The Role of New Generations of MDCT in The Evaluation of Coronary Atherosclerosis

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By

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Abstract

Background: Multislice CT is a recent development in the spiral CT that allows ECG-gated complete coronary coverage in a reasonable time.

Objectives: To investigate the ability of new generations of MSCT coronary angiography, using the 64-slice CT scanners to detect high-grade coronary artery stenosis and occlusion and to evaluate the vascular conduits in patients with previous CABG operations.

Conclusion: CT angiography permits non-invasive coronary imaging, particularly at the proximal coronary segments. However, because of the limited temporal & spatial resolutions and the various artifacts associated with data creation & reformation, post-processing methods, and image interpretation, MSCT angiography is not ready to replace conventional coronary angiography at this time. In view of the high NPV, patients without significant CAD would be selected accurately at CT, and hence, avoiding the unnecessary invasive coronary angiography.

Key words: Coronary artery disease (CAD) – multislice computed tomography (MSCT) – Computed tomography angiography (CTA).

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Introduction

Coronary artery disease (CAD) remains a leading cause of death in Western nations. The standard of reference for diagnosis of CAD still is conventional coronary angiography. The greatest advantage of conventional angiography is the option of direct performance of interventions .However, only one-third of all conventional coronary angiographic examinations are performed in conjunction with an interventional procedure, while the rest are performed only for diagnostic purposes that is, only for verification of the presence and degree of CAD In the face of limited health care resources and in the interest of patients who undergo unnecessary invasive tests, a reliable noninvasive tool for imaging of the coronary arteries and for early diagnosis of CAD is highly desirable. **(Schoepf UJ et al 2004)**

The socioeconomic importance of heart disease provides considerable motivation for development of radiologic tools for noninvasive imaging of the coronary arteries. Current computed tomographic (CT) techniques combine high speed and spatial resolution with sophisticated electrocardiographic synchronization and robustness of use. Application of these modalities for evaluation of coronary artery disease is a topic of active current research.**(Schoepf UJ et al 2004)**

Recent insights into the patho-physiology of atherosclerotic CAD suggest that wall structure of the coronary arteries have a crucial role in these disorders. Since coronary angiography depicts only the intra-luminal morphology but not the wall, much research effort has been focused on other imaging modalities (including the MSCT) that, unlike conventional angiography, enable assessment of the vessel wall abnormalities. **(Heuschmid M et al 2002)**

Imaging of the heart has always been technically challenging because of the heart's continuous motion. The development of electrocardiographically (ECG) synchronized multidetector CT scanning and reconstruction techniques has yielded fast volume coverage and high spatial and temporal resolution as prerequisites for successful cardiac imaging. **(Schoepf UJ et al 2007)**

Aim of the work

The aim of this work is to describe the role of new generations of MDCT as a non-invasive imaging tool for morphological assessment of the coronary arterial tree in cases with coronary atherosclerosis including evaluation of patients after stent application and with previous CABG operation . A number of representative case was included

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List of Abbreviations

3 D & 4 D	Three and four dimensional
AHA	American heart association
ASA	Acetyl Salicylic Acid (Asprin)
ASE	Agatston score equivalent
bpm	Beat per minute
CABG	Coronary artery bypass graft
CAD	Coronary artery disease
CNR	Contrast-to-noise ratio
CT	Computed tomography
CTA	Computed tomographic angiography
CTCA	Computed tomographic coronary angiography
DSCT	Dual source computed tomography
EBCT	Electron beam computed tomography
ECG	Electrocardiogram
FOV	Field of view
GCV	Great cardiac vein
HR	Heart rate
HU	Hounsfield units
IVUS	Intra-vascular ultrasound
LAD	Left anterior descending artery
LCX	Left circumflex artery
LIMA	Left internal mammary artery
LMT	Left main (coronary) trunk
MRA	Magnetic resonance angiography
MRI	Magnetic resonance imaging
msec	Millisecond
mSv	Milliseiver (unit for radiation measurement)
NPV	Negative predictive value
PCI	Per-cutaneous intervention
PDA	Posterior descending artery
PE	Pulmonary embolism
PET	Positron emission tomography
PL	Postero-lateral artery
PPV	Positive predictive value
RIMA	Right internal mammary artery
SNR	Signal-to-noise ratio
SVC	Superior vena cava
TECAB	Totally endoscopic coronary artery bypass

Review of literature

Anatomy of the coronary arteries

Gross anatomy :

The human heart normally has two coronary arteries named after the location of their main branches in the coronary sulcus. The right and left coronary arteries issue from the ascending aorta in its anterior and left posterior sinuses respectively **(Figure 1)**. Functionally; the coronaries are terminal arteries, which mean that their acute occlusion results in necrosis of their myocardial supply areas. **(Rodenwaldt J 2003)**

Left Coronary Artery

The left coronary artery is larger in caliber, supplying a greater volume of the myocardium . The initial stem of the left main trunk (LMT) extending between its ostium in the left posterior aortic sinus and its bifurcation, varies in length from few millimeters to few centimeters. It lies between the pulmonary trunk and the left auricular appendage, reaching the left atrio-ventricular sulcus, the LMT divides into two main arteries:

- The anterior inter-ventricular (descending) artery (LAD) .
- The left circumflex artery (LCx) **(Gray ,2002)**.

- **The left anterior descending artery**

Also named as **anterior inter-ventricular artery** is considered as the direct continuation of the LMT. It descends obliquely forward and to the left in the anterior inter-ventricular sulcus. It reaches the apex, terminating there in one third of hearts, but more often turning around the apex into the posterior inter-ventricular sulcus, in which it traverses a third to half of its length to meet the terminal twigs of the posterior descending artery (PDA). The LAD supplies right and left anterior ventricular and anterior septal remi. **(Gray ,2002)**

The right ventricular remi are few and small as the right ventricle being supplied almost totally by the RCA. From two to nine large **left anterior ventricular remi (diagonal arteries)** arises at acute angles from the anterior inter-ventricular artery to cross diagonally the left ventricular anterior aspect, the large

terminals may reach the left border of the heart. One is often large and may arise separately from the LMT which then ends by trifurcation. **The anterior septal remi** leave the LAD almost perpendicularly, passing down in the septum, of which they usually supply about the ventral two thirds. **(Gray ,2002)**

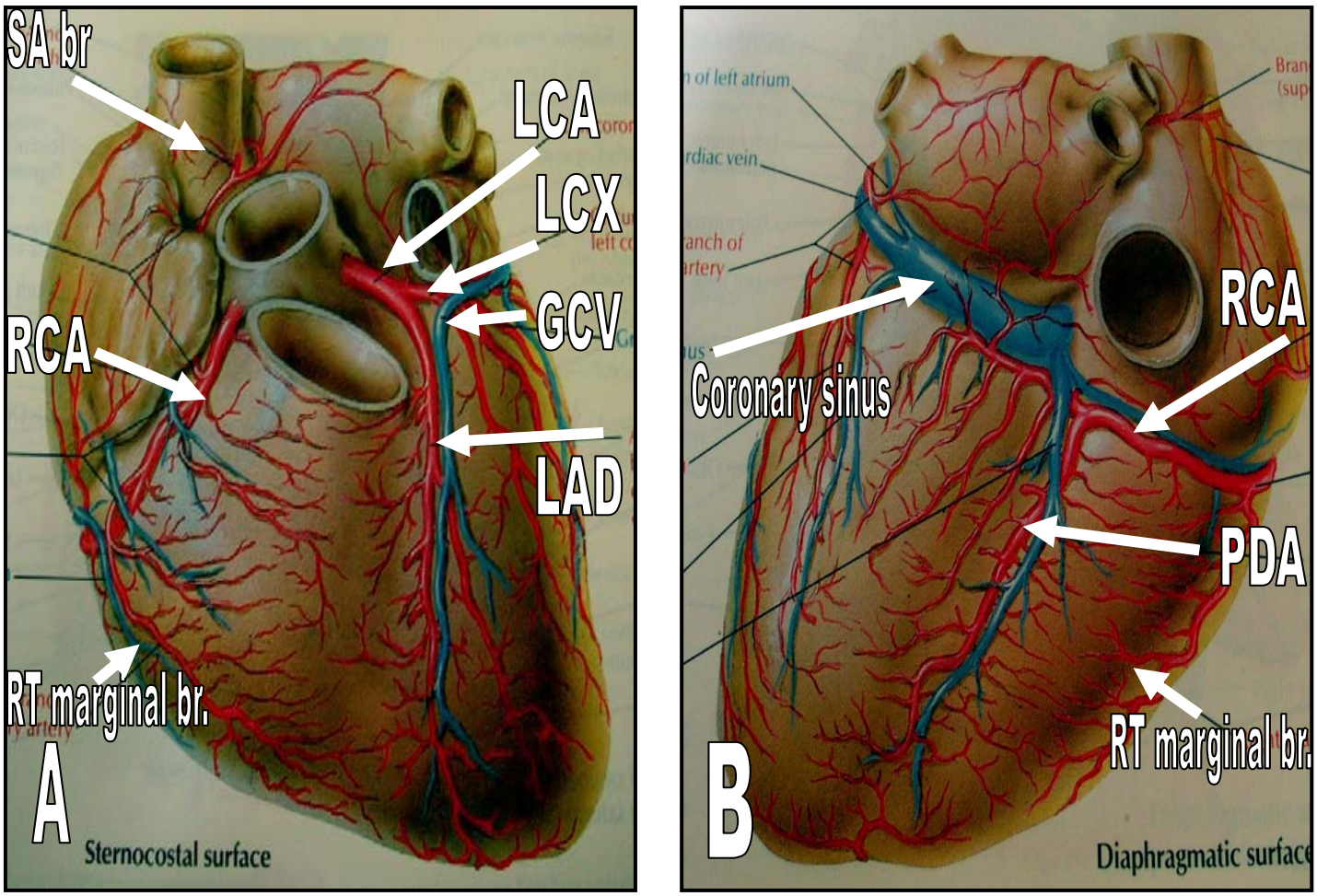

Figure (1) ; Illustrated colored plate showing the coronary arteries and veins
A: Viewed on the sterno-costal surface of the heart.
B: Viewed on the diaphragmatic surface of the heart .

- **The left circumflex artery (LCX)**

Is the second branch of the left coronary artery. It curves to the left in the atrio-ventricular sulcus, continuing around the left cardiac border into the posterior part of the sulcus and ending left to the crux. In about 90% of cases, one or multiple large

branches, known as the **left (obtuse) marginal arteries**, arise perpendicularly from the LCX to ramify over the lateral "obtuse" margin, supplying much of the adjacent wall of the left ventricle, usually down to the apex. Smaller anterior and posterior remi of the circumflex artery also supply the left ventricle. Atrial remi from the circumflex artery supply the left atrium.**(Gray ,2002)**.

Right coronary artery (RCA)

The RCA arises from the right coronary sinus of the aorta. It runs rightward posterior to the pulmonary outflow tract and then inferiorly in the right atrioventricular groove toward the posterior interventricular septum. The first branch of the RCA is the conus artery. It arises from the RCA or has a separate origin directly from the right coronary sinus. The sinus node artery also arises from the proximal RCA in 60% of individuals within a few millimeters of the RCA origin and runs superiorly and posteriorly . In the remaining cases, it arises from the proximal LCX artery. Next, several anterior branches supply the free wall of the right ventricle. The branch to the right ventricle at the junction of the mid- and distal RCA is called the acute marginal The distal RCA divides into the PDA and the posterior left ventricular branches. The PDA runs in the posterior interventricular groove. If the LAD artery, which usually supplies the apex of the heart, is small, the PDA can extend around the apex to supply one-third of the anterior interventricular septum **(Pannu HK,et al 2003)**

Right dominant circulation:

The RCA gives rise to the conus branch (which supplies the right ventricular outflow tract) and one or more acute atrial and ventricular remi, whether or not the circulation is right-dominant. In the 85% of patients who have a right dominant circulation, it goes on to form the AV nodal artery, the PDA, and the PL left ventricular branches which supply the inferior surface of the left ventricle and inter-ventricular septum.

Regardless of whether the patient is right – or left-dominant, the artery to the sinus node originates as a proximal branch of the RCA in 65% of patients and as a left atrial branch of the LCX in the remaining 35% of patients. **(Grossman, 2000). (Figure 2-C)**