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

Essay
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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	Instent 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	Multiplanar Reconstruction
MIP	Maximal Intensity Projection
MITI	Myocardial Infarction Triage and Intervention
OM	Obtuse Marginal

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. ***(Kachelrieb 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, sagital, 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).***