

**THE ROLE OF 64 - MULTI-DETECTOR
COMPUTED TOMOGRAPHY SCANNERS
IN EVALUATION OF
CORONARY ARTERY STENTS**

Essay

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By

Ahmed Samir Hamed

M.B., B.Ch.

Faculty of Medicine Cairo University

Supervised By

Prof. Dr. WAHID TANTAWY

Professor of Radio-diagnosis

Faculty of Medicine

Ain Shams University

Dr AHMED SAMIR IBRAHIM

Associate Professor of Radio-diagnosis

Faculty of Medicine

Ain Shams University

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LIST OF ABBREVIATIONS

| | |
|------|---|
| ACS | Acute Coronary Syndrome |
| AEC | Automatic Exposure Control |
| AM | Acute Marginal branch |
| AMI | Acute Myocardial Infarction |
| BMS | Bare Metal Stent |
| CABG | Coronary Artery Bypass Graft |
| CAD | Coronary Artery Disease |
| CHD | Congenital Heart Disease |
| CHF | Congestive Heart Failure |
| CF | Conversion Factor |
| CS | Coronary Sinus |
| CTA | Computed Tomography Angiography |
| CTDI | Computed tomography does index |
| DES | Drug-Eluting Stents |
| DLP | Dose Length Product |
| ECG | Electro-Cardiogram |
| EDRF | Endothelial derived relaxing factor |
| GCV | Great Cardiac Vein |
| ISR | Instant restenosis |
| IVUS | Intra Vascular Ultrasound |
| LAD | Left Anterior Descending Artery |
| LCA | Left Coronary Artery |
| LCx | Left Circumflex artery |
| LMT | Left Main Trunk |
| LV | Left Ventricle |
| MDCT | Multi-Detector Computed Tomography |
| MSCT | Multi-Slice Computed Tomography |
| MPR | Multipanar Reconstruction |
| MIP | Maximal Intensity Projection |
| MITI | Myocardial Infarction Triage and Intervention |
| OM | Obtuse Marginal |

ABBREVIATIONS

| | |
|-------|--|
| PDA | Posterior descending artery |
| PDAY | Pathobiologic Determinants of Atherosclerosis in Youth |
| PLA | Posterolateral artery |
| PTCA | Percutaneous Transluminal Coronary Angioplasty |
| QCA | Quantitative Coronary Analysis |
| RBS | Random Blood Sugar |
| RCA | Right Coronary Artery |
| RI | Ramus Intermedius artery |
| RV | Right Ventricle |
| SCAD | Spontaneous Coronary Artery Dissection |
| SFOV | Scan Field Of View |
| STEMI | ST-elevation myocardial infarction |
| SVG | Saphenous vein graft |
| TCFA | Thin Fibrous Cap Atheroma |
| TR | Temporal resolution |
| VR | Volume Rendering |

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CHAPTER *1*

INTRODUCTION TO **CORONARY CT** **ANGIOGRAPHY**

Computed tomography angiography (CTA) of the coronary arteries is a very quick and the most advanced imaging technique. Using a Multislice imaging approach together with specialized and dedicated software, CTA “freezes” cardiac movement thereby acquiring static images of the rapidly moving heart. In addition, the same approach produces contrast agent enhanced images of the coronary arteries, by employing a three dimensional technique with high spatial and temporal resolution. (*Pavone et al., 2009*).

The advent of multislice computed tomography was a quantum leap for CT technology. When this technical innovation was first introduced, the radiological community was faced with the task of putting its advantages to use for diagnostic patient management and optimizing its clinical applications. One of the major clinical challenges was to develop this new tool for noninvasive cardiac imaging applications ranging from coronary angiography, to ventricular function analysis, to cardiac valve evaluation. (*Hamm et al., 2009*).

The primary advantage of CT was the ability to obtain thin cross-sectional axial images, with improved spatial resolution over echocardiography, nuclear medicine, and magnetic resonance imaging. This imaging avoided superposition of three-dimensional (3-D) structures onto a planar 2-D representation, as is the problem with conventional projection X-ray (fluoroscopy). The increased contrast resolution of CT is the reason for its increase in sensitivity for atherosclerosis and coronary artery disease (CAD). (*Budoff et al., 2006*).

CHAPTER 2

PHYSICS OF 64-MDCT SCANNERS

CARDIAC CT

The aim of cardiac CT is to provide images of the heart that are free of motion artifacts and that correspond to a specified motion phase. Only then can applications such as coronary CT angiography or coronary calcification quantification be carried out reliably and guarantee reproducible results. To achieve this goal one must be able to synchronize data acquisition and/or image reconstruction with the cardiac motion and must achieve a fairly high temporal resolution.

Synchronization is typically done using the patient ECG signal that is recorded simultaneously with CT data acquisition. Alternative approaches that derive the motion signal directly from the patient raw data or from a set of reconstructed images are in use, too.

Typical heart rates lie in the range from 40 bpm to 120 bpm and correspond to a duration of the heart cycle between 0.5 s and 1.5 s.

To avoid blurring due to heart motion it is desired to have no more than 10% of the motion cycle show up in the reconstructed images and the temporal resolution should be in the order of 50 ms to 150 ms, depending on the heart rate. Since this cannot always be achieved, high heart rates (above 70 bpm) are frequently avoided by using premedication with beta blockers. (*Kachelrieß et al., 2007*).

FROM CONVENTIONAL TO SPIRAL CT SCANNERS

Hounsfield's first-generation scanner used a translate/rotate technology. In this methodology, an X-ray source moving laterally activated a series of single detectors before moving to another position and repeating the process. This translate/rotate process was repeated

until the entire circumference of the patient was scanned. Scan times of 4.5 min per image were required. (*Stanford et al., 2005*).

The next step was the introduction of spiral systems, in which the tube is able to move freely in the track contained in the gantry and does not return to its initial position after each rotation. In these machines, introduced in the early 1990s, the electrical power that supplies the X-ray tube is transmitted along the same rotational track, thus avoiding both the need for long cables and a return to the start position after each rotation. “Spiral” refers to the fact that, once a continuous rotation of the tube around the patient is started, movement of the bed along the longitudinal axis creates a spiral acquisition of images along the human body instead of the axial images acquired in conventional CT. There is dramatic improvement of image quality with spiral CT in terms of speed of data acquisition and the consistency of the diagnostic information. This is due to the fact that images are not acquired on a single imaging plane X-ray absorption (axial); rather, data representative of an entire volume are reconstructed on the axial, coronal, sagittal, and curved planes of the target organ. The information provided by these three-dimensional images facilitates diagnostic evaluation of the internal organs of the human body. Moreover, the development of spiral CT has allowed the development of other techniques, such as virtual endoscopy and CTA, which nowadays are routine tools in clinical practice. (*Pavone et al., 2009*).