NOTES

There are several requirements for successful coronary CT angiography.

Temporal resolution (Speed with which we can capture the picture) must be very high in order to minimize motion artifacts. We achieve that with a fast gantry rotation. Spatial resolution (what is the smallest structure that we can clearly see) must also be high enough to accurately depict the coronary anatomy. We achieve that with thin collimation. Coverage must be fast and continuous so that we can image the entire heart in 1 comfortable patient breath-hold. We achieve that with multi slice CT. Imaging must be synchronized to the heartbeat, so that we can acquire data during a consistent cardiac phase. We achieve that with electrocardiographic (ECG) gating.

Advances in CT technology have markedly improved temporal resolution. Sixty-four-slice CT scanners now have a temporal resolution of approximately 165 msec. Still, conventional cardiac angiography is better yet, with a temporal resolution of about 20 msec.

The spatial resolution of today's multislice CT scanners is approaching that of conventional angiography. A 64-slice scanner has an isotropic spatial resolution of 0.4 mm, whereas conventional angiography has a spatial resolution of 0.2 mm.

There are many advantages to coronary CT angiography. It is noninvasive, it provides both intra- and extraluminal information about the coronary arteries, and it provides information about myocardial function. Disadvantages include its high radiation dose, the need for intravenous contrast administration, and the frequent need for beta-blockers to slow the heart rate to <65 bpm. Contraindications to coronary CT angiography include the inability to receive intravenous contrast material, pregnancy and cardiac arrhythmias. Relative contraindications include highly calcified coronary arteries and a high heart rate. In general, the higher the heart rate, the worse the image quality.

ECG TRIGGERING AND GATING

Because of the limitations of current helical mechanical CT, one needs a method to extract the coronary images that are the most diastolic and motionless from a series of complete cardiac cycles. Two methods in use are echocardiographic (ECG) triggering and ECG gating. Using ECG triggering, the scanner acquires data only for a defined period after the signal from the R wave of the ECG trace. This is applied to a nonhelical, translational “step and shoot” scan technique, and an image is acquired every second heartbeat to allow table translation between image generation. Using ECG gating, the scanner acquires data in a nonstop, helical mode while an independent ECG trace is generated at the same time. Images are thus acquired both during systole and diastole. Subsequently, the ECG trace is mapped alongside the acquired image data so that one can deduce the systolic and diastolic images.

To summarize, ECG triggering uses the ECG to acquire data and is prospective, while ECG gating is used to reconstruct data and is retrospective. Also, ECG triggering may be used for coronary calcification scoring and aortic root imaging, whereas ECG gating is required for coronary artery CTA.

CTA

First, it is important to appreciate which patients should not have coronary artery CTA. Conventional coronary angiography remains the standard of care for coronary artery evaluation. Time is critical for those presenting with a threat to myocardial viability. Patients presenting with a high pretest probability of unstable disease should still go on to conventional imaging in cases in which catheter-directed therapeutic intervention is highly likely or if emergent surgical intervention is anticipated. Patients who have a coronary calcification study that reveals a large burden of disease should be reconsidered for CTA, as the ability to accurately and comprehensively detect and quantify all stenoses may be limited. Coronary MDCT is a reasonable test to evaluate stenoses in those with a low to moderate pretest probability of disease where the negative-predictive value of the study is very high. CTA is ideal test for assessing total plaque burden. It has also been shown to be of value in depicting aberrant coronary artery anatomy by accurately defining their site of origin, size, and course. Such vessels often defy definition by conventional projectional technique. It is of proven value in evaluating the patency of bypass grafts, which are relatively motionless vessels and can be imaged with ease, although one should note that we are limited in evaluating the anastomosis and small-vessel disease beyond the anastomosis. A CTA luminogram does not provide information
on flow dynamics and usually cannot reveal collateral formation. Its use in establishing coronary stent patency is limited and has been limited by beam hardening in its sensitivity to early restenosis.5

**POTENTIAL INDICATIONS FOR CVCTA**


**AVERAGE HOUNSFIELD MEASUREMENTS FOR TISSUE CHARACTERIZATION**

Atheroma (soft plaque) +20 to +130
Calcified plaque: +130 to +200
Contrast: +130 to +300
Thrombus, soft and tissue: +50
Blood: +30
Water: -20 to +20
Beam hardening artifact: -50
Fat: -80 to -100
Air: -1000.

**CTA VIEWING TECHNIQUES:**

3D volume rendering: To get a global and gross view of the cardiac structures. MIP (Maximum Intensity Projection): Usually 5.0 mm thick slices and hence easy to navigate the vessels. MPR (Multi planar reconstruction): Thinner slices, usually 0.75 mm. Hence ideal to analyze the lesions in multiple planes because of isotropic voxels.

**CHOOSE ONE BEST ANSWER:**

1. CTA technology is available now for clinical utility because of all the following except:
   a. Improved temporal resolution
   b. New generation scanners can deliver high photon energy (kv)
   c. Improved spatial resolution
   d. ECG gating.

2. CTA is valuable tool to identify all except:
   a. coronary artery anomalies.
   b. coronary arteries less than 0.5 mm diameter
   c. Atheroscloric plaque burden.
   d. Pericardial cyst.

3. Hemodynamically significant anomalies, which might cause myocardial perfusion defects Are listed below except one:
   a. coronary arising from pulmonary artery.
   b. Inter arterial course (Between PA & AO)
   c. single coronary artery.
   d. coronary artery fistula.

4. Radiation dose of selected exposure (in msv): all are true except one
   a. chest x-ray: 0.02
   b. conventional coronary angiogram: 4.0
   c. 64 slice CTA: 20.0
   d. Dual isotope stress nuclear scan: 17.0

**CHOOSE THE CORRECT ANSWER. (MORE THAN ONE CAN BE CORRECT FOR EACH QUESTION)**

5. When compared to prospective ECG triggering, the retrospective ECG gating:
   a. Has lower radiation exposure.
   b. Has true spiral data acquisition.
   c. Allows flexibility to choose reconstruction window to avoid motion artifacts.
   d. Requires longer breath hold.

6. Which patient characteristics are less suitable for CTA
   a. Patients with low heart rate (60 per minute)
   b. Irregular rhythm.
   c. High Calcium burden.
   d. Congestive heart failure.

7. Current multislice CT technology allows :
   a. Accurate evaluation of L.V.function.
   b. Accurate measurement of degree of stenosis.
   c. Assessment of vulnerable plaque characteristics, like thin cap atheroma.
d. Evaluation of plaque tissue component and classify into soft, fibrous and calcific.

ANSWER KEY

1. b
2. b
3. c
4. c
5. b,c
6. b,c,d
7. a,d