Introduction

CT atherosclerosis imaging is a major area of imaging research with CTA. By simultaneously assessing luminal stenosis and plaque burden, CTA allows the description of atherosclerotic disease patterns ***(Pundziute et al., 2007).***

Multi-slice CT coronary angiography is a rapidly developing noninvasive diagnostic technique that can be used to detect coronary stenosis ***(De Feyter, 2007).***

The technology advancement from 16- to 64-slice systems progressed in a relatively uniform fashion with improved craniocaudal volume coverage, decreased gantry rotation time, and smaller detector elements ***(Pugliese et al., 2008).***

Scanners with significant further increase in the number of detectors will allow imaging of the entire heart in one rotation, therefore obviating the need to move the patient table. A recent study describes the initial experience with such a 320-detector row CT system ***(Rybicki et al., 2008).***

The system has craniocaudal coverage of 16 cm in a single gantry rotation, which allows coronary imaging in a single heartbeat in a majority of patients. This eliminates potential artifacts at the transitions zone between gantry rotations, which are still seen with current state-of-the-art 64-slice systems. Coupled with prospective image acquisition, the radiation exposure appears to compare favorably to current CT systems ***(Husmann et al., 2008).***

Aim of the Work

To highlight the role of 320-Multidetector CT in the evaluation of coronary heart disease and its importance of being non invasive diagnostic technique.

Anatomy of the Coronary by Multi-Slice CT

An adequate knowledge of the anatomy of coronary arteries and its normal variants is an important point for the analysis of multidetector computed tomography images ***(Petracca, 2006)*.**

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 ***(Dewey, 2009)*.**

The coronary *ostia* are situated at the level of the sinotubular junction or slightly below it (56% of cases), followed by a high left orifice and a low right orifice or at the level of the junction (30% of individuals**)** (Fig. 1) ***(Petracca, 2006)*.**

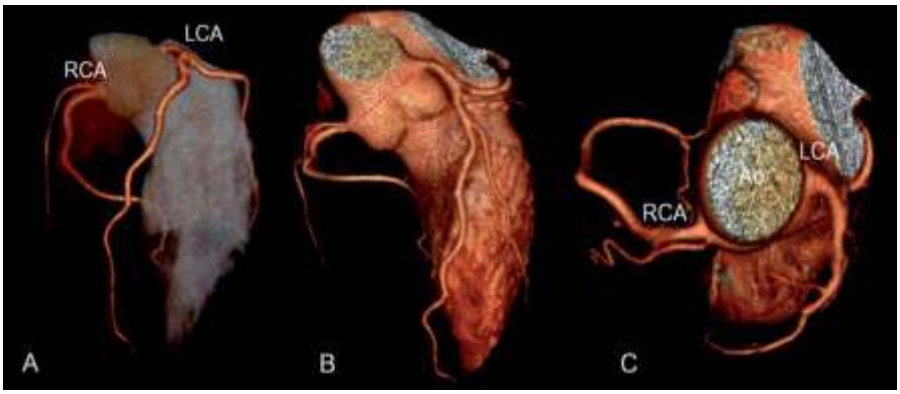

Figure (1): Origin of the coronary arteries as seen from frontal **(A and B)** and cranial **(C)** views: observe that the right coronary ostium is anterior and caudal with respect to the left one, while both are equidistant from the coaptation point of the aortic valve **(B panel)**. Ao: aorta; LCA: left coronary artery; RCA: right coronary artery ***(Petracca, 2006)***.

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 (Fig. 2). The coronary arteries and their side branches vary greatly in terms of their presence or absence and their size, shape, and length ***(Dewey, 2009)*.**

A. Right Coronary Artery (RCA):

The right coronary artery (RCA) arises from the aorta at the right sinus of Valsalva and courses in the right atrioventricular groove. Along its course, it first gives off the conus artery (in 50% of all individuals; in the other 50%, the conus artery arises directly from the aorta). It then gives off the sinoatrial node artery (in roughly 60%; in the remaining individuals, it arises from the left circumflex coronary artery [LCX]). Acute marginal branches arise from the mid-segment and posterior right ventricular branches from the distal segment ***(Dewey, 2009)*.**

In case of a right dominant circulation, the RCA gives rise to the posterior descending artery at or near the crux cordis (where the left and right atrioventricular groove and posterior interventricular groove join). The posterior descending artery courses in the posterior interventricular groove and the RCA gives rise to posterolateral artery branches as it continues in the left atrioventicular groove beyond the crux. The RCA supplies both the myocardium of the right atrium and ventricle and posterior portions of the left ventricle and interventricular septum ***(Dewey, 2009)*.**

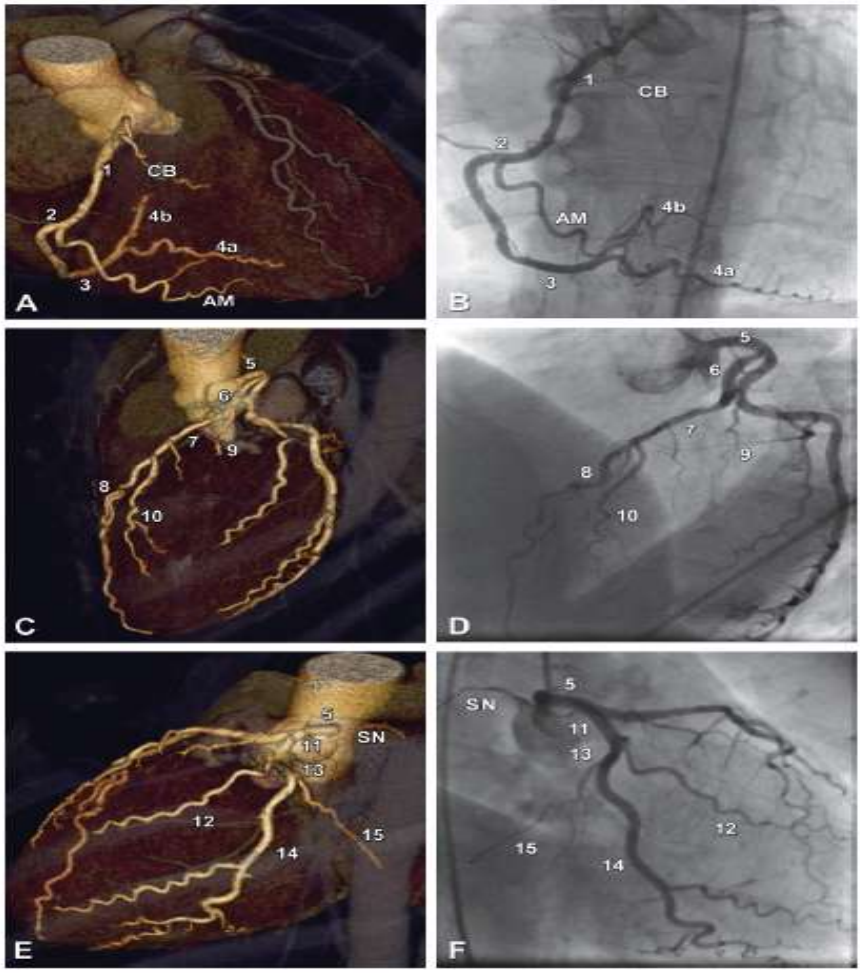

Figure (2): Direct comparison of segmental coronary artery anatomy, as depicted by multislice CT (*left panels*, three-dimensional reconstructions) and conventional coronary angiography (*right panels*). The RCA is shown in **Panels A** and **B**, and the left coronary artery with its two main branches – the left anterior descending and the left circumflex – in **Panels C–F**. The RCA (**Panels A** and **B**) is composed of segments 1–4, with the distal segment (4) being further subdivided into 4a (posterior descending artery) and 4b (right posterolateral branch). The left main coronary artery (**Panels C–F**) is referred to as segment 5, and the left anterior descending coronary artery (**Panels C** and **D**) is composed of segments 6–10, with the two diagonal branches being segments 9 and 10. The LCX (**Panels E** and **F**) is composed of segments 11–15, with the two (obtuse) marginal branches being segments 12 and 14. Note that the distal left circumflex (segment15) is rather small in this patient with a right-dominant coronary circulation. The sinus node artery (SN) is the first branch of the LCX in this patient (**Panels E** and **F**) but is more commonly one of the first branches of the RCA. *AM* acute marginal branch; *CB* conus branch ***(Dewey, 2009)*.**

Table (1): gives an overview of all coronary artery segment numbers and names:

Segment no.	Vessel name	Segment name
1	Right coronary artery (RCA)	Proximal right coronary
2		Mid right coronary
3		Distal right coronary
4a		Posterior descending artery[b]
4b		Right posterolateral branch[b]
5	Left main coronary artery (LM)	Left main coronary artery
6	Left anterior descending artery (LAD)	Proximal left anterior descending
7		Mid left anterior descending
8		Distal left anterior descending
9		First diagonal branch
10		Second diagonal branch
11	Left circumflex artery (LCX)	Proximal left circumflex
12		First (obtuse) marginal
13		Mid left circumflex
14		Second (obtuse) marginal
15		Distal left circumflex[b]
16	Ramus intermedius[c]	Ramus intermedius[c]

[a] This segmentation is based on the AHA segmentation published in 1975 by Austen et al.

[b] In case of RCA dominance, at least one right posterolateral branch (segment 4b) is present and supplies the inferolateral myocardial segments. If the left coronary artery is dominant, the distal LCX ends as the posterior descending coronary artery (segment 4a). In case of codominance, segment 4a is part of the RCA, and the distal left circumflex ends as a posterolateral branch after giving off two marginal branches

[c] A ramus intermedius (intermediate) branch is present in approximately 30% of patients

B. Left Coronary Artery:

The left main coronary artery (LM) arises from the aorta at the left sinus of Valsalva and has a length that varies from 0–15 mm. The LM usually bifurcates into the left anterior descending coronary artery (LAD) and LCX; however, in a third of the population, the LM ends as a trifurcation with an intermediate branch (IMB, also called ramus medianus) arising between the LAD and the LCX (Fig. 3). An IMB can be regarded as a diagonal branch or as an obtuse marginal branch, depending on its course along the left ventricle. In about 1% of the population, the LM is absent, and there are separate ostia for the LAD and LCX (Fig. 3) ***(Dewey, 2009)*.**

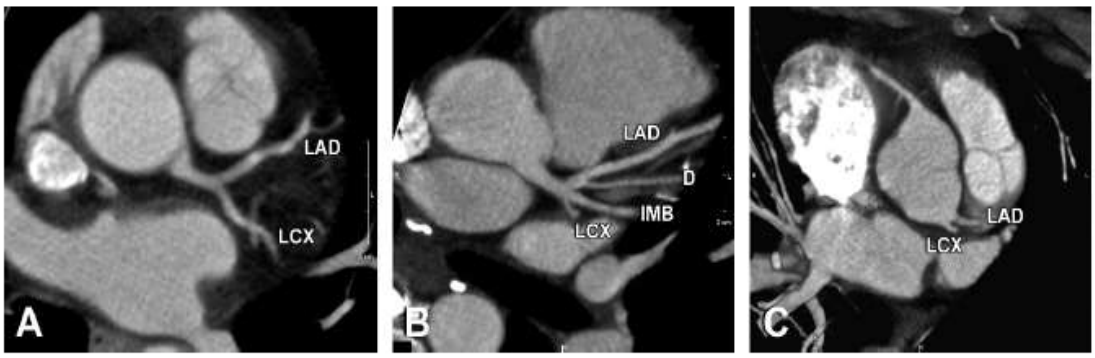

Figure (3): Different types of left main coronary artery bifurcation. Oblique transverse thin-slab maximum-intensity projection images. The left main coronary artery is shown bifurcating into the left anterior descending coronary artery (LAD) and LCX (**Panel A**), the left main with trifurcation into the LAD and the LCX, and in between an intermediate branch (IMB, **Panel B**). Note the high diagonal branch (D) from the LAD (**Panel B**). An absent left main coronary artery, with separate origins for the LAD and LCX (**Panel C**) ***(Dewey, 2009)*.**

- **Left anterior descending (LAD):**

The LAD courses in the anterior interventricular groove. The major branches of the LAD are the septal branches that pass downward into the interventricular septum and the diagonal branches (usually one to three are present) that pass over the anterolateral aspect of the heart. The LAD and its side branches supply the anterior as well as the anteroseptal and anterolateral left ventricular segments. The septal branches, in particular, serve as important collateral pathways ***(Dewey, 2009)*.**

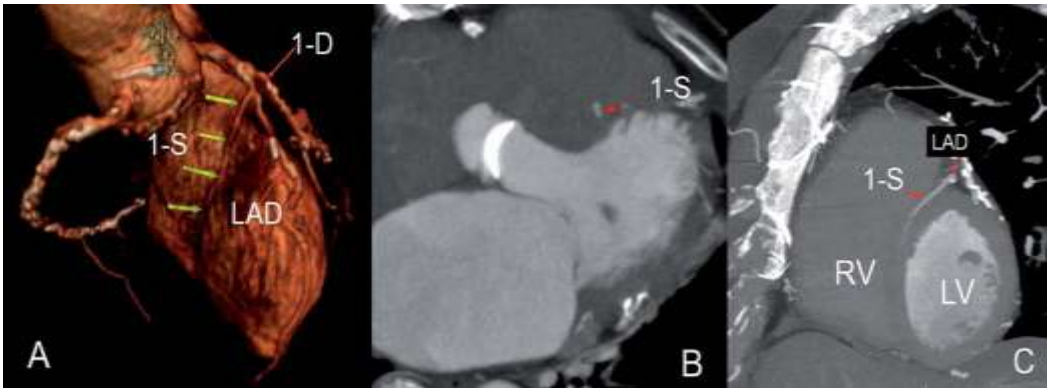

Figure (4): First septal branch (1-S) of the left anterior descending (LAD). **(A)** The weak contrast opacification of the right heart chambers allows the visualization of the course of 1-S through the interventricular septum; B and C: Maximal Intensity Projection (MIP) images showing transverse **(B)** and longitudinal **(C)** sections of 1-S into the septum; LV: left ventricle; RV: right ventricle***(Petracca, 2006)*.**

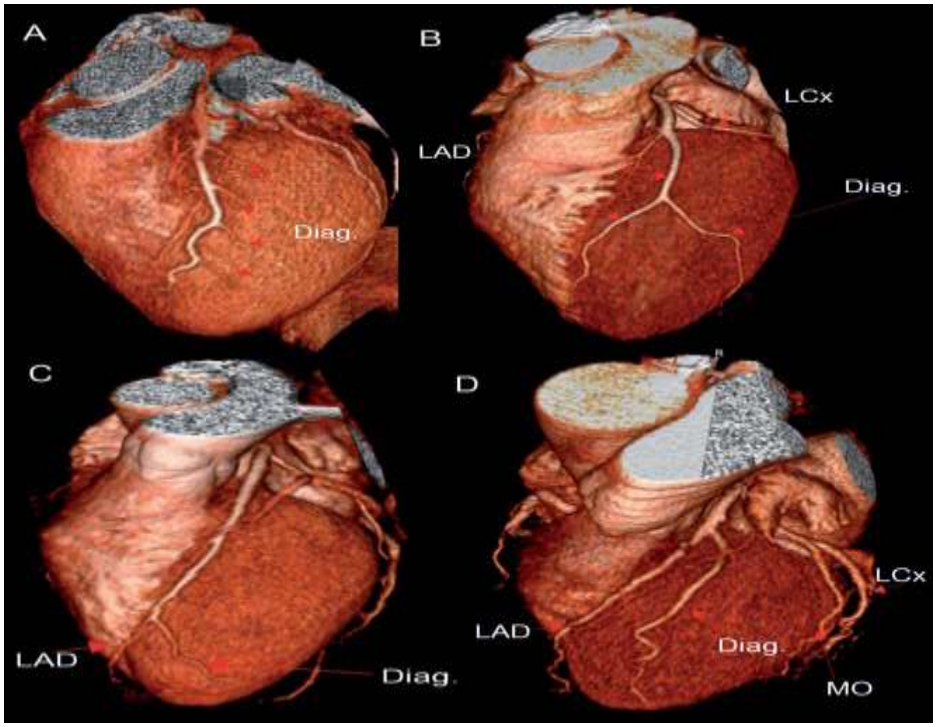

Figure (5): Normal anatomical variants of diagonal (Diag) branches. **(A)** Multiple small brief branches; **(B)** Single branch emerging from the middle left anterior descending (LAD); **(C)** Single branch emerging from the distal LAD; **(D)** Large vessel coursing parallel to the LAD; LCx: left circumflex; MO: marginal obtuse branch ***(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 ***(Dewey, 2009)*.**

The LCx gives origin to different branches during its course:

1. Anterior or anterolateral ventricular branches: when present, these small vessels (Figs. 7,8A) arise proximally and course parallel to the first diagonal artery. When this artery is absent, it is substituted by these branches ***(Petracca, 2006)***.

2. Sinusal or sinoatrial branch (Fig. 8): although usually arising from the right artery, the sinusal branch emerges from the proximal segment of the LCx in 30–35% of individuals, courses around the left atrium, and reaches the sinus node region at the superior vena cava drainage ***(Reig et al., 2003)***.

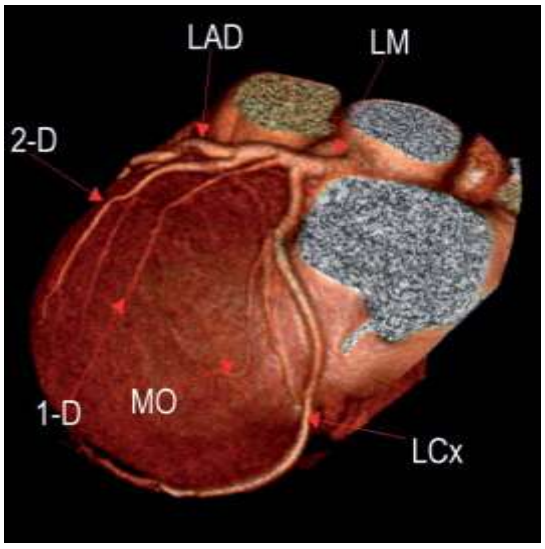

Figure (6): Left circumflex (LCx) artery ending at the (left) obtuse margin of the heart. LAD: left anterior descending; LM: left main; MO: marginal obtuse; 1D and 2D: first and second diagonal branches ***(Petracca, 2006)***.

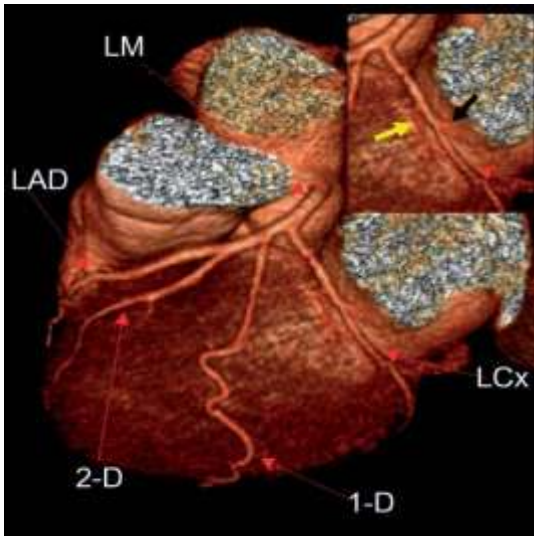

Figure (7): Left circumflex (LCx) artery, with a small anterolateral branch (yellow arrow) and an atrial branch (black arrow) (see inset at top right). LAD: left anterior descending; LM: left main; 1D and 2D: first and second diagonal branches ***(Petracca, 2006)*.**

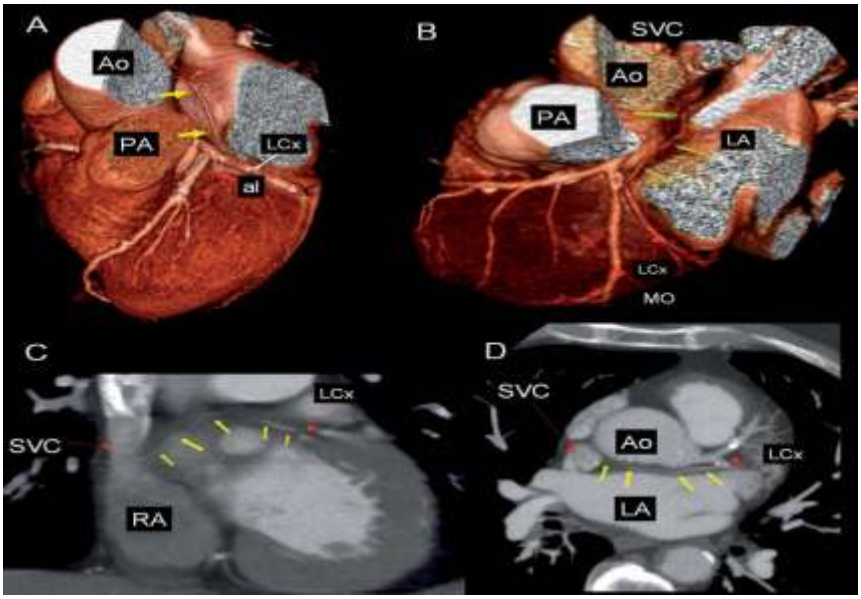

Figure (8): Left circumflex (LCx) artery. **(A)** Anterior view showing an anterolateral (al) branch (red arrow) and a sinus branch (yellow arrows); **(B)** Cranial view also displaying the sinus branch (yellow arrows); **(C)** MPR on an oblique view with volume render, and; **(D)** Axial slice with MIP, both showing the sinus branch of the LCx and its course towards the region of the superior vena cava (SVC); Ao: aorta; LA: left atrium; MO: marginal obtuse branch; PA: pulmonary artery; RA: right atrium ***(Petracca, 2006)***.

3. Atrial arteries (Fig.7): these small vessels are usually located beneath the base of the left atrial appendage or at the posterior aspect of the left atrium ***(Cavalcanti et al., 1995).***

4. Obtuse marginal branches (Fig. 9): usually one or two, their origin is used as a reference dividing the proximal and middle segments of the LCx. These branches are well-developed vessels emerging orthogonally from the LCx and coursing along the left margin of the heart until they reach the apex, where they can communicate with vessels from the LAD ***(Reig et al., 2003)***.

5. Posterior ventricular branches (Fig.9): although the posterior wall of the left ventricle is mostly irrigated by branches from the right PDA, when this vessel is absent, a variable number of these posterior ventricular branches together with a number of interventricular branches of the LCx are responsible for the blood supply to this region ***(Reig et al., 2003)***.

6. Atrioventricular nodal branch: it arises from the LCx in up to20% of subjects, particularly in cases of left dominance ***(Reig et al., 2003).***

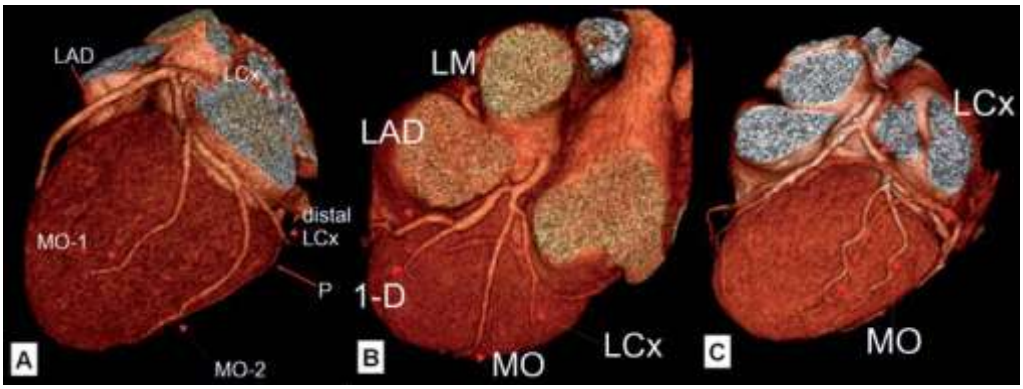

Figure (9): Anatomy of marginal obtuse (MO) branches. **(A)** Two MO branches are seen (1 and 2) and, also, a posterior branch irrigating the posterior aspect of the left ventricle; **(B)** Occasionally, only a single MO branch is present which arises early from the left circumflex (LCx) and is frequently larger than the LCx itself; **(C)** Bifurcated MO branch; LAD: left anterior descending; LM: left main; 1D: first diagonal ***(Pons et al, 2006)*.**

- **Intermediate coronary artery**

In a proportion of individuals, reported as between 25–40%, the LM divides into three branches; in addition to the LAD and the LCx, a third vessel is found, known as median or intermediate artery, arising from the vertex of the angle formed by the two former arteries (Fig. 10) ***(Reig et al., 2003)***.

Usually a large vessel, the intermediate artery runs over the antero-lateral aspect of the left ventricle, giving septal anterior branches (Fig.11) as well as to the anterior papillary muscle. The length of the vessel is variable, although frequently it ends near the obtuse left margin of the heart. Not rarely, however, it reaches the apex or even the inferior aspect of the left ventricle ***(Petracca, 2006)***.

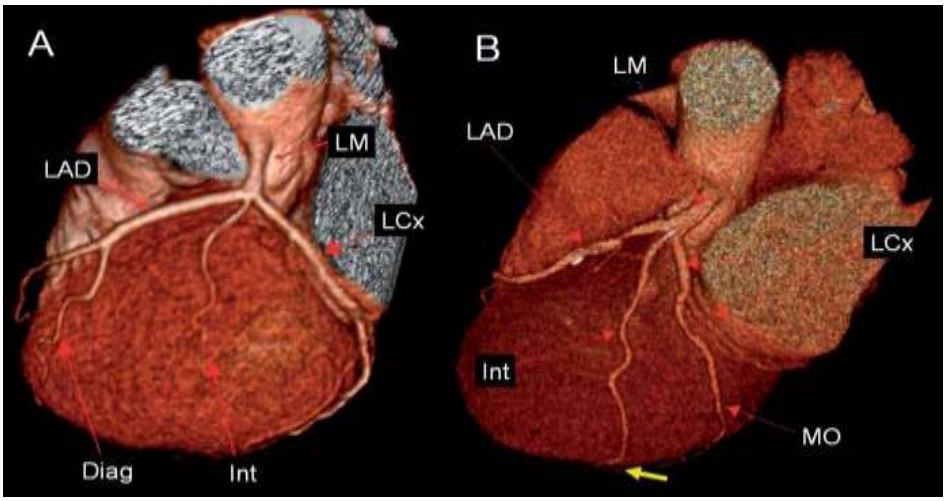

Figure (10): Intermediate (Int) coronary arteries from two different subjects: in case B, the vessel is large, reaching the left margin of the heart (yellow arrow). Diag: diagonal branch; LAD: left anterior descending; LCx: circumflex artery; LM: left main; MO: marginal obtuse branch ***(Petracca, 2006)*.**

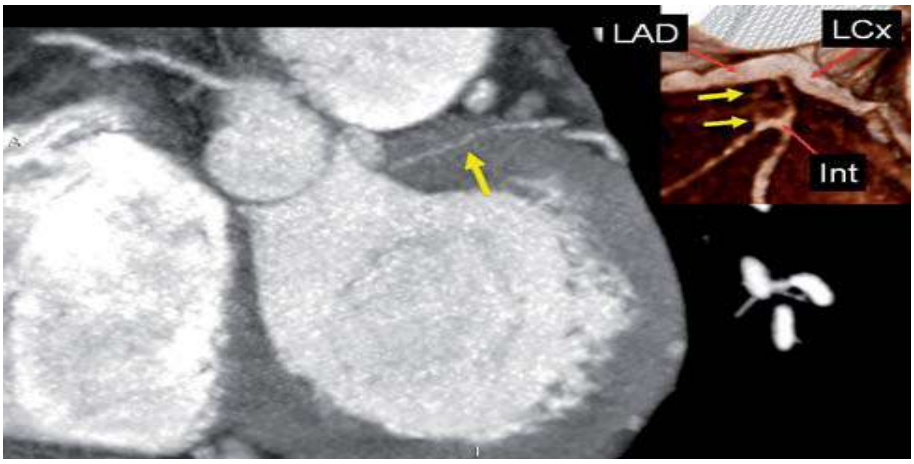

Figure (11): Example of septal branch originated from one of the bifurcating branches of an intermediate (Int) artery (yellow arrows, at the inset, top right) with an intramyocardial course through the anteroseptal wall (arrow on the large panel). LAD: left anterior descending; LCx: circumflex artery ***(Petracca, 2006)***.

In those cases with a largely developed intermediate artery, the diagonal and obtuse marginal arteries are, accordingly, smaller vessels ***(Pons et al, 2006)***.

Pattern of Dominance of the Coronary Arteries:

The circulation is right-dominant in about 60–85% of the population (the RCA gives rise to the posterior descending and at least one posterolateral branch). Left coronary dominance (the LCX gives rise to the posterior descending branch) is found in 7–20% of the population, whereas a balanced (or codominant) distribution is seen in 7–20% (the RCA gives rise to the posterior descending, and the LCX gives rise to posterolateral branches). In the case of a left-dominant circulation, the RCA is small and does not supply blood to the left ventricular myocardium. Recognizing the dominancy of the circulation is important, so as to avoid confusing this situation with branch occlusion (e.g., a short RCA in a left-dominant circulation (Fig. 12). Although it is the RCA that is typically dominant, it is usually the left coronary artery that supplies the major part of the left ventricular myocardium as well as the anterior and mid portions of the interventricular septum ***(Dewey, 2009)*.**