>(diagonal arteries) :

Variable in number, these branches distribute diagonally over the anterior aspect of the left ventricle .The origin of the first diagonal artery is used as the anatomical point dividing the middle and distal segments of the LAD. Frequently, one of these diagonal arteries is particularly large and follows a course parallel to the LAD, from which it can be distinguished by the lack of septal branches and the presence of secondary small diagonal branches. In cases where this diagonal artery reaches the obtuse margin of the heart, and from there, the posterior aspect of the left ventricle, it is known as posterolateral artery. ***(Petracca, 2006)*****.**

## Anterior septal branches:

Variable in number, these branches arise orthogonally from the LAD and distribute into the anterior two thirds of the interventricular septum. The first septal branch is usually a well developed vessel , its origin being considered as the reference point dividing the proximal and middle portions of the LAD.(Figure 1.9). ***(Petracca, 2006)*****.**

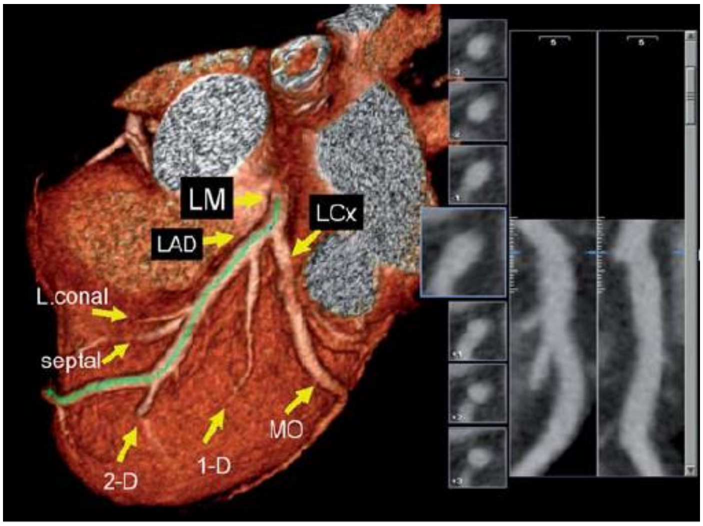



**Fig. (1.10).** Left coronary artery with its branches, as seen on a 3D (left) and a multiplanar reconstruction (MPR) of its proximal segment (right). LAD: left anterior descending; L. Conal: left conal branch; LCx: left circumflex; LM: left main; MO: marginal obtuse branch of the LCx; Septal: first septal anterior branch of the LAD; 1D and 2D: first and second diagonal branches of the LAD. ***(Petracca, 2006).***

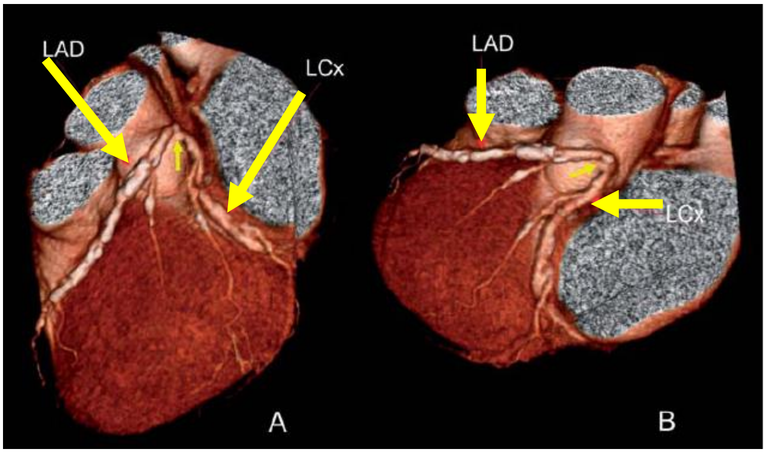



**Fig. (1.11).** Left oblique (A) and left lateral (B) views in a case of absent left main (LM) (small yellow arrow), with an independent origin of the (LAD) and (LCx) arteries.( large yellow arrows). ***(Petracca, 2006).***

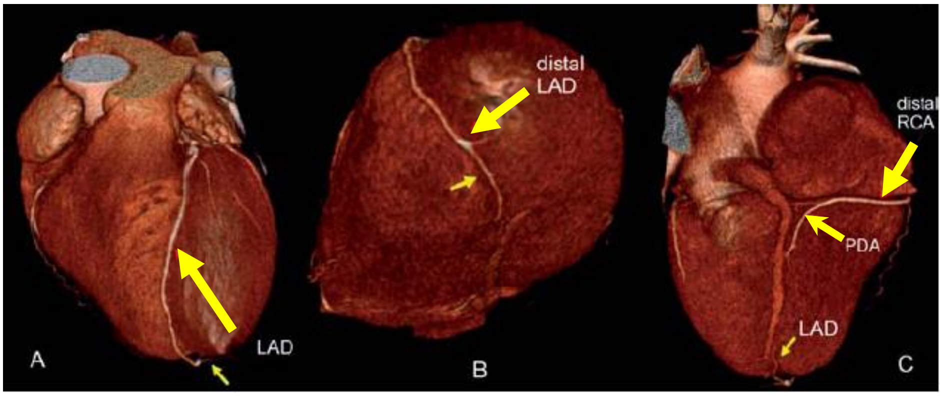



**Fig. (1.12).** Recurrent course of the distal segment of the left anterior descending (LAD) artery reaching the interventricular posterior groove. A: anterior view; B: apical view; C: posterior view. PDA: posterior descending artery ***(Petracca, 2006).***

# Left circumflex (LCx):

The LCX courses in the left atrioventricular groove, where the major side branches are the obtuse marginal branches (usually one to three are present) that supply the lateral free wall of the left ventricle. The left atrial circumflex branches that supply the lateral and posterior aspect of the left atrium also arise from the LCX. (Figure 1.13). ***(Dewey and Kroft, 2009)*.**